2007 Bellairs
CAMPaM Workshop

A Study of Model Transformation Technologies:

Reconciling TGGs with QVT

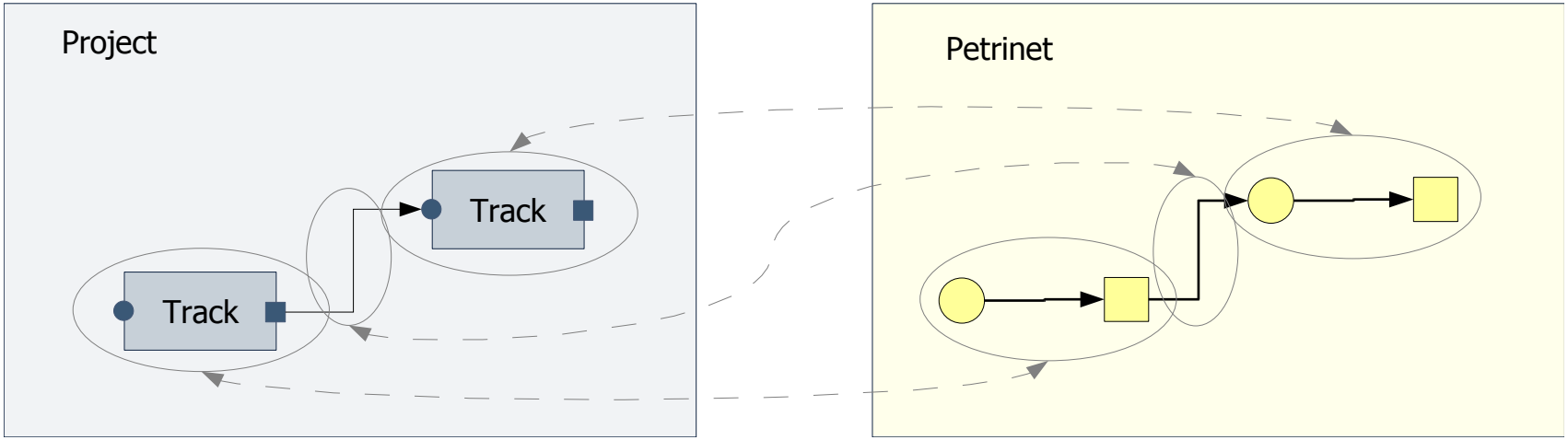
Joel Greenyer

Diploma Thesis supervised by Dr. Ekkart Kindler and Robert Wagner

UNIVERSITÄT PADERBORN
Institut für Informatik – FG Softwaretechnik

Software Engineering Group

Example: ComponentTools To Petrinet



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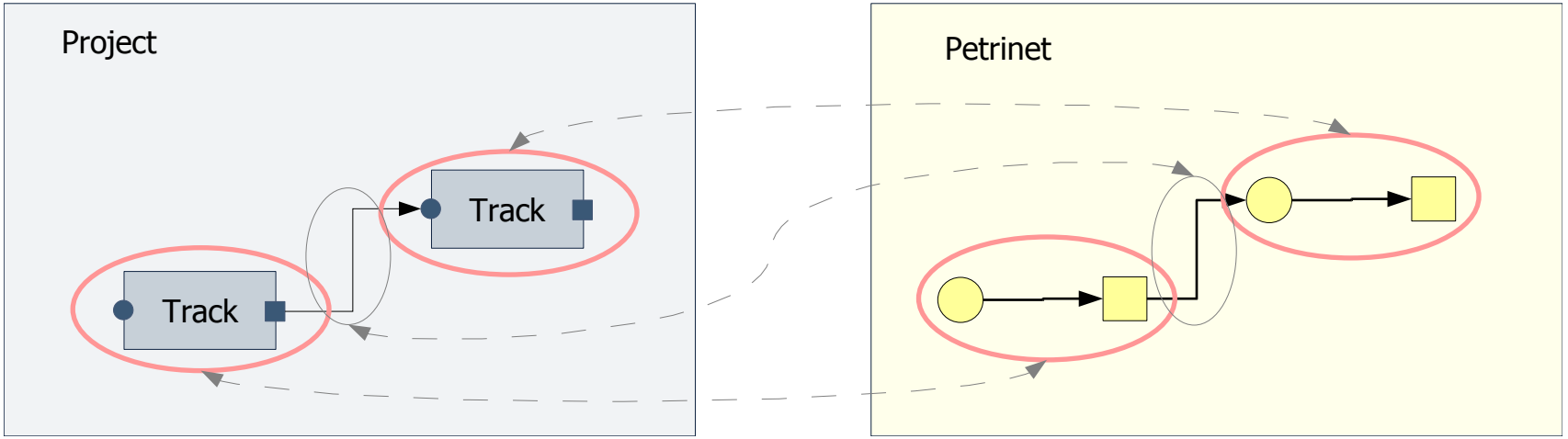
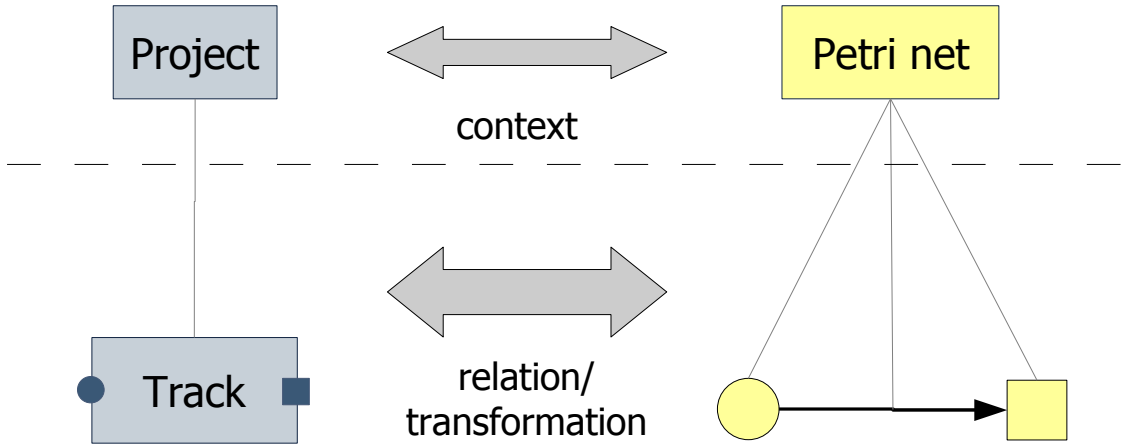
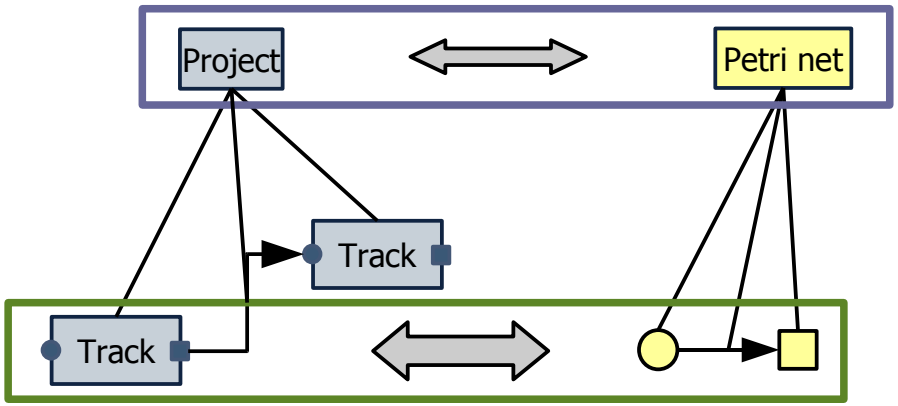


