An Open Visualization Framework for Metamodel-Based Modeling Languages

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GraBaTs 2002

Outline

- Visual modeling languages and standardization
- An SVG-based visualization framework
  - Conceptual overview
  - Drawing metamodel
  - Automated transformations
- Running example: Petri Nets
- Conclusions and Future work

Defining Visual Modeling Languages

- Abstract syntax
  - visual definition by metamodels
  - UML notation
- Concrete syntax
  - visual representation for models
- Static well-formedness constraints
  - textual constraints
  - graph patterns as constraints
- Dynamic behavior
  - meta-level specification: graph transformation

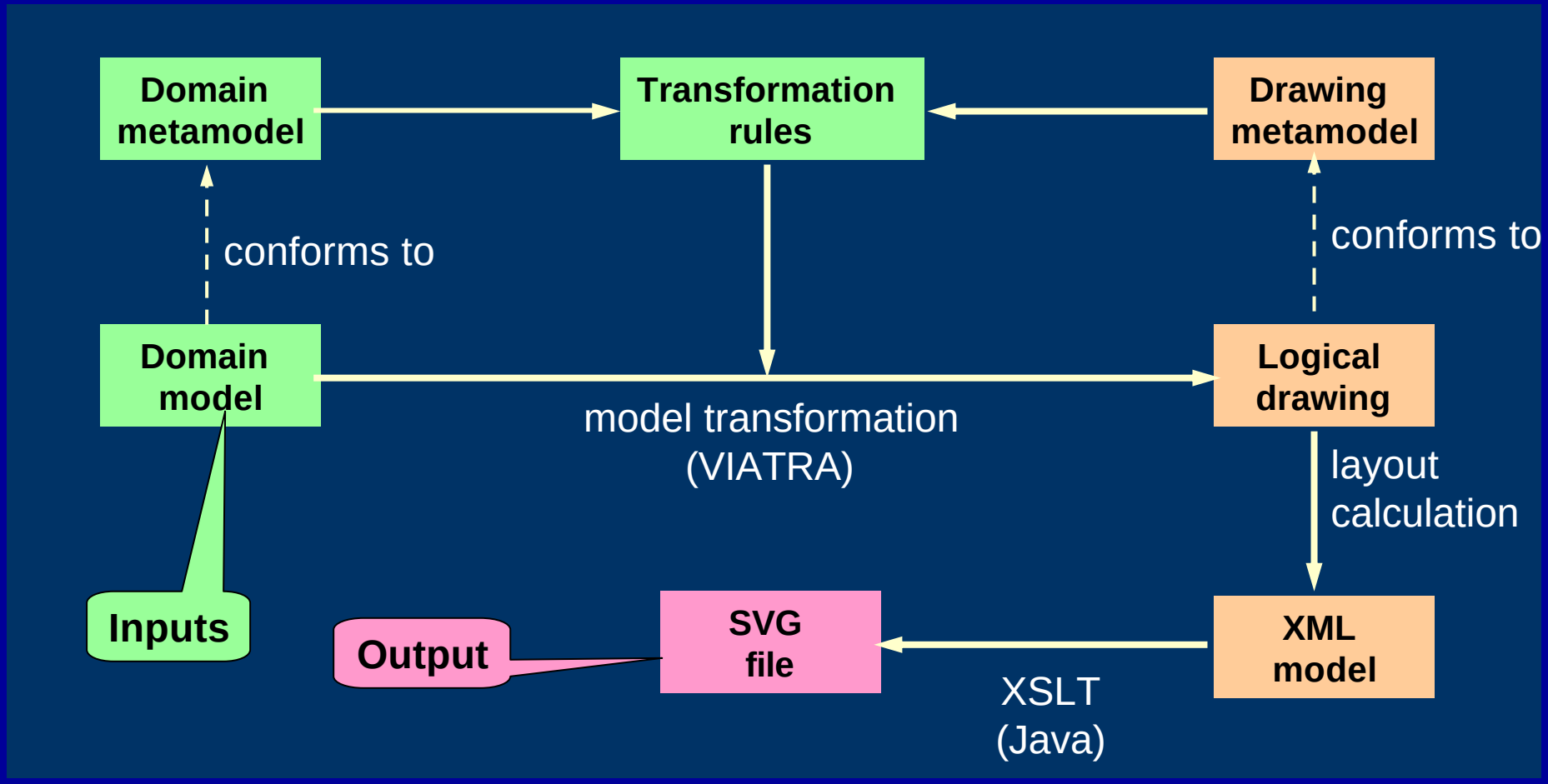
Objectives

- Automated derivation of graphical representation
  - from elementary AS ? CS mappings
  - automated calculation of graphical layout
- Standard, XML-based environment
  - XMI (XML Metadata Interchange) for models
  - XSLT (XSL Transformations) for transformations
  - SVG (Scalable Vector Graphics) for graphics
- Evaluation for GTXL Standardization
  - default visualization for GXL / GTXL?
  - standard mappings?

