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Apêndice I

Como Modelar em LawML com a Ferramenta CASE

Este apêndice apresenta informações importantes da ferramenta CASE usada para a especificação da lei. O desenvolvedor de leis deve seguir cuidadosamente as orientações desse apêndice para garantir a transformação correta pela ferramenta *LawGenerator*.

Para especificar a lei de interação na ferramenta, deve-se importar o modelo conceitual¹⁴ do Diagrama de Instâncias de Elementos de Lei (DIEL) da LawML, que contém as classes relativas aos elementos de lei que serão instanciadas nos diagramas de objetos, relacionados aos diagramas de instâncias.

Dentro da aplicação, o desenvolvedor de leis deve clicar no menu “File > Import> XML” e selecionar o arquivo XML¹⁵ que contém o modelo conceitual do DIEL. Trata-se de um *template*, um ponto de partida para a especificação de leis em LawML. Após realizar a importação, o desenvolvedor de leis deve “salvar como um novo projeto”, para evitar a edição direta sobre o *template*. Veja a tela da aplicação (Figura I-1) com o novo projeto que contém apenas o modelo conceitual.

¹⁴ Veja as Figuras 4-1 e 4-2.

¹⁵ O arquivo pode ser obtido em http://wiki.les.inf.puc-rio.br/index.php/Ricardo_Gralhoz

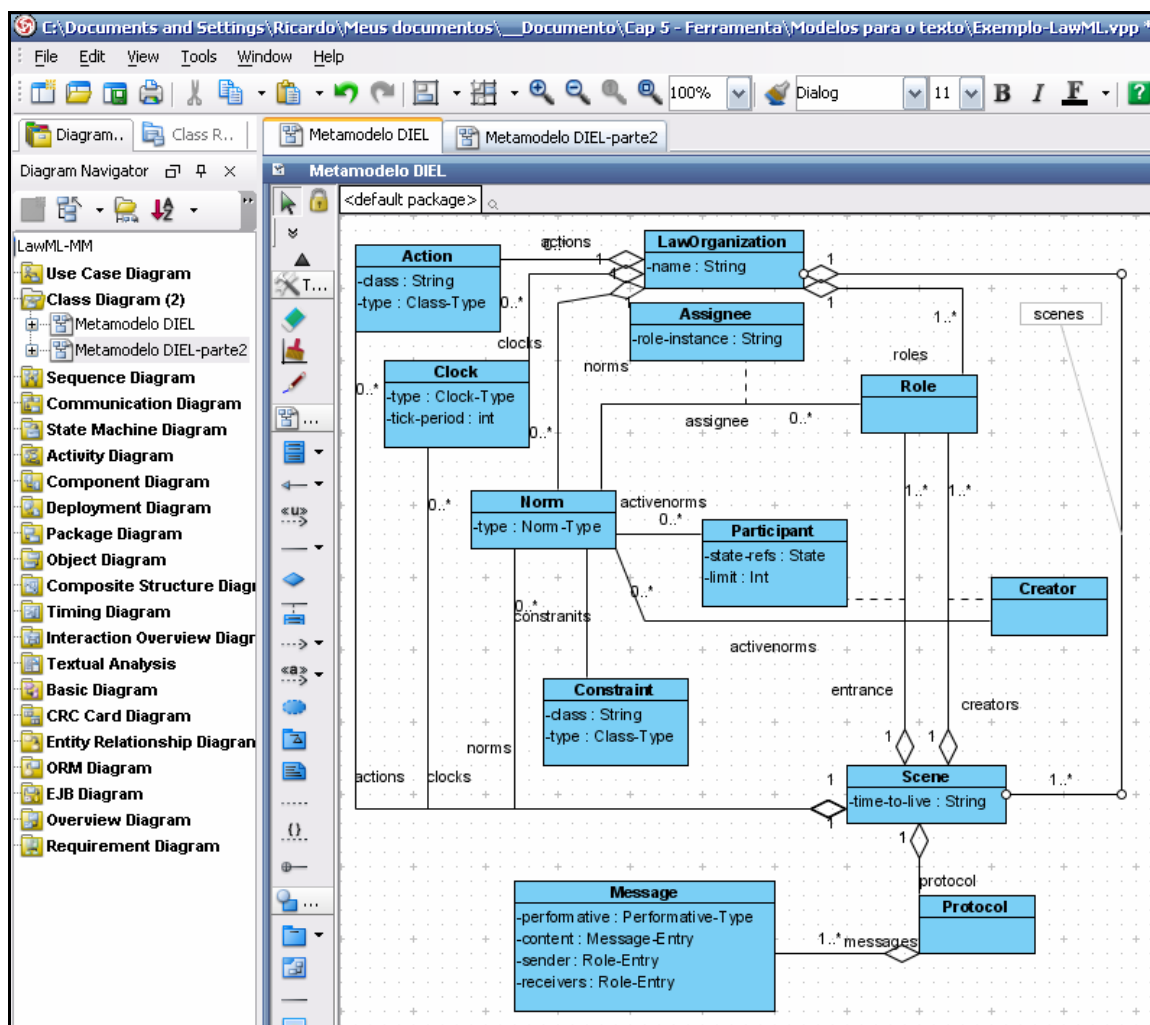


Figura I-1 – Projeto do Visual Paradigm que contém apenas o modelo conceitual.

Como o DIEL corresponde ao Diagrama de Objetos da UML, o DCIEL corresponde ao Diagrama de Comunicação e o DEP corresponde ao Diagrama de Estados, para criar um diagrama LawML, basta criar no editor seu respectivo diagrama da UML.

A seguir, exemplos simples de especificação LawML com o uso dessa ferramenta.

DIEL

Cada instância de elemento de lei desse diagrama deve ser uma instância de uma classe definida no modelo conceitual. Portanto, ao se criar uma instância nesse diagrama, deve-se definir seu classificador – um elemento de lei. Veja na Figura I-2 um exemplo.

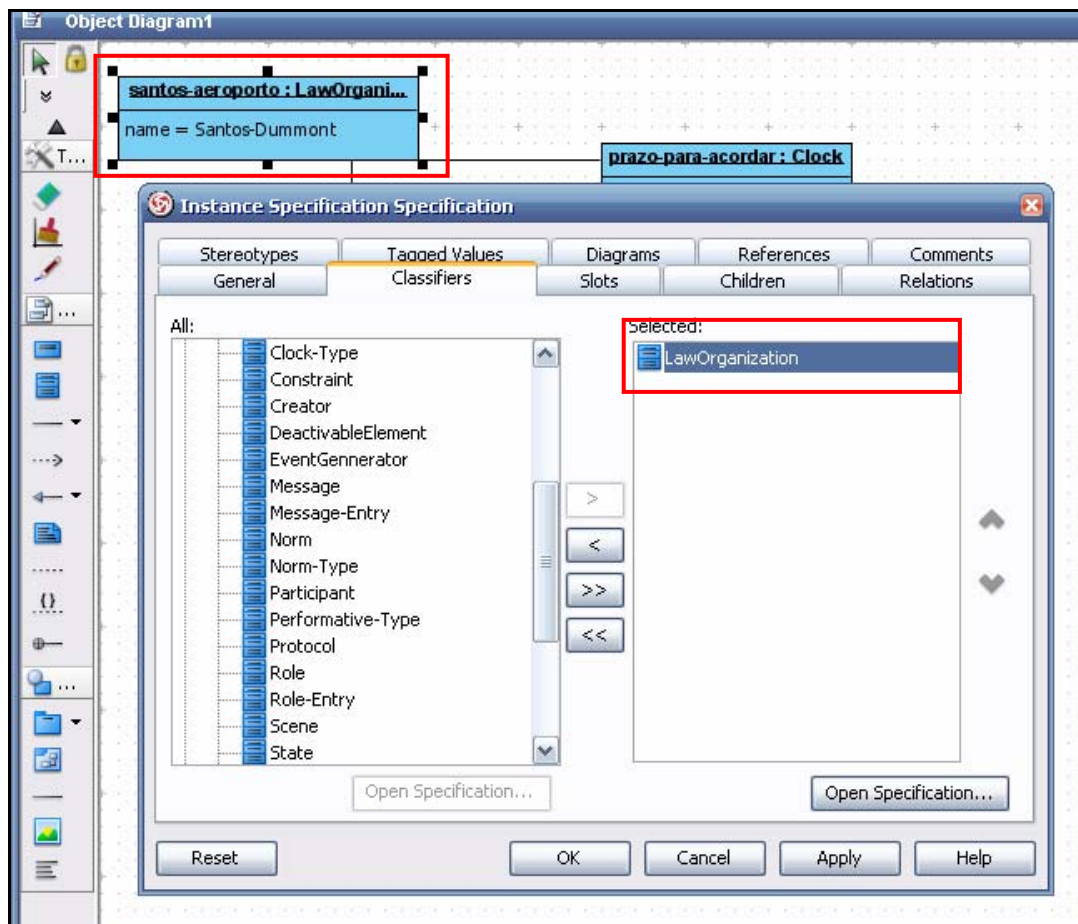


Figura I-2 – Exemplo de atribuição de classificador a uma instância

A atribuição de valores aos atributos é feita com base nos atributos do elemento de lei disponíveis no metamodelo. Veja um exemplo na Figura I-3.