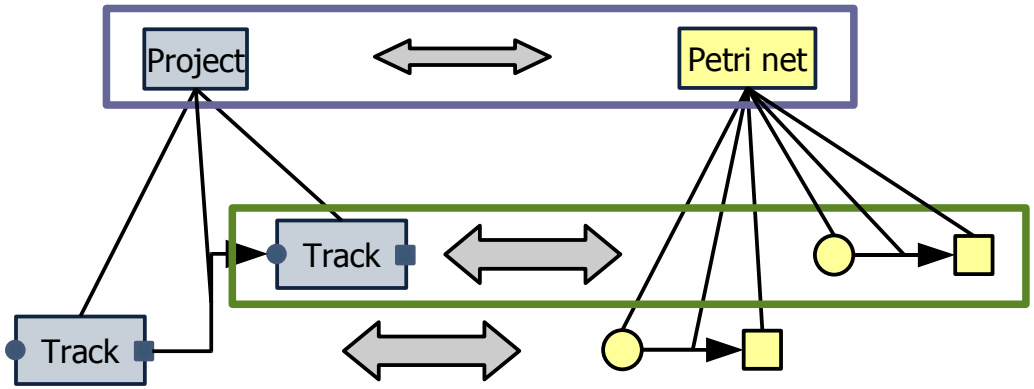
- Example Rule: TrackToPlaceArcTransition



- Declarative
- Relational
- Graph-pattern-based

Example: ComponentTools To Petrinet





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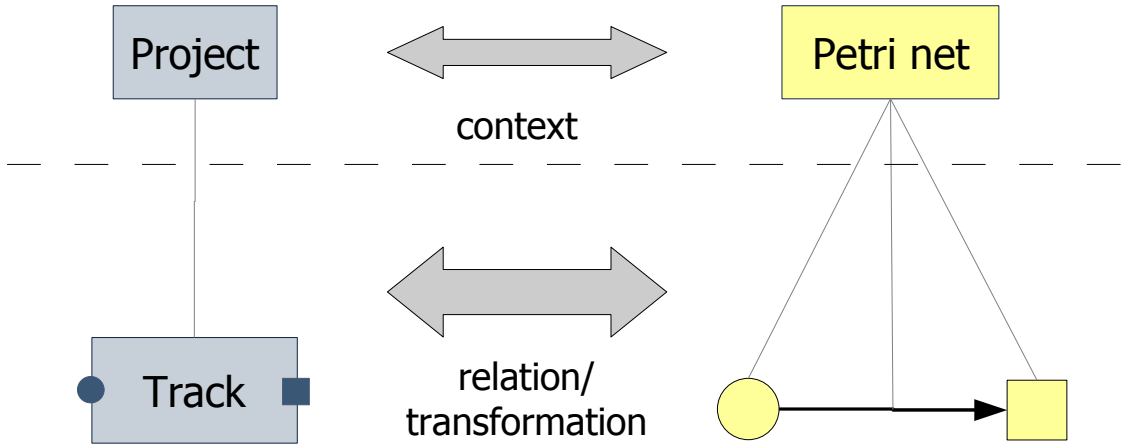