Characteristics

- Abstract syntax: Metamodeling
  - MOF approach
- Concrete syntax:
  SVG (Scalable Vector Graphics)
  - XML standard
  - visualized by web browsers
- Derivation process:
  - mapping abstract syntax to concrete syntax by model transformations
  - off-line approach (for documentation/evaluation)

Conceptual Overview



Conceptual Overview

Domain metamodel:

•defines the abstract syntax

•Petri nets:
concepts of places, transitions

Domain model:

•a concrete model instance

•well-formedness assumed

•modeled by typed and attributed graphs

•XMI representation

Transformation rules:

•mapping abstract syntax into concrete syntax

•graph transformation rules with spec. structure

Drawing metamodel:

•drawing primitives (circle, line, box, text)

•logical relations (e.g. containment)

Logical drawing

model transformation
(VIATRA)

SVG file:

•easy generation from logical drawing model

•automatically re
by web browser

SVG generation:

•XSLT technology

•model independent!!!

Layout calculation:

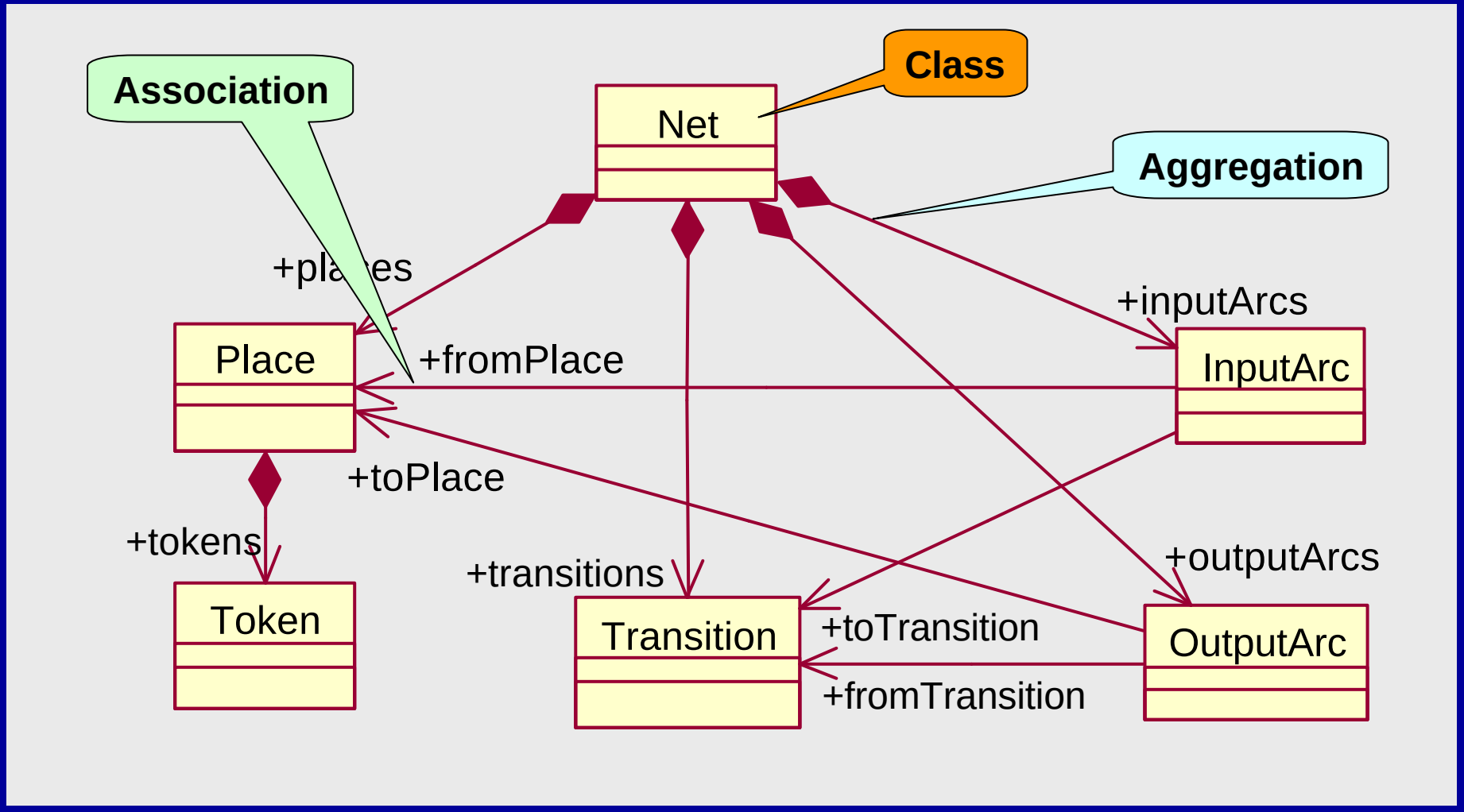
•generating physical coordinates

-the-shelf toolkit
M GFC)

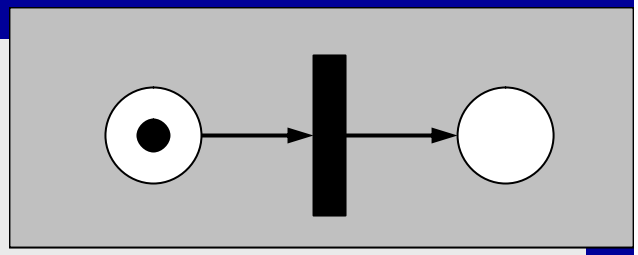
porting in XMI

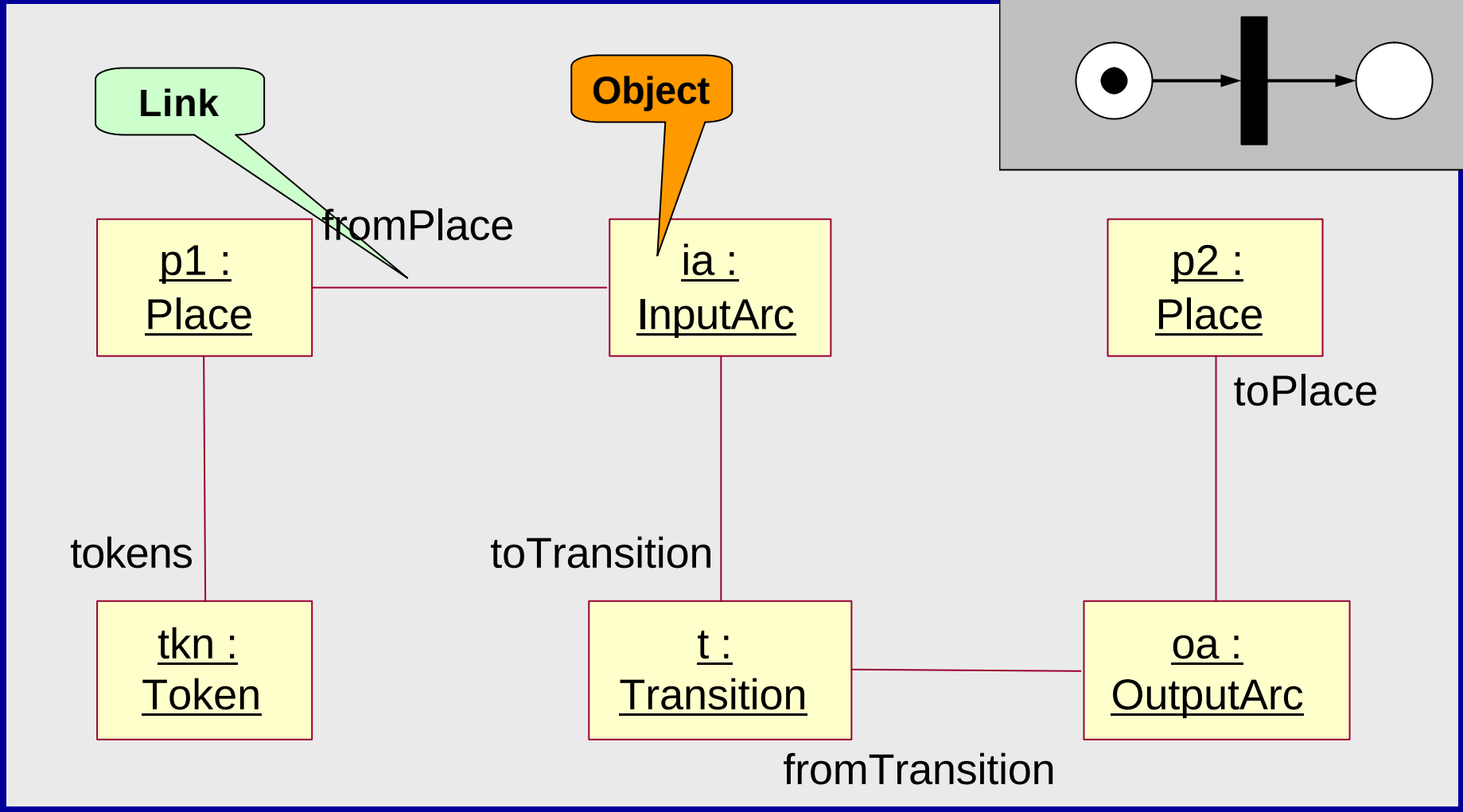
Example:
SVG Visualization of Petri Nets