Quando uma atribuição de valor a um atributo exigir um tipo/formato especial, o tipo/formato deve ser respeitado, ao adicionar o elemento de maneira textual no atributo. Veja um exemplo na Figura I-4.

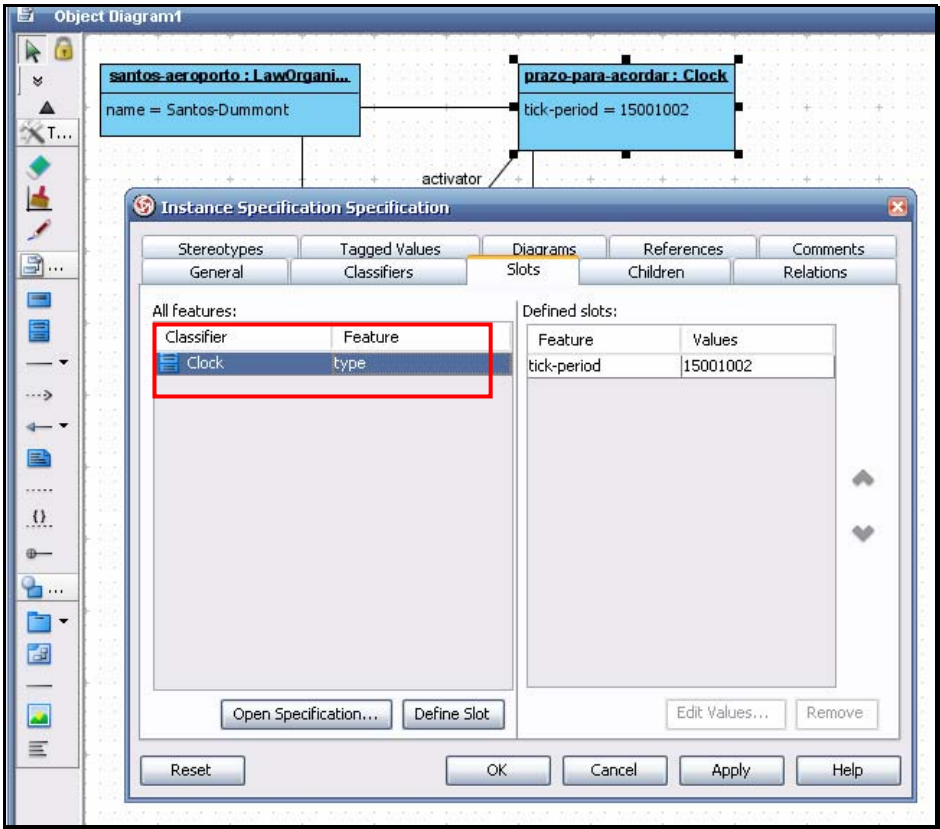


Figura I-3 – Exemplo de atribuição de valor a atributo de uma instância

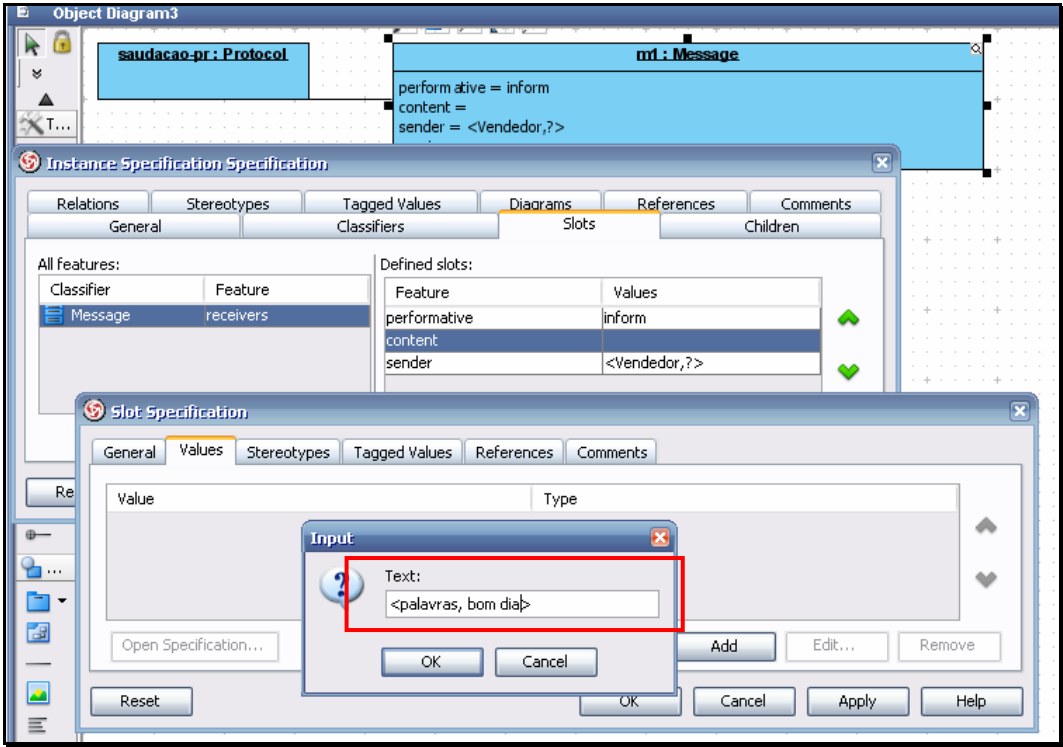


Figura I-4 – Exemplo de atribuição de valor com formato especial a atributo

A criação de vínculos entre as instâncias é feita de maneira semelhante à da UML, coloca-se o nome do vínculo e de papéis, quando obrigatório e/ou permitido. Veja um exemplo na Figura I-5.

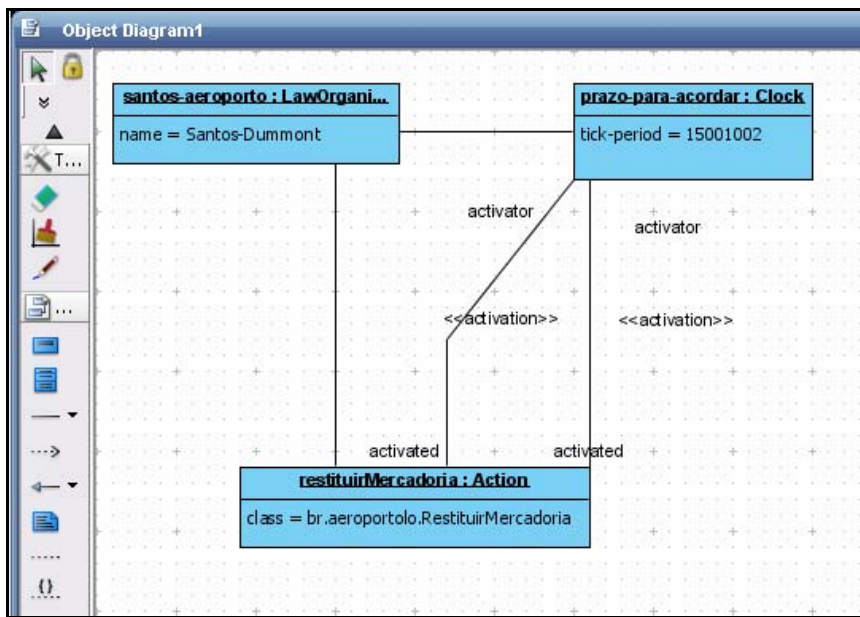


Figura I-5 – Exemplo de vínculos entre instâncias

As instâncias de classes de associação (*assinatura*, *criador*, e *participante*) são criadas de maneira especial. Como a ferramenta não apresenta esta funcionalidade para as instâncias, o desenvolvedor de leis deve criar uma instância de classe de associação de maneira usual e conectá-la ao seu respectivo vínculo através de um “conector genérico”. Veja um exemplo na Figura I-6.