- Declarative
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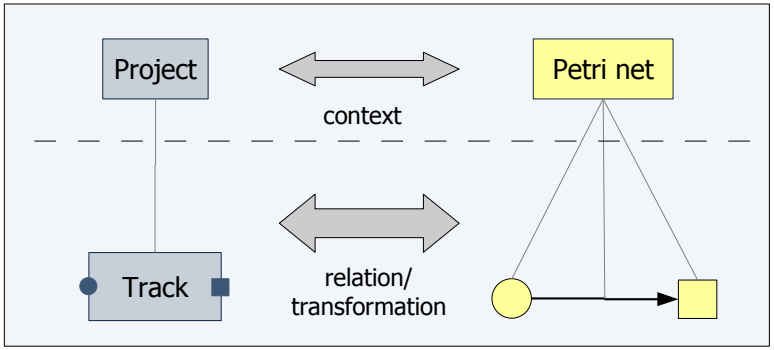
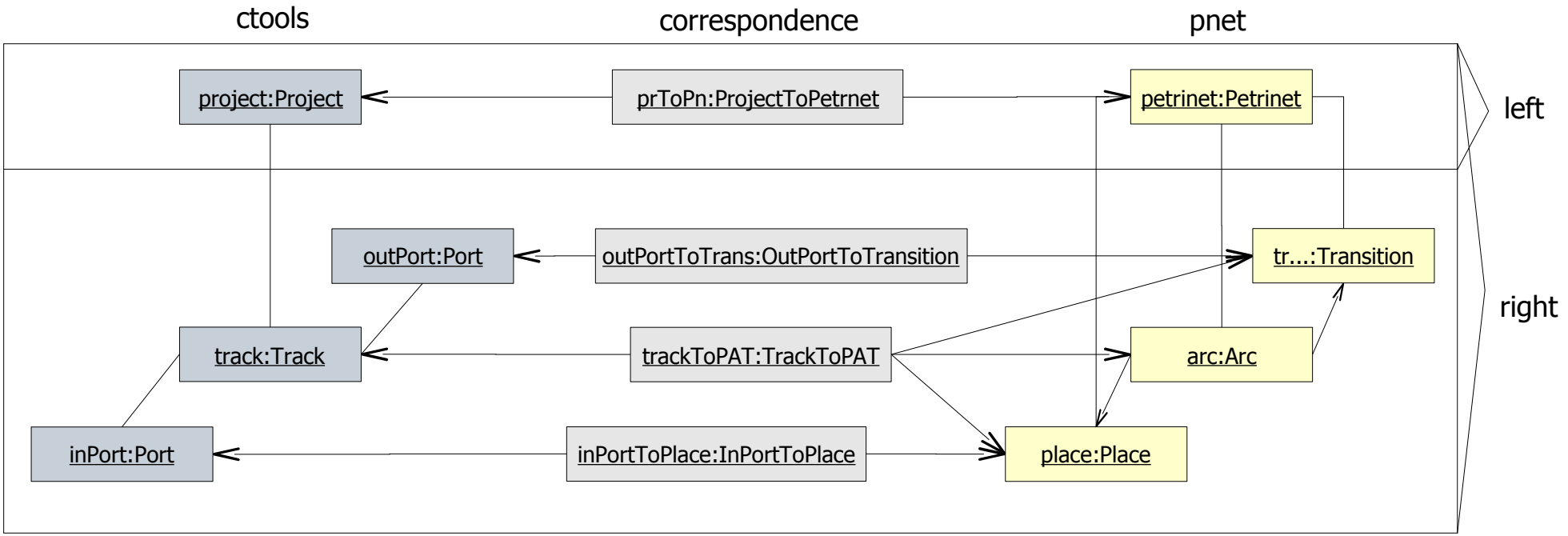
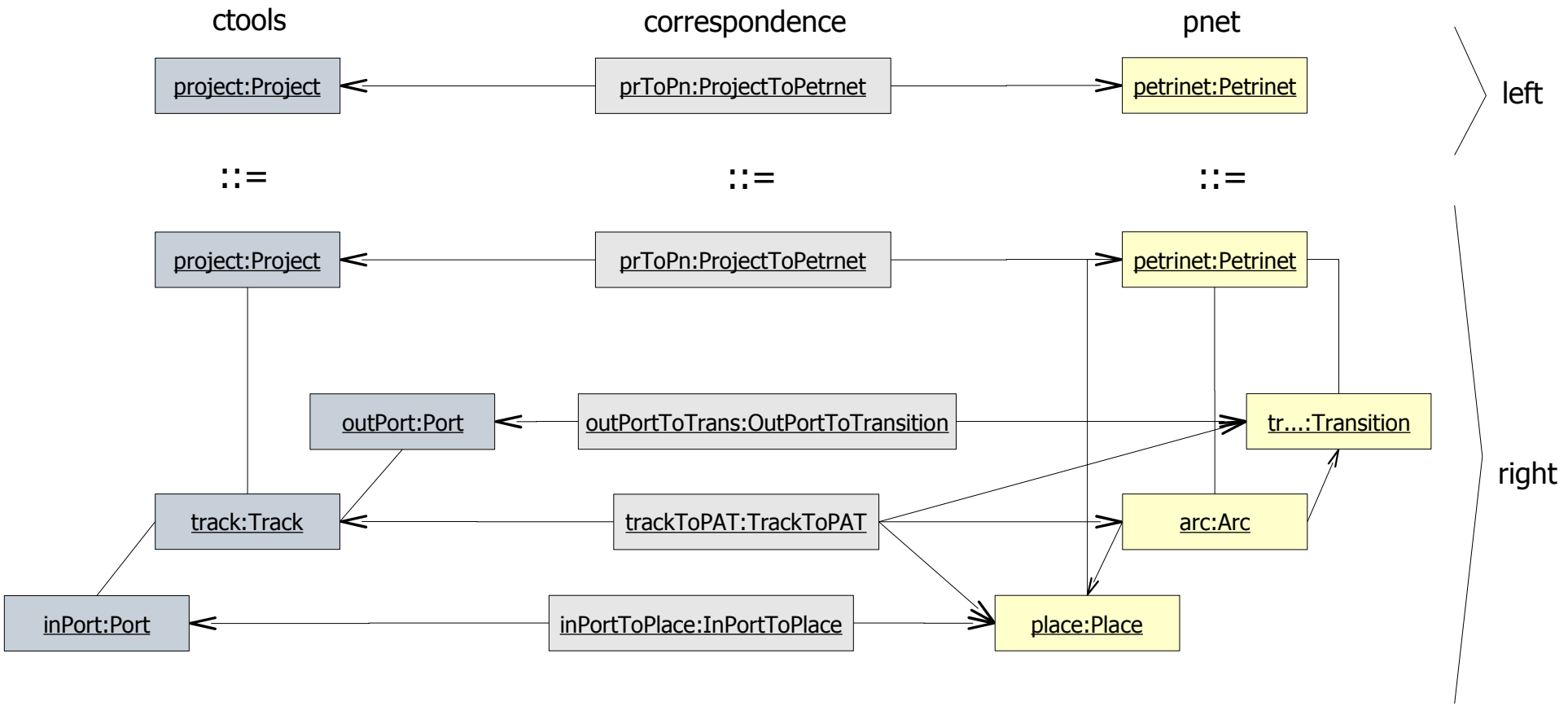
TGG Rule TrackToPlaceArcTransition

- The corresponding TGG rule:





TGG Rule TrackToPlaceArcTransition



TGG Rule TrackToPlaceArcTransition

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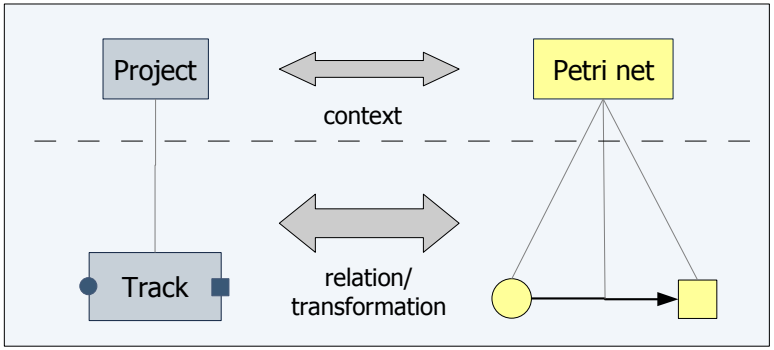