A Metamodel of Petri Nets

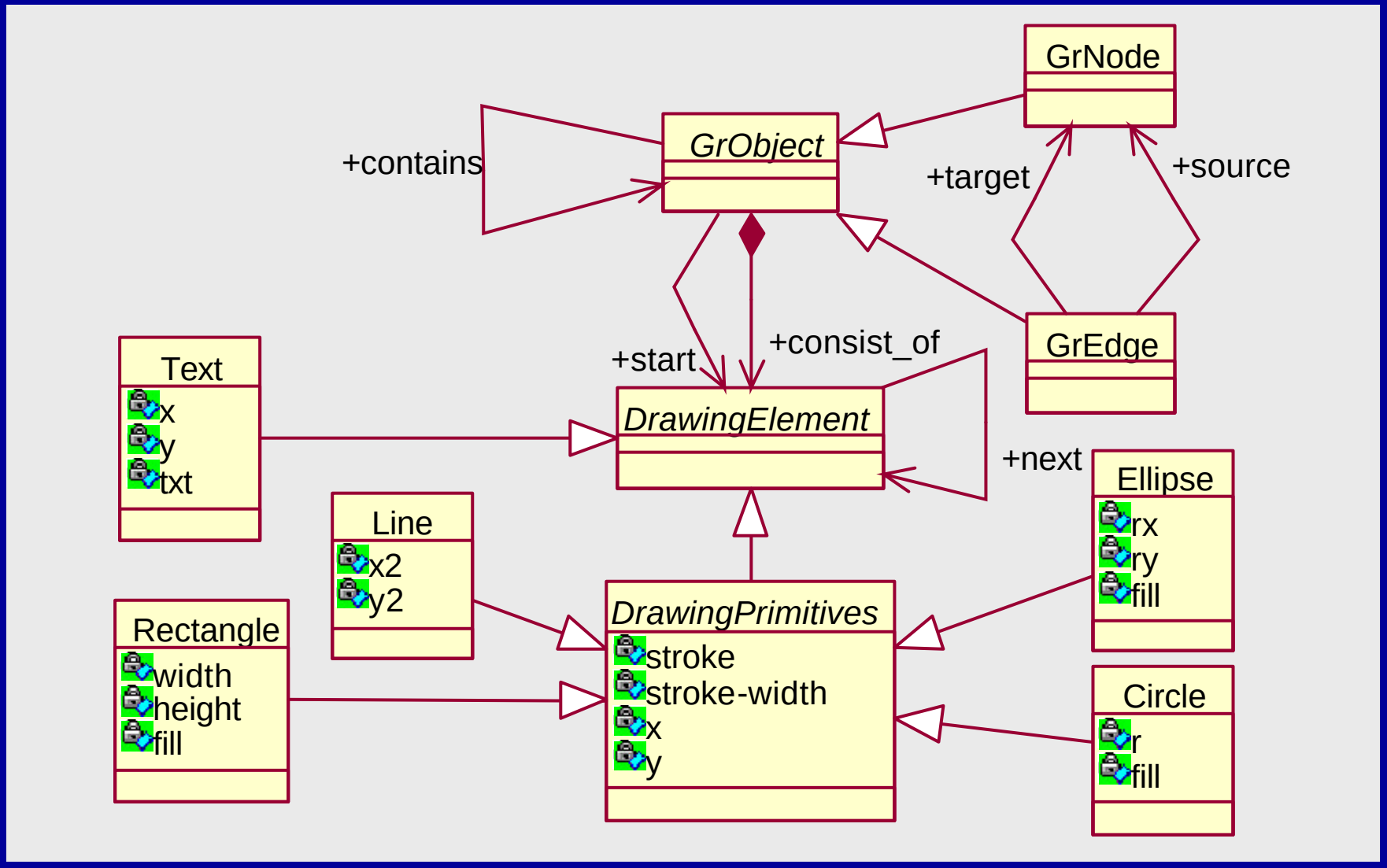


Graph Representation of a Petri Net Model