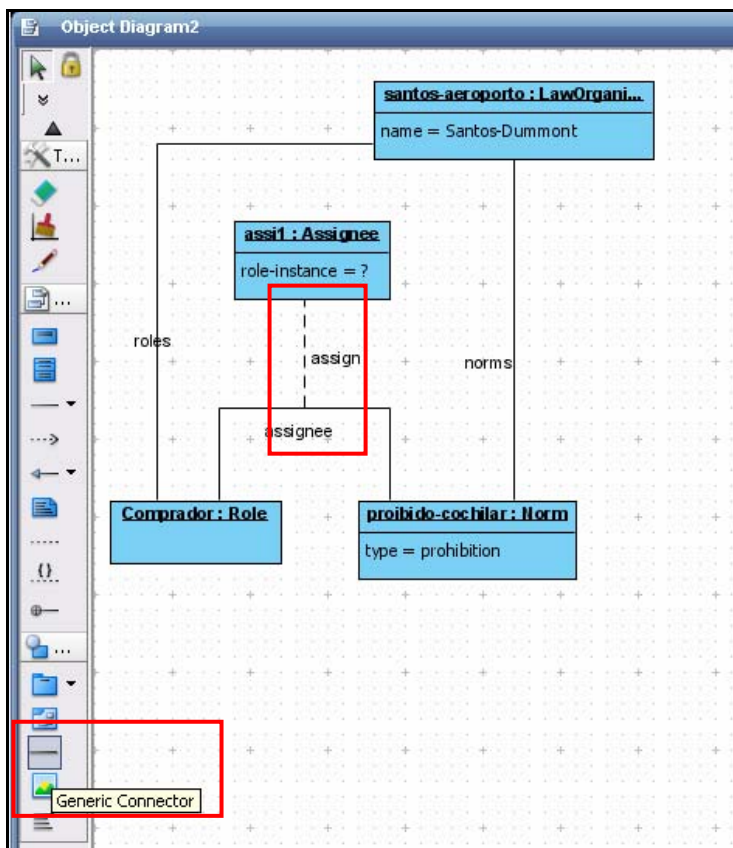


Figura I-6 – Exemplo instância de classe de associação

DCIEL

Para cada instância que participa desse diagrama, é necessária a criação de uma “linha de vida” (*lifeline*). Cada vínculo deve ter como “nome” o estereótipo << activation >> (ativação) ou << deactivation >> (desativação). O evento é representado através de uma “mensagem” trocada entre as instâncias. O “nome” é o elemento que caracteriza o tipo do evento. Veja um exemplo na Figura I-7.

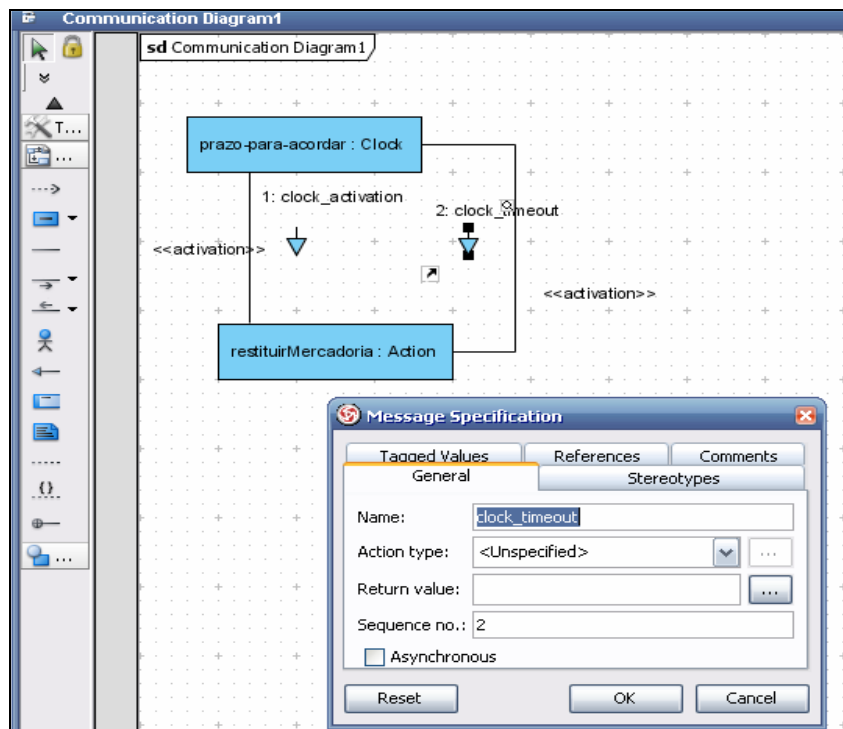


Figura I-7 – Exemplo de DCIEL no Visual Paradigm

DEP

Os estados e transições são representados de maneira análoga à de UML. Como cada DEP deve ser obrigatoriamente associado a uma instância de Protocolo, utiliza-se, para isso, um recurso especial de representação nessa ferramenta: coloca-se no campo de documentação (*documentation*) da especificação do diagrama um texto “*protocol=<protocol-id>*”, onde *<protocol-id>* indica o protocolo associado a esse diagrama. Veja um exemplo na Figura I-8.

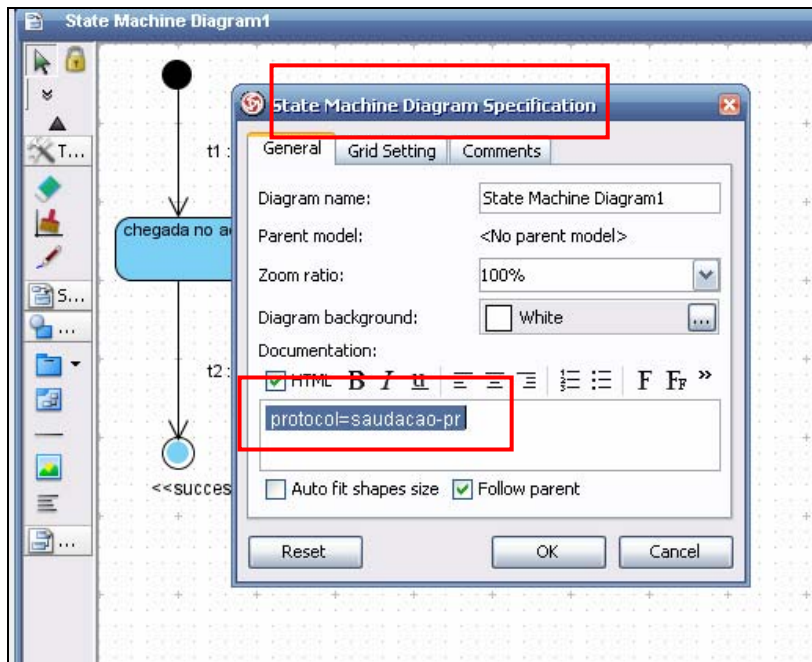


Figura I-8 – Exemplo de representação de um DEP associado a um protocolo

O atributo *id* de um estado, assim como seu *tipo* (no caso de conclusão com sucesso ou com falha) são representados no campo de documentação (*documentation*) da especificação do estado, conforme indicado na Figura I-9.