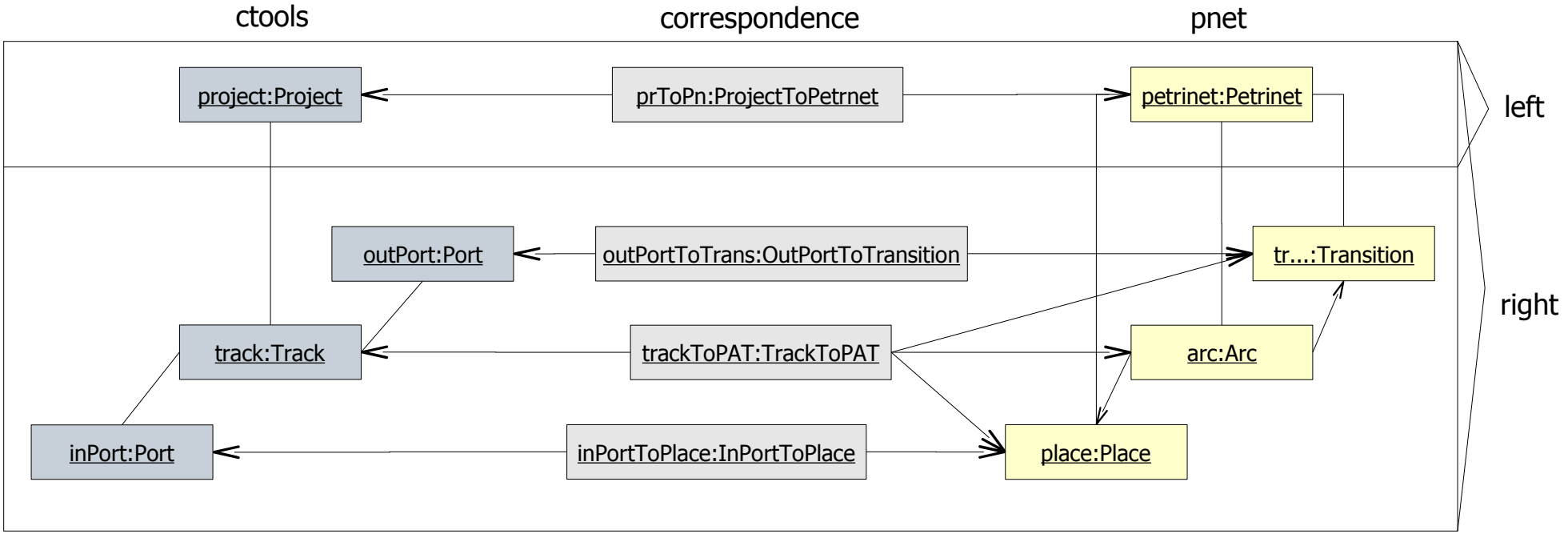

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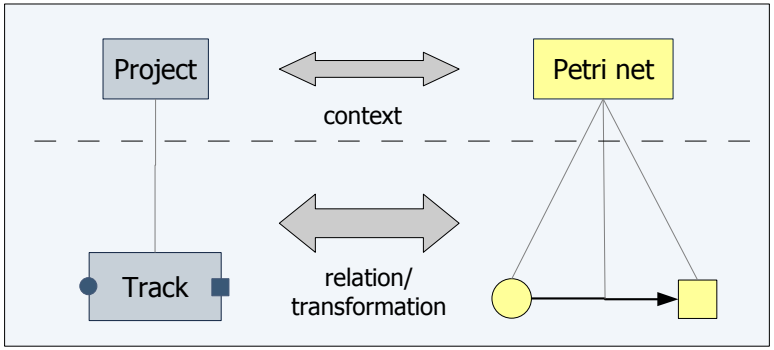