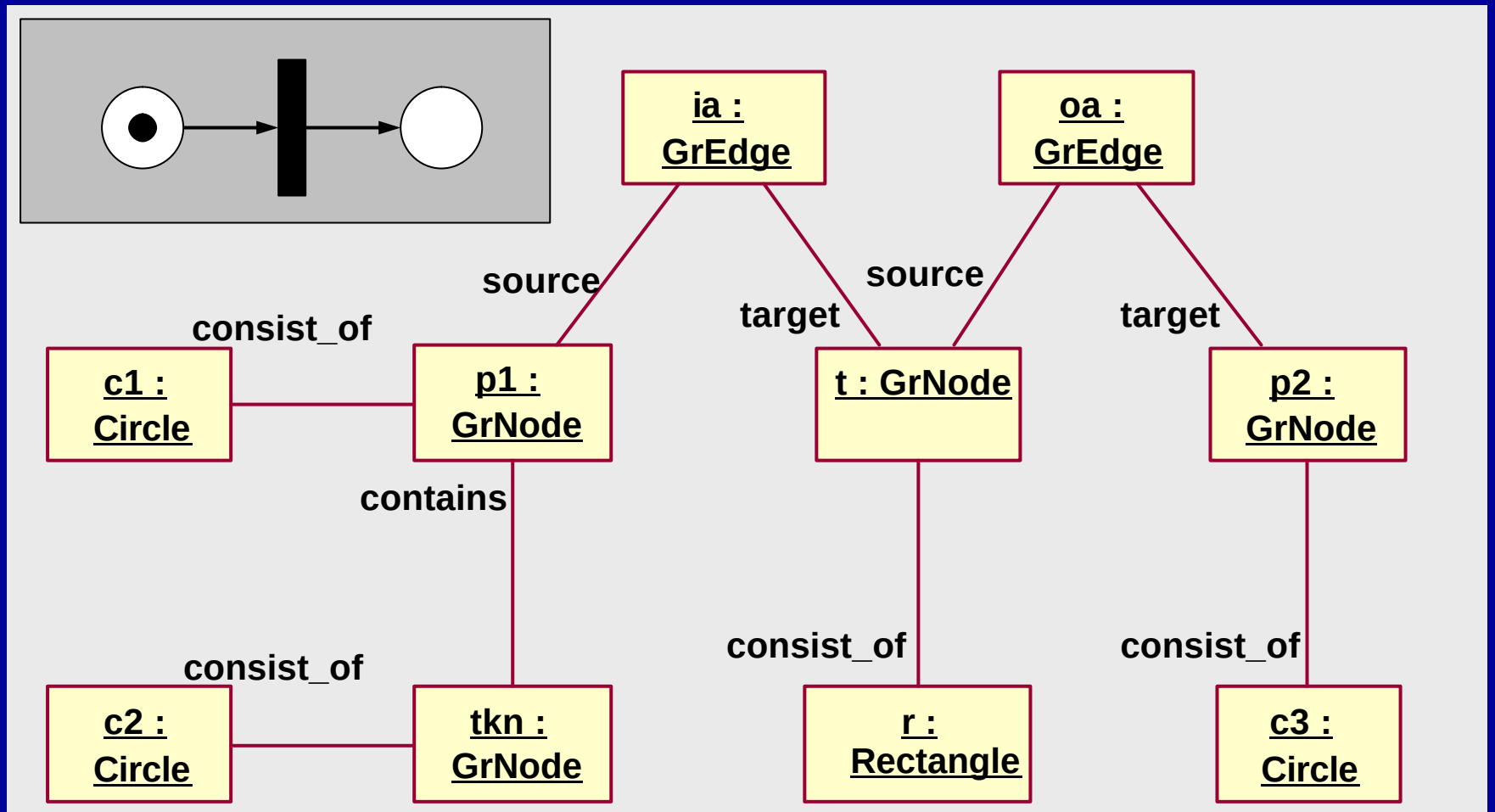




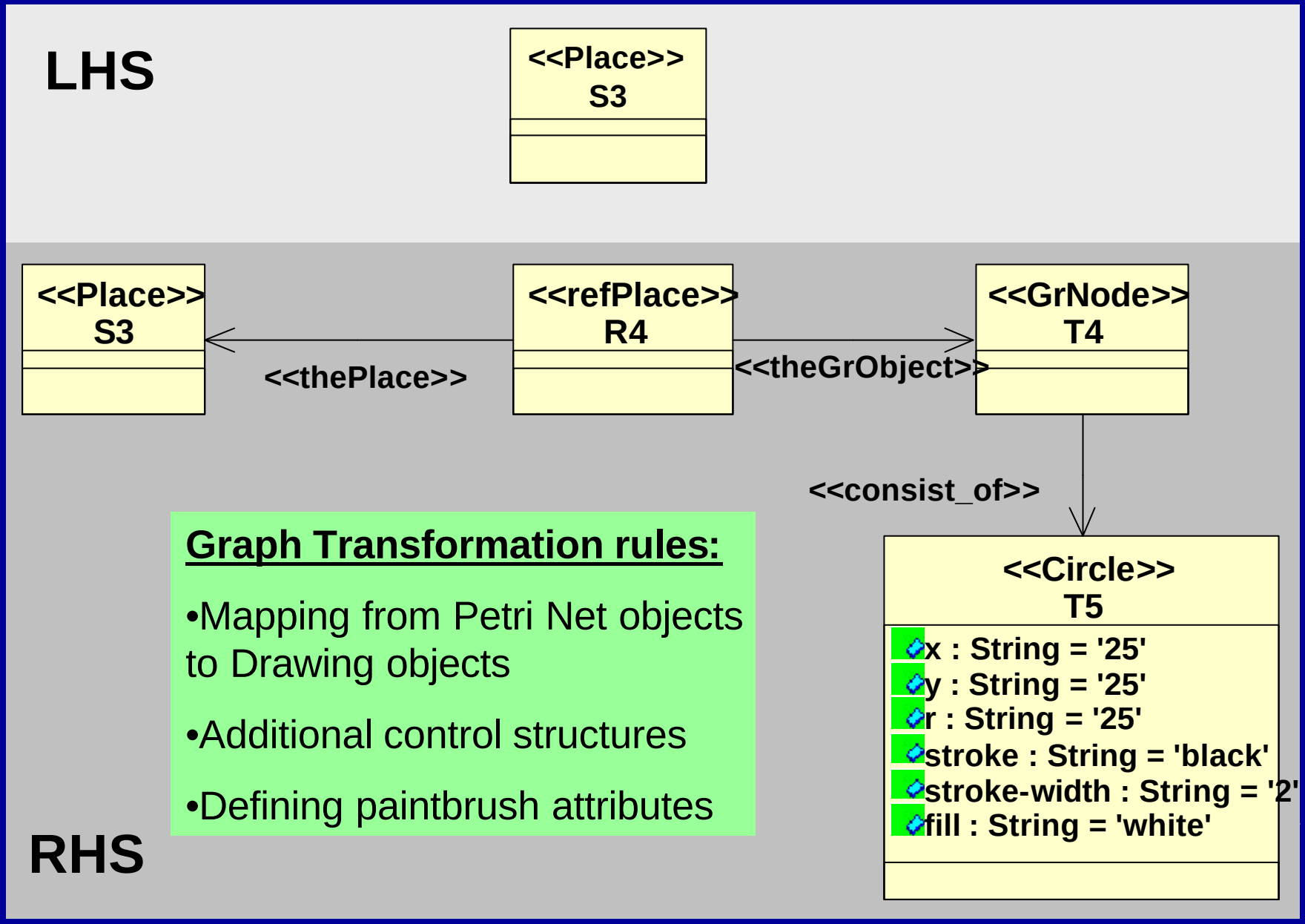
A Metamodel of Drawing Primitives



The Drawing Model of Sample Petri Net