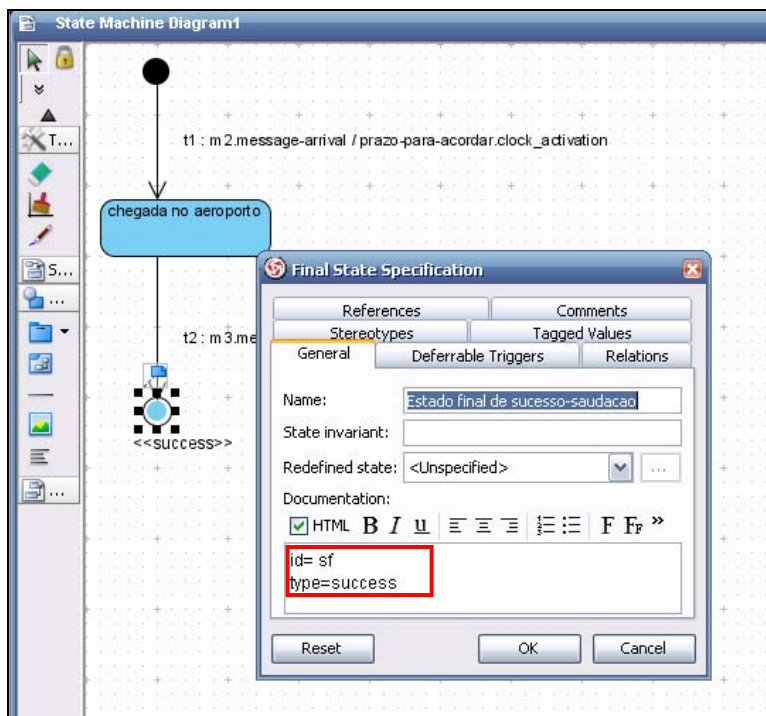


Figura I-9 – Exemplo de atributos de Estado

O evento de ativação (ou desativação) como efeito da ativação da transição é representado no campo “efeito” (*effect*) da especificação da transição. Veja um exemplo na Figura I-10.

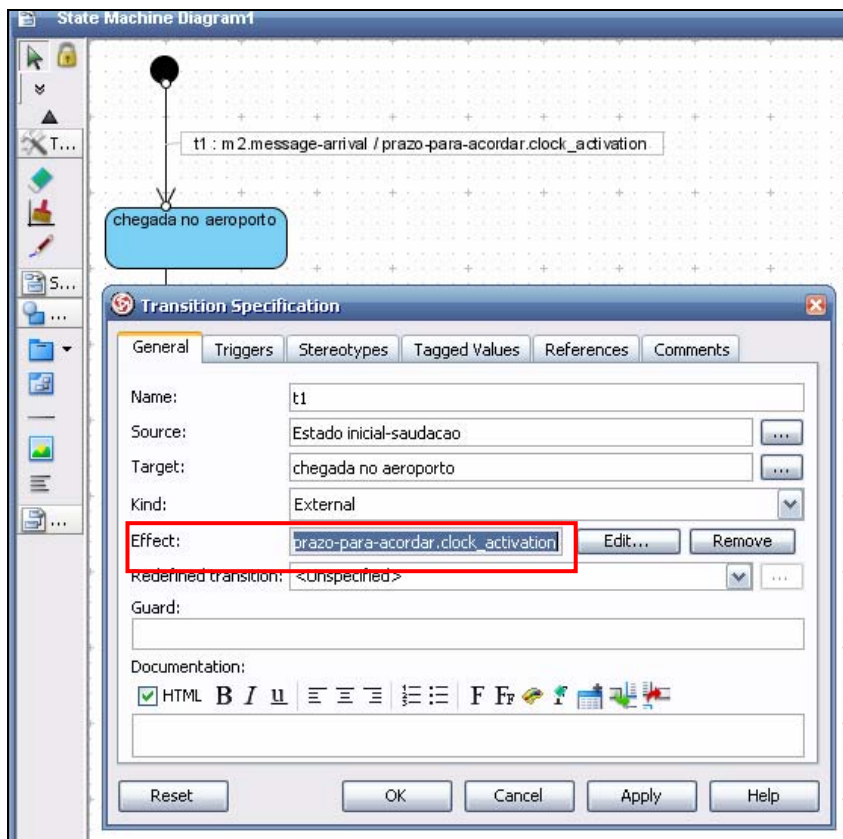


Figura I-10 – Exemplo de efeito da ativação de uma transição

As condições de guarda da transição (restrições e normas ativas) são representadas no campo “guarda” (*guard*) da especificação da transição, conforme mostrado na Figura I-11.

O evento de ativação da transição é representado na aba “*triggers*” da especificação da transição, conforme mostrado na Figura I-12.

Após as tarefas especificação da lei e validação da consistência, o desenvolvedor de lei deve exportar o modelo para um arquivo XML, que será lido pelo sistema *LawGenerator*. Ele deve clicar no menu “File > Export> XML” e selecionar o nome (e endereço) do arquivo XML a ser exportado.