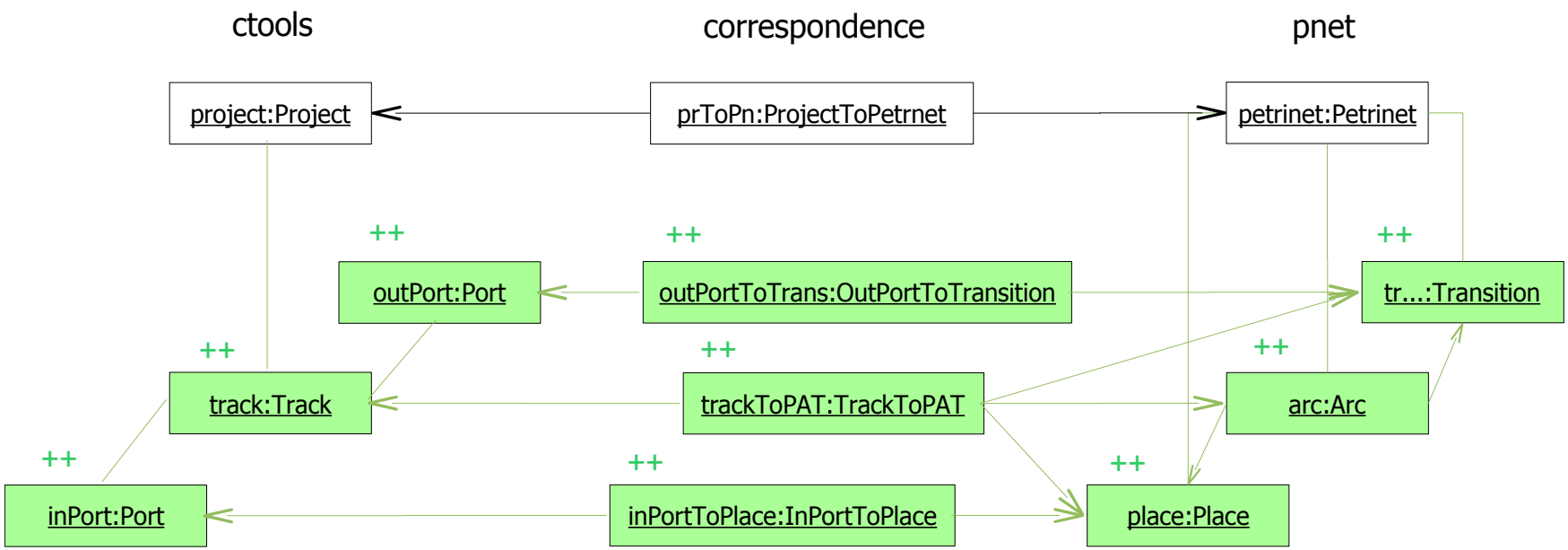

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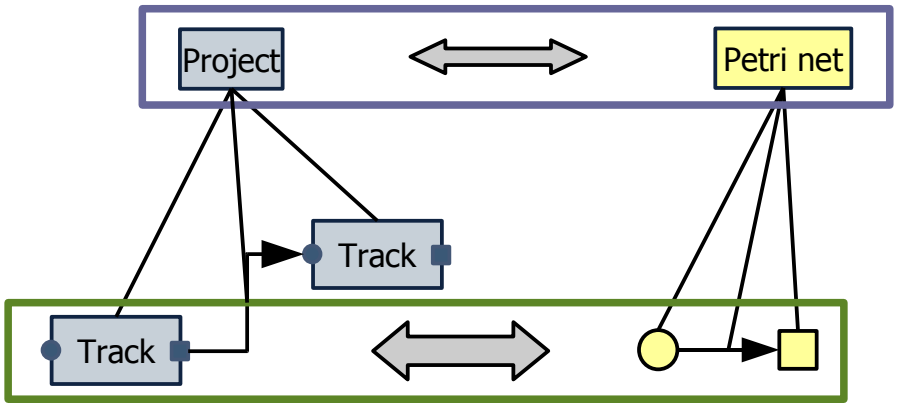
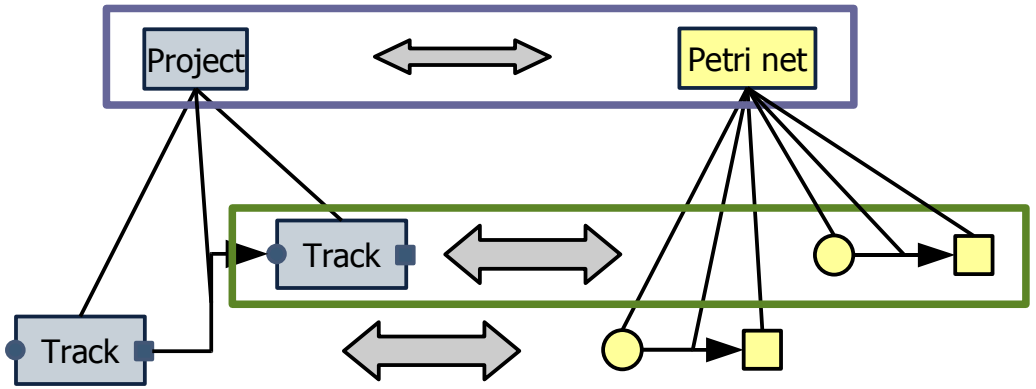
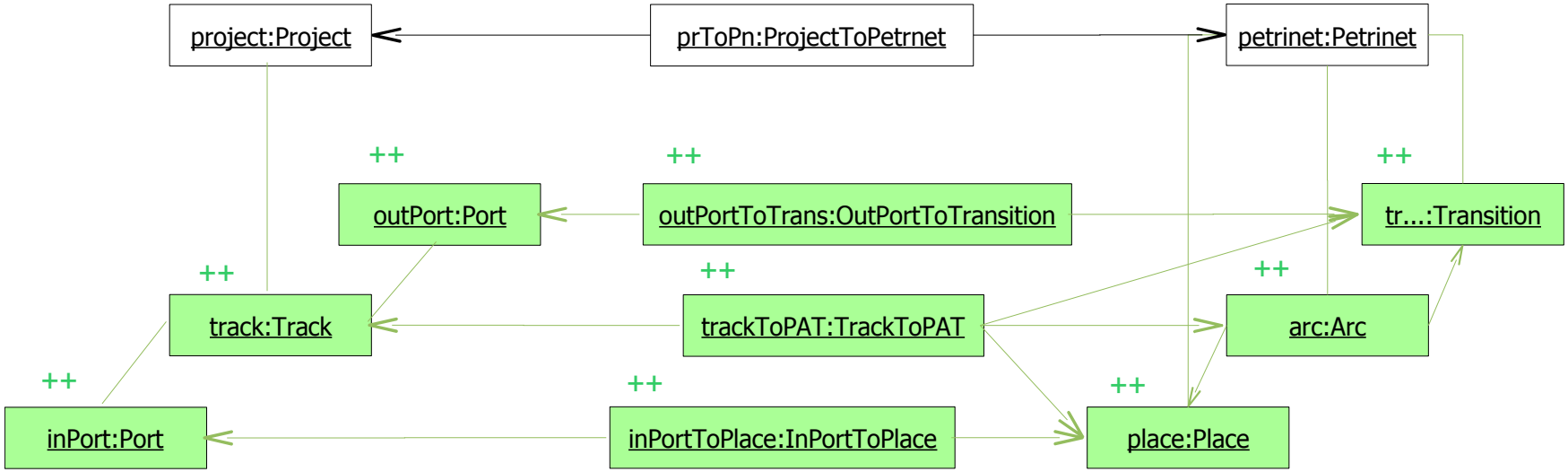




ctools correspondence pnet



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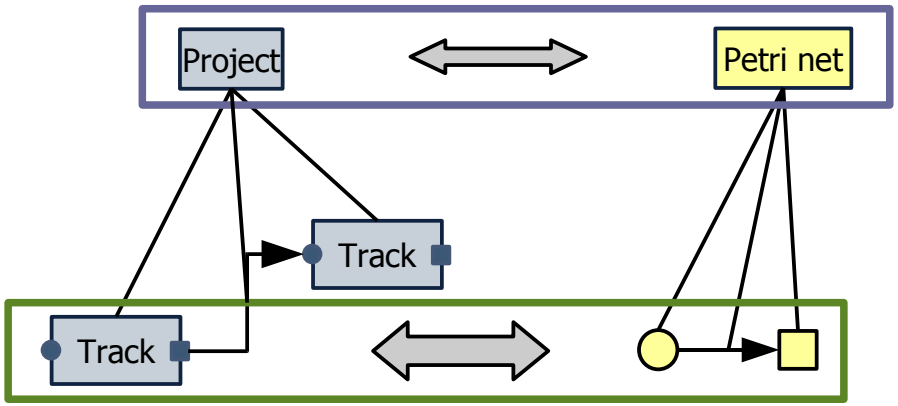