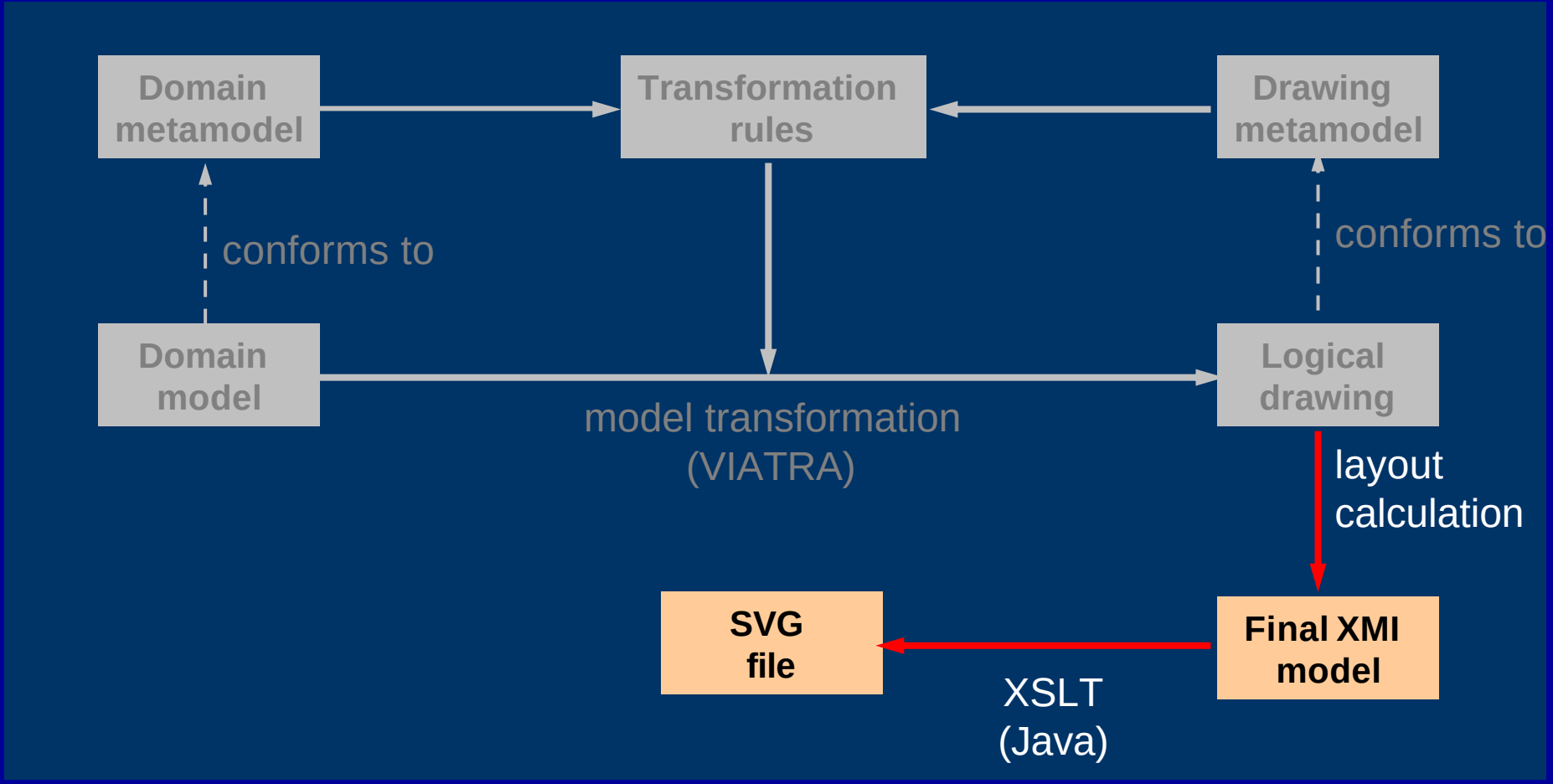
Model Transformation Rules



Graph Transformation rules:

- Mapping from Petri Net objects to Drawing objects
- Additional control structures
- Defining paintbrush attributes

Checkpoint: What Comes Next?