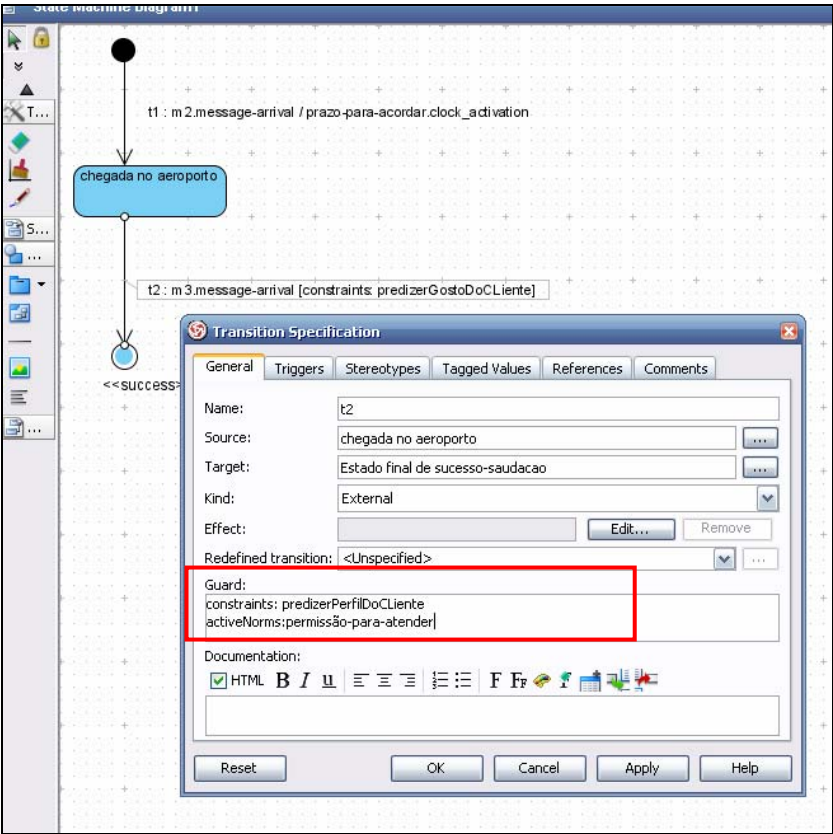


Figura I-11 – Exemplo de representação de condições de guarda de uma transição

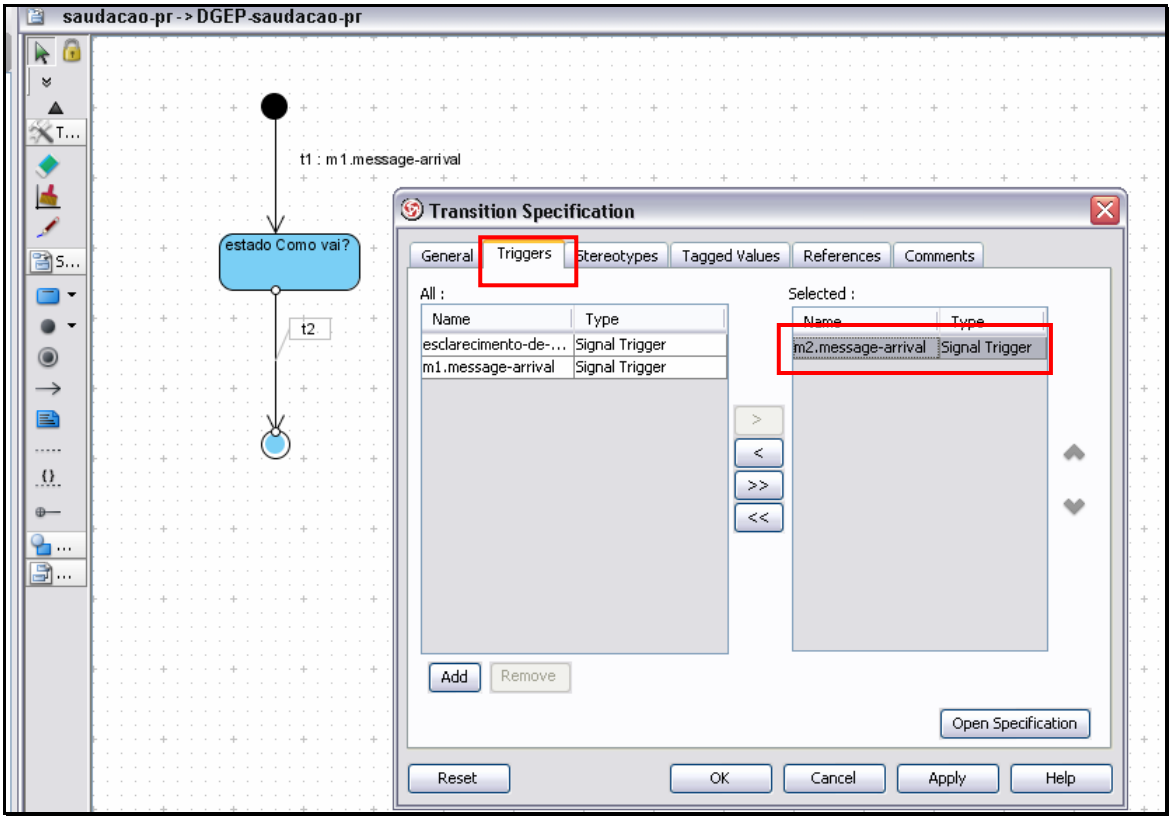


Figura I-12 – Exemplo de evento de ativação de uma transição

Anexo A.

Gramática do XMLaw – XML Schema Definition

A seguir, segue a gramática do XMLaw, segundo o formato XML Schema (XML Schema, URL, 2007). As leis especificadas em XMLaw em arquivos XML devem respeitar esse XML Schema Definiiton (XSD).

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<!--W3C Schema generated by XMLSpy v2006 sp2 U Rgralhoz (PUC) in 13/03/2007-->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:xi="http://www.w3.org/2001/XInclude" elementFormDefault="qualified">
  <xs:import namespace="http://www.w3.org/2001/XInclude"
    schemaLocation="C:\include.xsd"/>
  <xs:element name="Action">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="Element" maxOccurs="unbounded"/>
        <xs:element ref="xi:include" minOccurs="0"/>
      </xs:sequence>
      <xs:attribute name="id" use="required">
        <xs:simpleType>
          <xs:restriction base="xs:string"/>
        </xs:simpleType>
      </xs:attribute>
      <xs:attribute name="class" use="required">
        <xs:simpleType>
          <xs:restriction base="xs:string"/>
        </xs:simpleType>
      </xs:attribute>
      <xs:attribute name="type" type="class-typeType" use="optional"/>
    </xs:complexType>
  </xs:element>
  <xs:element name="Activations">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="Element" maxOccurs="unbounded"/>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
```

```

<xs:element name="ActiveNorms">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="Norm" maxOccurs="unbounded">
        <xs:complexType>
          <xs:attribute name="ref">
            <xs:simpleType>
              <xs:restriction
base="xs:string"/>
            </xs:simpleType>
          </xs:attribute>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Assignee">
  <xs:complexType>
    <xs:attribute name="role-ref" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="role-instance" use="optional">
      <!--use="required" -->
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="Clock">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Activations"/>
      <xs:element ref="Deactivations" minOccurs="0"/>
      <xs:element ref="xi:include" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="id" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="type" type="clock-typeType"
use="required"/>

```

```

        <xs:attribute name="tick-period" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:nonNegativeInteger"/>
            </xs:simpleType>
        </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:element name="Constraint">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="xi:include" minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="id" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="class" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="semantics" use="optional">
            <xs:simpleType>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="type" type="class-typeType" use="optional"/>
    </xs:complexType>
</xs:element>
<xs:element name="Constraints">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Constraint" maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="Content">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Entry" maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>

```

```

<xs:element name="Creator">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="ActiveNorms" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="role_ref" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="Creators">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Creator" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="CriticalityAnalysis">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Weight" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element ref="Increases" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element ref="Decreases" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Deactivations">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Element" minOccurs="0"
maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Decrease">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Assignee" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>

```

```

        <xs:attribute name="event-id" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="event-type" type="event-typeType"
use="required"/>
        <xs:attribute name="value" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:decimal"/>
            </xs:simpleType>
        </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:element name="Decreases">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Decrease" maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="Element">
    <xs:complexType>
        <xs:attribute name="ref" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="event-type" type="event-typeType"
use="required"/>
    </xs:complexType>
</xs:element>
<xs:element name="Entrance">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Participant" maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="Entry">
    <xs:complexType>
        <xs:attribute name="key" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
        </xs:attribute>

```

```

        <xs:attribute name="value" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
        </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:element name="Increase">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Assignee" maxOccurs="unbounded"/>
        </xs:sequence>
        <xs:attribute name="event-id" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="event-type" type="event-typeType"
use="required"/>
        <xs:attribute name="value" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:decimal"/>
            </xs:simpleType>
        </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:element name="Increases">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Increase" maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="LawOrganization">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="CriticalityAnalysis" minOccurs="0"/>
            <xs:element ref="Role" maxOccurs="unbounded"/>
            <xs:element ref="Scene" maxOccurs="unbounded"/>
            <xs:element ref="Action" minOccurs="0"
maxOccurs="unbounded"/>
            <xs:element ref="Clock" minOccurs="0"
maxOccurs="unbounded"/>
            <xs:element ref="Norm" minOccurs="0"
maxOccurs="unbounded"/>

```

```

        <xs:element ref="xi:include" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="id" use="required">
        <xs:simpleType>
            <xs:restriction base="xs:string"/>
        </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="name" use="required">
        <xs:simpleType>
            <xs:restriction base="xs:string"/>
        </xs:simpleType>
    </xs:attribute>
</xs:complexType>
</xs:element>
<xs:element name="Laws">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="LawOrganization"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="Message">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Content"/>
            <xs:element ref="Sender"/>
            <xs:element ref="Receivers"/>
            <xs:element ref="xi:include" minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="id" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string"/>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="performative" type="performative-typeType"
use="required"/>
    </xs:complexType>
</xs:element>
<xs:element name="Messages">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Message" maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>

```

```

<xs:element name="Norm">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Assignee" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element ref="Activations"/>
      <xs:element ref="Deactivations" minOccurs="0"/>
      <xs:element ref="Constraints" minOccurs="0"/>
      <xs:element ref="xi:include" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="type" type="norm-typeType"
use="required"/>
    <xs:attribute name="id" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="Participant">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="ActiveNorms" minOccurs="0"/>
      <xs:element name="State" maxOccurs="unbounded">
        <xs:complexType>
          <xs:attribute name="ref">
            <xs:simpleType>
              <xs:restriction
base="xs:string"/>
            </xs:simpleType>
          </xs:attribute>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
    <xs:attribute name="role_ref" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="limit" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:nonNegativeInteger"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>

```

```

<xs:element name="Protocol">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Messages"/>
      <xs:element ref="States"/>
      <xs:element ref="Transitions"/>
      <xs:element ref="xi:include" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="id" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="Receiver">
  <xs:complexType>
    <xs:attribute name="role-ref" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="role-instance" use="optional">
      <!--"required"-->
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="Receivers">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Receiver" maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Role">
  <xs:complexType>
    <xs:attribute name="id" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>

```