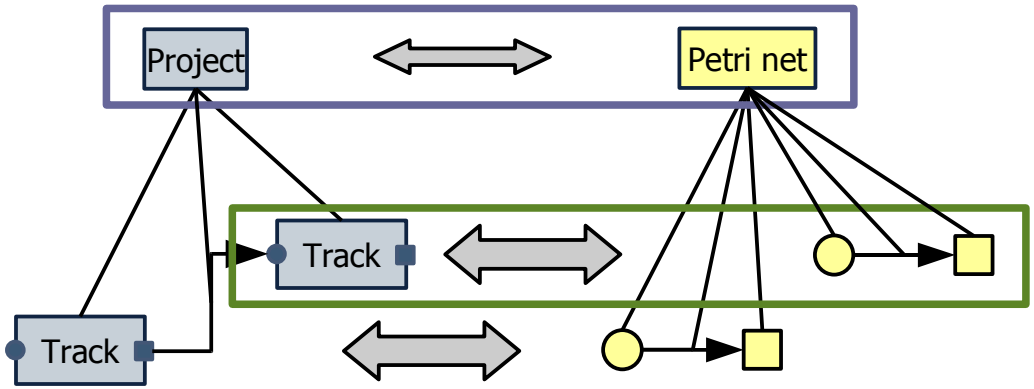

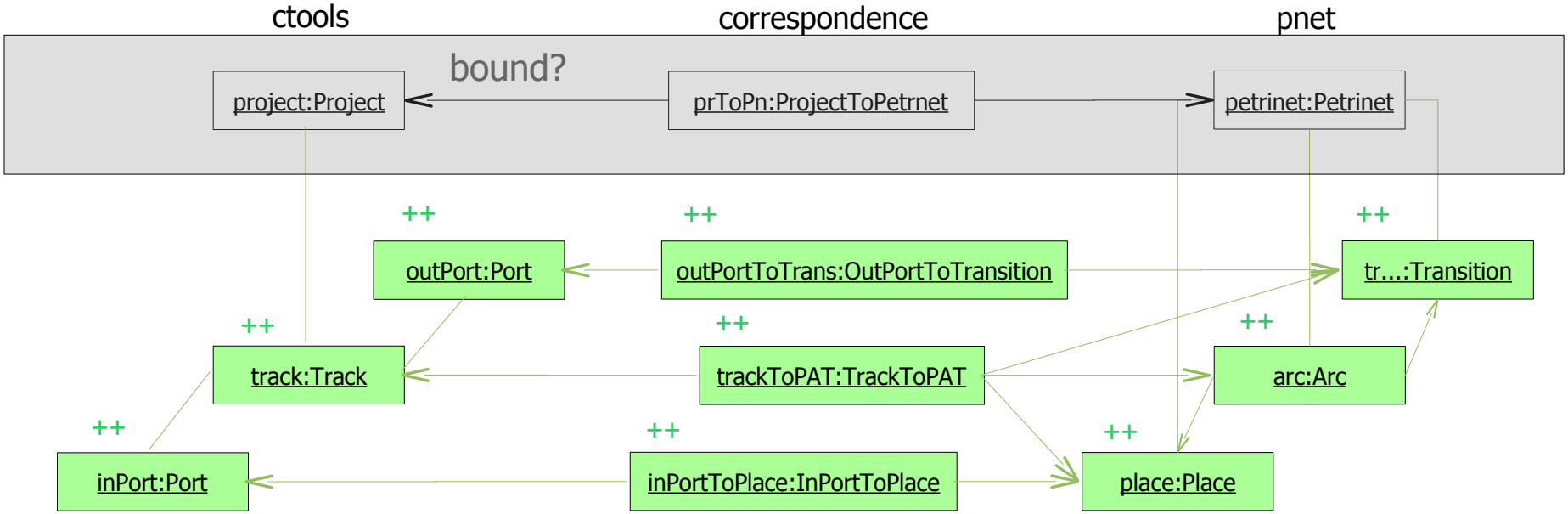

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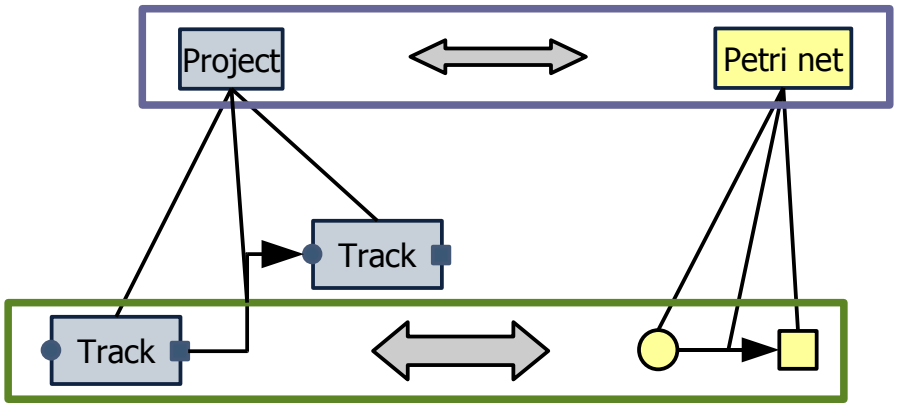