XMI Representation of Drawing Model

```
<GrNode xmi.id="13">
  <contains>
    <GrNode xmi.idref="24"/>
  </contains>
  <start>
    <Circle xmi.idref="14"/>
  </start>
  <consist_of>
    <Circle xmi.id="14">
      <r>25</r>
      <stroke>black</stroke>
      <stroke_width>2</stroke_width>
      <fill>white</fill>
      <next/>
    </Circle>
  </consist_of>
</GrNode>
```

XML Element

```
<GrNode xmi.id="24">
  <contains/>

<start>
    <Circle xmi.idref="25"/>
  </start>
  <consist_of>
    <Circle xmi.id="25">
      <r>10</r>
      <stroke>black</stroke>
      <stroke_width>2</stroke_width>
      <fill>black</fill>
      <next/>
    </Circle>
  </consist_of>
</GrNode>
```

XML Attribute

<u>XMI = XML Metadata Interchange</u>

- XML dialect defined for each metamodel
- “meta” standard

<u>Current phase:</u>

- paintbrush parameters, BUT
- no physical coordinates

Graph Layout Calculation

- Method:
  - abstracting from drawing primitives
  - calculating coordinates for *GrObjects*
- Off-the-shelf tool support:
  IBM Graph Foundation Classes (GFC)
  + Java class library for graph
    - creation
    - manipulation
    - visualization
  - problems in visualizing non-planar graphs

Result of Graph Layout Calculation

```
<GrNode xmi.id="13">
  <contains>
    <GrNode xmi.idref="24"/>
  </contains>
  <start>
    <Circle xmi.idref="14"/>
  </start>
  <consist_of>
    <Circle xmi.id="14">
      <cx>25</cx>
      <cy>25</cy>
    <r>25</r>
      <stroke>black</stroke>
      <stroke_width>2</stroke_width>
      <fill>white</fill>
      <next/>
    </Circle>
  </consist_of>
</GrNode>
```

```
<GrNode xmi.id="24">
  <contains/>

<start>
    <Circle xmi.idref="25"/>
  </start>
  <consist_of>
    <Circle xmi.id="25">
      <cx>25</cx>
      <cy>25</cy>
      <r>10</r>
      <stroke>black</stroke>
      <stroke_width>2</stroke_width>
      <fill>black</fill>
      <next/>
    </Circle>
  </consist_of>
</GrNode>
```

Java + GFC:

- easy XML handling
- platform independence

Current phase:

- paintbrush parameters, AND
- concrete physical coordinates

XSL Transformation

- XSL Transformations
  - XML standard for syntactic manipulation of XML documents
- In Our Framework:
  - From: Drawing XMI
  - To: SVG format
- General solution
  - one XSLT sheet ?
    any instance of any modeling language
  - another transformation technique, BUT
    hidden from the user

Scalable Vector Graphics (SVG)

- SVG = an XML-based language to describe vector graphical images
  - Drawing primitives: circle, rectangle, line, etc.
  - Grouping: for composite drawing objects
  - Basic manipulations: rotate, scale, translate,
  - User interaction...

```
<svg width="100%" height="100%"
    viewBox="0 0 200 600">
<g transform="translate(125 125)">
 <g>   <!-- place -->
  <circle cx='25' cy='25' r='25'
          stroke='black' stroke-width='2'
    fill='white'/>
 </g>
 <g>   <!-- token -->
  <circle cx='25' cy='25' r='10'
          stroke='black' stroke-width='2'
    fill='black'/>
 </g>
</g>
```

Conclusions

- Open visualization framework for VLs
  - + highly automated
    - model transformations
    - graph layout calculation
  - + heavily relies on XML technologies
  - + tool independent architecture

  - – off-line (no user interaction)
  - – GFC: not suitable for complex graph layout
  - – lack of graphical constraints

Future Work (Suggestions)

- More sophisticated graph drawing tools
  - IBM GFC: not strong enough
- Drawing Constraints: CSVG (Constraint SVG)
  http://www.cs.washington.edu/research/constraints/web/csvg-www10
  - using constraints as further graphical restrictions
- User Interaction in SVG
  - handling of mouse events, etc.
  - Vision: SVG-based UI for visual language tools?
- Default SVG representation for GXL/GTXL