```

<xs:element name="Scene">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="CriticalityAnalysis" minOccurs="0"/>
      <xs:element ref="Creators"/>
      <xs:element ref="Protocol"/>
      <xs:element ref="Entrance"/>
      <xs:element ref="Action" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element ref="Clock" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element ref="Norm" minOccurs="0"
maxOccurs="unbounded"/>
      <xs:element ref="xi:include" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="id" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="time-to-live" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="Sender">
  <xs:complexType>
    <xs:attribute name="role-ref" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="role-instance" use="optional">
      <!-- required-->
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="State">
  <xs:complexType>
    <xs:attribute name="id" use="required">
      <xs:simpleType>

```

```

        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="type" type="state-typeType" use="required"/>
    <xs:attribute name="label" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>
<xs:element name="States">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="State" minOccurs="2"
maxOccurs="unbounded"/>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element name="Transition">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="ActiveNorms" minOccurs="0"/>
      <xs:element ref="Constraints" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="id" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="from" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="to" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
    <xs:attribute name="ref" use="required">
      <xs:simpleType>
        <xs:restriction base="xs:string"/>
      </xs:simpleType>
    </xs:attribute>
  </xs:complexType>
</xs:element>

```

```

        <xs:attribute name="event-type" type="event-typeType"
use="required"/>
    </xs:complexType>
</xs:element>
<xs:element name="Transitions">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Transition" maxOccurs="unbounded"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
<xs:element name="Weight">
    <xs:complexType>
        <xs:attribute name="ref" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="message"/>
                    <xs:enumeration value="role"/>
                    <xs:enumeration value="clock"/>
                    <xs:enumeration value="norm"/>
                    <xs:enumeration value="transition"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="value" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:decimal"/>
            </xs:simpleType>
        </xs:attribute>
    </xs:complexType>
</xs:element>
<xs:simpleType name="event-typeType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="message_arrival"/>
        <xs:enumeration value="transition_activation"/>
        <xs:enumeration value="clock_tick"/>
        <xs:enumeration value="deactivation_event"/>
        <xs:enumeration value="norm_activation"/>
        <xs:enumeration value="clock_activation"/>
        <xs:enumeration value="final_state_reached"/>
        <xs:enumeration value="time_to_live_elapsed"/>
        <xs:enumeration value="failure_scene_completion"/>
        <xs:enumeration value="successful_scene_completion"/>
        <xs:enumeration value="action_activation"/>
        <xs:enumeration value="role_activation"/>
    </xs:restriction>
</xs:simpleType>

```

```

        <xs:enumeration value="role_deactivation"/>
        <xs:enumeration value="clock_timeout"/>
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="class-typeType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="abstract"/>
        <xs:enumeration value="completes"/>
        <xs:enumeration value="extends"/>
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="clock-typeType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="once"/>
        <xs:enumeration value="periodic"/>
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="norm-typeType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="obligation"/>
        <xs:enumeration value="permission"/>
        <xs:enumeration value="prohibition"/>
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="performative-typeType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="accept-proposal"/>
        <xs:enumeration value="cancel"/>
        <xs:enumeration value="cfp"/>
        <xs:enumeration value="inform"/>
        <xs:enumeration value="propose"/>
        <xs:enumeration value="refuse"/>
        <xs:enumeration value="reject-proposal"/>
        <xs:enumeration value="request"/>
    </xs:restriction>
</xs:simpleType>
<xs:simpleType name="state-typeType">
    <xs:restriction base="xs:string">
        <xs:enumeration value="execution"/>
        <xs:enumeration value="failure"/>
        <xs:enumeration value="initial"/>
        <xs:enumeration value="success"/>
    </xs:restriction>
</xs:simpleType>
</xs:schema>

```

Anexo B.

Código no formato XMLaw do SELIC

A seguir, segue o código no formato XMLaw da especificação da lei do SELIC (Capítulo 6) gerado pela ferramenta *LawGenerator* (Capítulo 5) a partir da especificação do modelo da lei em LawML (Capítulo 4) e validado pela gramática do XMLaw (Anexo A).

```
<?xml version="1.0" encoding="ASCII"?>
<Laws>
  <LawOrganization id="bc" name="Banco Central">
    <Role id="comprador"/>
    <Role id="vendedor"/>
    <Role id="selic"/>
    <Scene id="OpCompPUAberto" time-to-live="infinity">
      <Creators>
        <Creator role_ref="selic"/>
      </Creators>
      <Protocol id="protocoloNegociacao">
        <Messages>
          <Message id="comeco" performative="inform">
            <Content>
              <Entry key="anuncio" value="Negocia&#xe7;&#xf5;es abertas"/>
            </Content>
            <Sender role-instance="?" role-ref="selic"/>
            <Receivers>
              <Receiver role-instance="?" role-ref="comprador"/>
              <Receiver role-instance="?" role-ref="vendedor"/>
            </Receivers>
          </Message>
          <Message id="reqCompra2" performative="cfp">
            <Content>
              <Entry key="CodMsg" value="SEL1054"/>
              <Entry key="TpCompr" value="02"/>
            </Content>
            <Sender role-instance="?" role-ref="comprador"/>
            <Receivers>
              <Receiver role-instance="?" role-ref="selic"/>
            </Receivers>
          </Message>
        </Messages>
      </Protocol>
    </Scene>
  </LawOrganization>
</Laws>
```

```

</Message>
<Message id="reqCompra4" performative="cfp">
  <Content>
    <Entry key="CodMsg" value="SEL1054"/>
    <Entry key="TpCompr" value="04"/>
  </Content>
  <Sender role-instance="?" role-ref="comprador"/>
  <Receivers>
    <Receiver role-instance="?" role-ref="selic"/>
  </Receivers>
</Message>
<Message id="reqVenda2" performative="cfp">
  <Content>
    <Entry key="CodMsg" value="SEL1054"/>
    <Entry key="TpCompr" value="02"/>
  </Content>
  <Sender role-instance="?" role-ref="vendedor"/>
  <Receivers>
    <Receiver role-instance="?" role-ref="selic"/>
  </Receivers>
</Message>
<Message id="reqVenda4" performative="cfp">
  <Content>
    <Entry key="CodMsg" value="SEL1054"/>
    <Entry key="TpCompr" value="04"/>
  </Content>
  <Sender role-instance="?" role-ref="vendedor"/>
  <Receivers>
    <Receiver role-instance="?" role-ref="selic"/>
  </Receivers>
</Message>
<Message id="aguardoCompra" performative="inform">
  <Content>
    <Entry key="CodMsg" value="SEL1054"/>
    <Entry key="NOPRET" value="\d+"/>
    <Entry key="SitOpSEL" value="negociacao_aguardando_compra"/>
  </Content>
  <Sender role-instance="?" role-ref="selic"/>
  <Receivers>
    <Receiver role-instance="?" role-ref="vendedor"/>
  </Receivers>
</Message>
<Message id="aguardoVenda" performative="inform">
  <Content>
    <Entry key="CodMsg" value="SEL1054"/>
    <Entry key="NOPRET" value="\d+"/>
    <Entry key="SitOpSEL" value="negociacao_aguardando_venda"/>
  </Content>
  <Sender role-instance="?" role-ref="selic"/>
  <Receivers>
    <Receiver role-instance="?" role-ref="vendedor"/>
  </Receivers>
</Message>

```