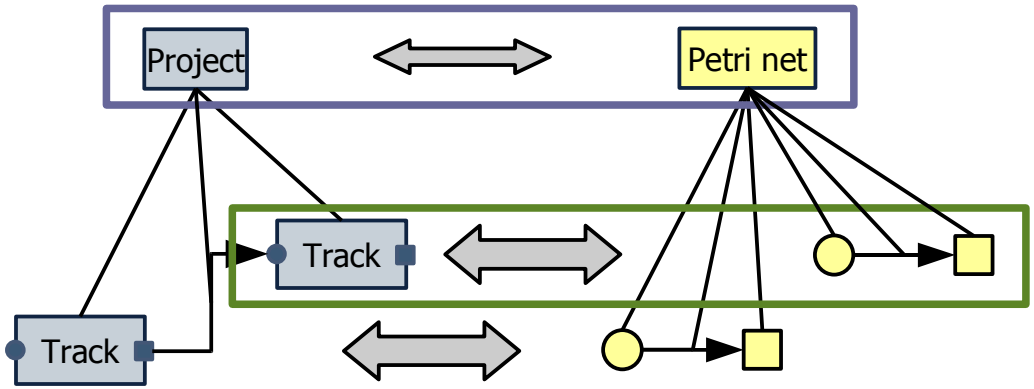

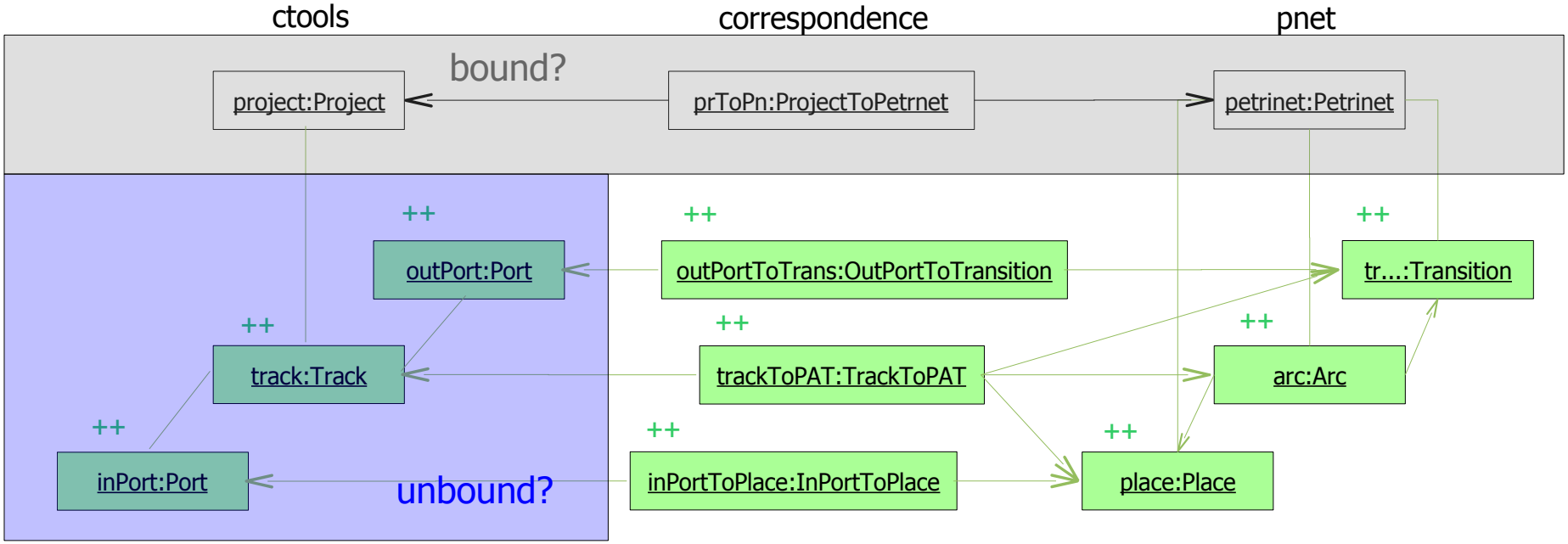

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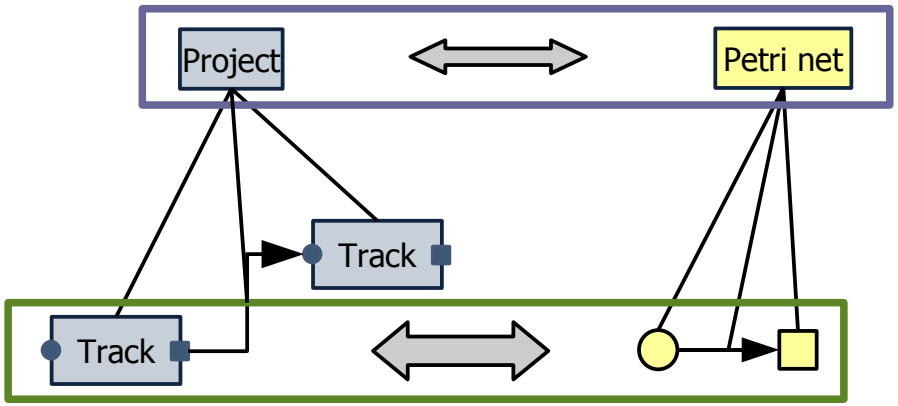
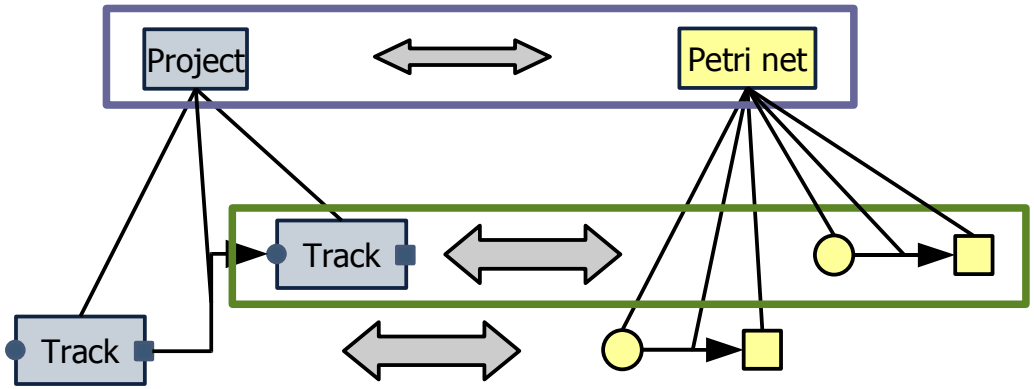
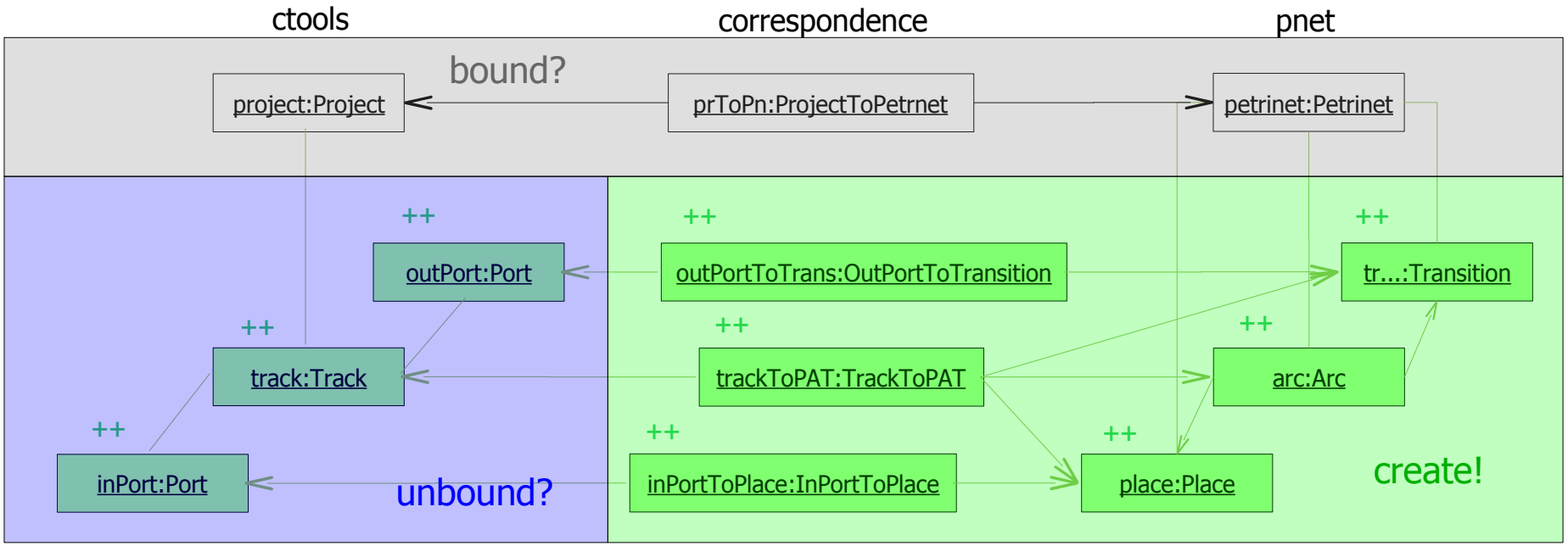
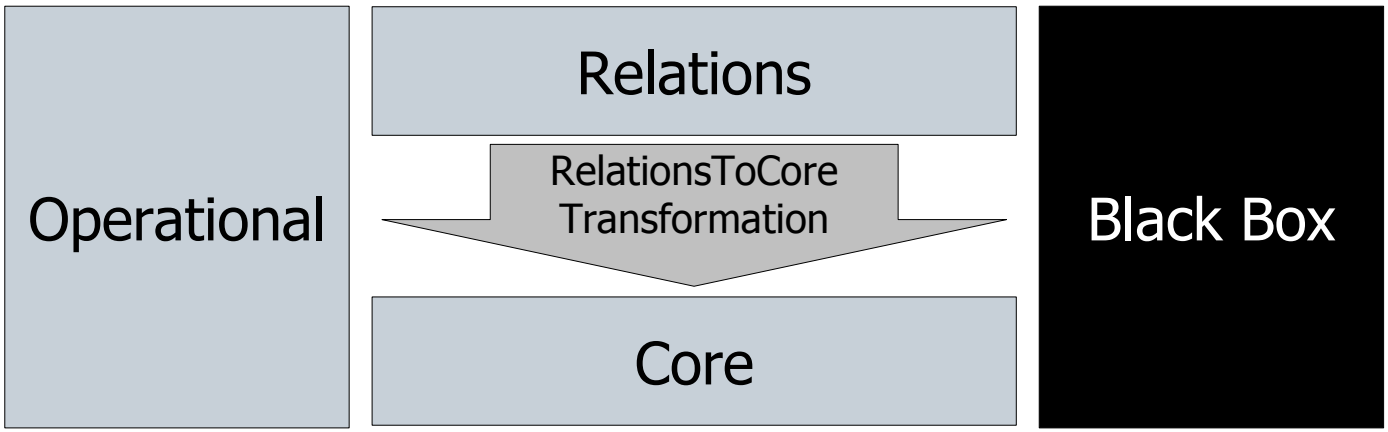