```

    </Content>
    <Sender role-instance="?" role-ref="selic"/>
    <Receivers>
      <Receiver role-instance="?" role-ref="comprador"/>
    </Receivers>
  </Message>
  <Message id="CompraOK" performative="inform">
    <Content>
      <Entry key="CodMsg" value="SEL1054"/>
      <Entry key="NOPRET" value="\d+"/>
    </Content>
    <Sender role-instance="?" role-ref="selic"/>
    <Receivers>
      <Receiver role-instance="?" role-ref="comprador"/>
    </Receivers>
  </Message>
  <Message id="VendaOK" performative="inform">
    <Content>
      <Entry key="CodMsg" value="SEL1054"/>
      <Entry key="NOPRET" value="\d+"/>
    </Content>
    <Sender role-instance="?" role-ref="selic"/>
    <Receivers>
      <Receiver role-instance="?" role-ref="vendedor"/>
    </Receivers>
  </Message>
</Messages>
<States>
  <State id="psInicioNegociacao" label="psInicioNegociacao" type="initial"/>
  <State id="inicioNegociacao" label="Inicio da Negociacao" type="execution"/>
  <State id="nenhumaSolicitacao" label="Negociacao aberta" type="execution"/>
  <State id="compraSolicitada" label="Pedido de Compra Solicitado"
type="execution"/>
  <State id="vendaSolicitada" label="Pedido de Venda Solicitado"
type="execution"/>
  <State id="negociacaoExecutada" label="Negocia&#xe7;&#xe3;o
Executada&#xA; (match de compra e venda)" type="execution"/>
  <State id="negociacaoFinalizada1" label="Negociacao Concluida&#xA; (1/2)"
type="execution"/>
  <State id="negociacaoFinalizada2" label="Negociacao Concluida (1/2)"
type="success"/>
</States>
<Transitions>
  <Transition id="automatica1" ref="" event-type="message_arrival"
from="psInicioNegociacao" to="inicioNegociacao"/>
  <Transition id="t0" ref="comeco" event-type="message_arrival"
from="inicioNegociacao" to="nenhumaSolicitacao"/>

```

```

    <Transition id="t2" ref="reqCompra4" event-type="message_arrival"
    from="nenhumaSolicitacao" to="compraSolicitada">
        <Constraints>
            <Constraint id="ConditionNOPRET"
class="br.pucrio.inf.les.law.application.selic.constraint.ConditionNOPRET"/>
        </Constraints>
    </Transition>
    <Transition id="t1" ref="reqCompra2" event-type="message_arrival"
    from="nenhumaSolicitacao" to="compraSolicitada">
        <Constraints>
            <Constraint id="ConditionNOPRET"
class="br.pucrio.inf.les.law.application.selic.constraint.ConditionNOPRET"/>
        </Constraints>
    </Transition>
    <Transition id="t4" ref="reqVenda4" event-type="message_arrival"
    from="nenhumaSolicitacao" to="vendaSolicitada">
        <Constraints>
            <Constraint id="ConditionNOPRET"
class="br.pucrio.inf.les.law.application.selic.constraint.ConditionNOPRET"/>
        </Constraints>
    </Transition>
    <Transition id="t3" ref="reqVenda2" event-type="message_arrival"
    from="nenhumaSolicitacao" to="vendaSolicitada">
        <Constraints>
            <Constraint id="ConditionNOPRET"
class="br.pucrio.inf.les.law.application.selic.constraint.ConditionNOPRET"/>
        </Constraints>
    </Transition>
    <Transition id="t5" ref="aguardoVenda" event-type="message_arrival"
    from="compraSolicitada" to="compraSolicitada"/>
    <Transition id="t6" ref="aguardoCompra" event-type="message_arrival" from="
vendaSolicitada" to="vendaSolicitada"/>
    <Transition id="t7" ref="reqVenda2" event-type="message_arrival"
    from="compraSolicitada" to="negociacaoExecutada"/>
    <Transition id="t8" ref="reqVenda4" event-type="message_arrival"
    from="compraSolicitada" to="negociacaoExecutada"/>
    <Transition id="t9" ref="reqCompra2" event-type="message_arrival" from="
vendaSolicitada" to="negociacaoExecutada"/>
    <Transition id="t10" ref="reqCompra4" event-type="message_arrival" from="
vendaSolicitada" to="negociacaoExecutada"/>
    <Transition id="t11" ref="aguardoCompra" event-type="message_arrival" from="
negociacaoExecutada" to="negociacaoExecutada"/>
    <Transition id="t12" ref="aguardoVenda" event-type="message_arrival" from="
negociacaoExecutada" to="negociacaoExecutada"/>
    <Transition id="t13" ref="CompraOK" event-type="message_arrival" from="
negociacaoExecutada" to="negociacaoFinalizada1"/>

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        <Transition id="t14" ref="VendaOK" event-type="message_arrival" from="
negociacaoFinalizada1" to="negociacaoFinalizada2"/>
    </Transitions>
</Protocol>
<Entrance>
    <Participant limit="1" role_ref="comprador">
        <State ref="nenhumaSolicitacao"/>
    </Participant>
    <Participant limit="1" role_ref="vendedor">
        <State ref="nenhumaSolicitacao"/>
        <State ref="compraSolicitada"/>
    </Participant>
    <Participant limit="1" role_ref="selic">
        <State ref="inicioNegociacao"/>
    </Participant>
</Entrance>
</Scene>
<Scene id="OpRecompPUAberto" time-to-live="infinity">
    <Creators>
        <Creator role_ref="selic"/>
    </Creators>
    <Protocol id="protocoloRenegociacao">
        <Messages>
            <Message id="reqRevenda1" performative="cfp">
                <Content>
                    <Entry key="CodMsg" value="SEL1056"/>
                    <Entry key="TpCompr" value="01"/>
                    <Entry key="NOPRET" value="\d+"/>
                </Content>
                <Sender role-instance="?" role-ref="comprador"/>
                <Receivers>
                    <Receiver role-instance="?" role-ref="selic"/>
                </Receivers>
            </Message>
            <Message id="reqRevenda3" performative="cfp">
                <Content>
                    <Entry key="CodMsg" value="SEL1056"/>
                    <Entry key="TpCompr" value="03"/>
                    <Entry key="NOPRET" value="\d+"/>
                </Content>
                <Sender role-instance="?" role-ref="comprador"/>
                <Receivers>
                    <Receiver role-instance="?" role-ref="selic"/>
                </Receivers>
            </Message>
            <Message id="reqRecompra1" performative="cfp">
                <Content>

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        <Entry key="CodMsg" value="SEL1056"/>
        <Entry key="TpCompr" value="01"/>
        <Entry key="NOPRET" value="\d+"/>
    </Content>
    <Sender role-instance="?" role-ref="vendedor"/>
    <Receivers>
        <Receiver role-instance="?" role-ref="selic"/>
    </Receivers>
</Message>
<Message id="reqRecompra3" performative="cfp">
    <Content>
        <Entry key="CodMsg" value="SEL1056"/>
        <Entry key="TpCompr" value="03"/>
        <Entry key="NOPRET" value="\d+"/>
    </Content>
    <Sender role-instance="?" role-ref="vendedor"/>
    <Receivers>
        <Receiver role-instance="?" role-ref="selic"/>
    </Receivers>
</Message>
<Message id="RevendaOK" performative="inform">
    <Content>
        <Entry key="CodMsg" value="SEL1056"/>
        <Entry key="NOPRET" value="\d+"/>
    </Content>
    <Sender role-instance="?" role-ref="selic"/>
    <Receivers>
        <Receiver role-instance="?" role-ref="comprador"/>
    </Receivers>
</Message>
<Message id="RecompraOK" performative="inform">
    <Content>
        <Entry key="CodMsg" value="SEL1056"/>
        <Entry key="NOPRET" value="\d+"/>
    </Content>
    <Sender role-instance="?" role-ref="selic"/>
    <Receivers>
        <Receiver role-instance="?" role-ref="vendedor"/>
    </Receivers>
</Message>
<Message id="aguardoRevenda" performative="inform">
    <Content>
        <Entry key="CodMsg" value="SEL1056"/>
        <Entry key="NOPRET" value="\d+"/>
        <Entry key="SitOpSEL" value="negociacao_aguardando_revenda"/>
    </Content>
    <Sender role-instance="?" role-ref="selic"/>

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    <Receivers>
      <Receiver role-instance="?" role-ref="vendedor"/>
    </Receivers>
  </Message>
  <Message id="aguardoRecompra" performative="inform">
    <Content>
      <Entry key="CodMsg" value="SEL1056"/>
      <Entry key="NOPRET" value="\d+"/>
      <Entry key="SitOpSEL" value="negociacao_aguardando_recompra"/>
    </Content>
    <Sender role-instance="?" role-ref="selic"/>
    <Receivers>
      <Receiver role-instance="?" role-ref="comprador"/>
    </Receivers>
  </Message>
</Messages>
<States>
  <State id="renegociacaoFinalizada2" label="Renegociacao Concluida (1/2)"
type="success"/>
  <State id="renegociacaoFinalizada1" label="Renegociacao Concluida&#xA; (1/2)"
type="execution"/>
  <State id="renegociacaoExecutada" label="Renegociacao Executada&#xA; (match
de compra e revenda)" type="execution"/>
  <State id="revendaSolicitada" label="Pedido de Revenda Solicitado"
type="execution"/>
  <State id="recompraSolicitada" label="Pedido de Recompra Solicitado"
type="execution"/>
  <State id="nenhumaResolicitacao" label="Renegociacao aberta" type="execution"/>
  <State id="psInicioRenegociacao" label="psInicioRenegociacao" type="initial"/>
</States>
<Transitions>
  <Transition id="automatica2" ref="" event-type="message_arrival"
from="psInicioRenegociacao" to="nenhumaResolicitacao"/>
  <Transition id="tr1" ref="reqRecompra1" event-type="message_arrival"
from="nenhumaResolicitacao" to="recompraSolicitada"/>
  <Transition id="tr2" ref="reqRecompra3" event-type="message_arrival"
from="nenhumaResolicitacao" to="recompraSolicitada"/>
  <Transition id="tr3" ref="reqRevenda1" event-type="message_arrival"
from="nenhumaResolicitacao" to="revendaSolicitada"/>
  <Transition id="tr4" ref="reqRevenda3" event-type="message_arrival"
from="nenhumaResolicitacao" to="revendaSolicitada"/>
  <Transition id="tr7" ref="reqRevenda1" event-type="message_arrival"
from="recompraSolicitada" to="renegociacaoExecutada"/>
  <Transition id="tr8" ref="reqRevenda3" event-type="message_arrival"
from="recompraSolicitada" to="renegociacaoExecutada"/>
  <Transition id="tr5" ref="aguardoRevenda" event-type="message_arrival"
from="recompraSolicitada" to="recompraSolicitada"/>

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        <Transition id="tr9" ref="reqRecompra1" event-type="message_arrival"
from="revendaSolicitada" to="renegociacaoExecutada"/>
        <Transition id="tr10" ref="reqRecompra3" event-type="message_arrival" from="
revendaSolicitada" to="renegociacaoExecutada"/>
        <Transition id="tr6" ref="aguardoRecompra" event-type="message_arrival" from="
revendaSolicitada" to="revendaSolicitada"/>
        <Transition id="tr13" ref="RecompraOK" event-type="message_arrival"
from="renegociacaoExecutada" to="renegociacaoFinalizada1"/>
        <Transition id="tr14" ref="RevendaOK" event-type="message_arrival"
from="renegociacaoFinalizada1" to="renegociacaoFinalizada2"/>
        <Transition id="tr12" ref="aguardoRecompra" event-type="message_arrival"
from="renegociacaoExecutada" to="renegociacaoExecutada"/>
        <Transition id="tr11" ref="aguardoRevenda" event-type="message_arrival"
from="renegociacaoExecutada" to="renegociacaoExecutada"/>
    </Transitions>
</Protocol>
<Entrance>
    <Participant limit="1" role_ref="comprador">
        <ActiveNorms>
            <Norm ref="norma_obrigacao_de_revenda"/>
        </ActiveNorms>
        <State ref="nenhumaResolicitacao"/>
    </Participant>
    <Participant limit="1" role_ref="selic">
        <State ref="nenhumaResolicitacao"/>
        <State ref="recompraSolicitada"/>
        <State ref="renegociacaoExecutada"/>
    </Participant>
    <Participant limit="1" role_ref="vendedor">
        <ActiveNorms>
            <Norm ref="norma_obrigacao_de_recompra"/>
        </ActiveNorms>
        <State ref="nenhumaResolicitacao"/>
        <State ref="recompraSolicitada"/>
    </Participant>
</Entrance>
</Scene>
    <Action id="comprador_multado"
class="br.pucrio.inf.les.law.application.selic.action.FineAction">
        <Element event-type="clock_tick" ref="relógio_obrigacao_de_revenda"/>
    </Action>
    <Action id="vendedor_multado"
class="br.pucrio.inf.les.law.application.selic.action.FineAction">
        <Element event-type="clock_tick" ref="relógio_obrigacao_de_recompra"/>
    </Action>
    <Clock id="relógio_obrigacao_de_revenda" tick-period="86400000" type="periodic">
        <Activations>

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        <Element event-type="norm_activation"
ref="norma_obrigacao_de_revenda"/>
    </Activations>
    <Deactivations>
        <Element event-type="transition_activation" ref="tr3"/>
        <Element event-type="transition_activation" ref="tr4"/>
        <Element event-type="transition_activation" ref="tr7"/>
        <Element event-type="transition_activation" ref="tr8"/>
    </Deactivations>
</Clock>
<Clock id="relogio_proibicao_de_negociar" tick-period="864000000" type="once">
    <Activations>
        <Element event-type="norm_activation" ref="norma_obrigacao_de_revenda"/>
    </Activations>
    <Deactivations>
        <Element event-type="transition_activation" ref="tr3"/>
        <Element event-type="transition_activation" ref="tr4"/>
        <Element event-type="transition_activation" ref="tr7"/>
        <Element event-type="transition_activation" ref="tr8"/>
    </Deactivations>
</Clock>
<Clock id="relogio_obrigacao_de_recompra" tick-period="864000000"
type="periodic">
    <Activations>
        <Element event-type="norm_activation" ref="norma_obrigacao_de_recompra"/>
    </Activations>
    <Deactivations>
        <Element event-type="transition_activation" ref="tr1"/>
        <Element event-type="transition_activation" ref="tr2"/>
        <Element event-type="transition_activation" ref="tr9"/>
        <Element event-type="transition_activation" ref="tr10"/>
    </Deactivations>
</Clock>
<Clock id="relogio_proibicao_de_recompra" tick-period="864000000" type="once">
    <Activations>
        <Element event-type="norm_activation" ref="norma_obrigacao_de_recompra"/>
    </Activations>
    <Deactivations>
        <Element event-type="transition_activation" ref="tr1"/>
        <Element event-type="transition_activation" ref="tr2"/>
        <Element event-type="transition_activation" ref="tr9"/>
        <Element event-type="transition_activation" ref="tr10"/>
    </Deactivations>
</Clock>
<Norm id="norma_obrigacao_de_revenda" type="obligation">
    <Assignee role-instance="?" role-ref="comprador"/>
    <Activations>
        <Element event-type="transition_activation" ref="t14"/>
    </Activations>

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    <Deactivations>
      <Element event-type="norm_activation" ref="norma_proibicao_de_negociar"/>
      <Element event-type="transition_activation" ref="tr14"/>
    </Deactivations>
  </Norm>
  <Norm id="norma_proibicao_de_negociar" type="prohibition">
    <Assignee role-instance="?" role-ref="comprador"/>
    <Activations>
      <Element event-type="clock_timeout" ref="relogio_proibicao_de_negociar"/>
    </Activations>
  </Norm>
  <Norm id="norma_obrigacao_de_recompra" type="obligation">
    <Assignee role-instance="?" role-ref="vendedor"/>
    <Activations>
      <Element event-type="transition_activation" ref="t14"/>
    </Activations>
    <Deactivations>
      <Element event-type="norm_activation" ref="norma_proibicao_de_recompra"/>
      <Element event-type="transition_activation" ref="tr14"/>
    </Deactivations>
  </Norm>
  <Norm id="norma_proibicao_de_recompra" type="prohibition">
    <Assignee role-instance="?" role-ref="vendedor"/>
    <Activations>
      <Element event-type="clock_timeout" ref="relogio_proibicao_de_recompra"/>
    </Activations>
  </Norm>
</LawOrganization>
</Laws>

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