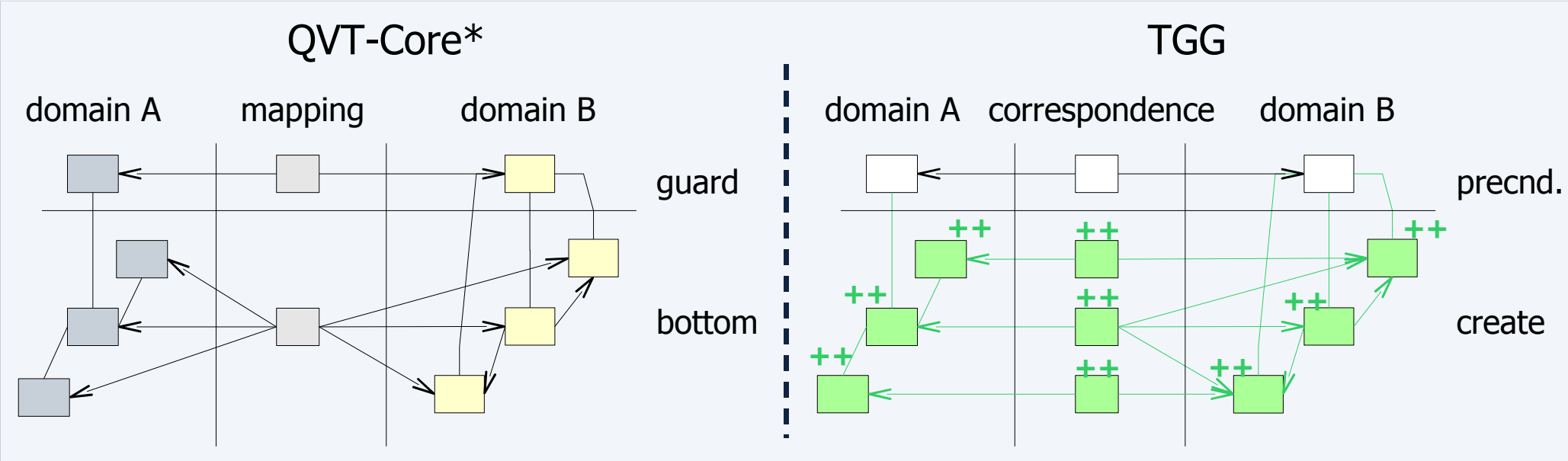
QVT Overview

- Model Transformation Approaches in MDD and MDA
  - Many techniques, different strenghts and weaknesses
- OMG's QVT (Query/Views/Transformations)[2]
  - Result of selecting and merging different approaches
  - Combination of declarative and imperative languages
  - Focus on declarative languages



QVT-Core vs. TGGs – Short Comparison

- Structurally similar rules



- Graph structure: Variables and OCL-Predicates
- One *Trace Class*

- Graph structure: Nodes and Edges
- Multiple *Correspondence Nodes*

*:QVT-Core does not specify a graphical notation

QVT-Core vs. TGGs – Short Comparison

- Structurally similar rules

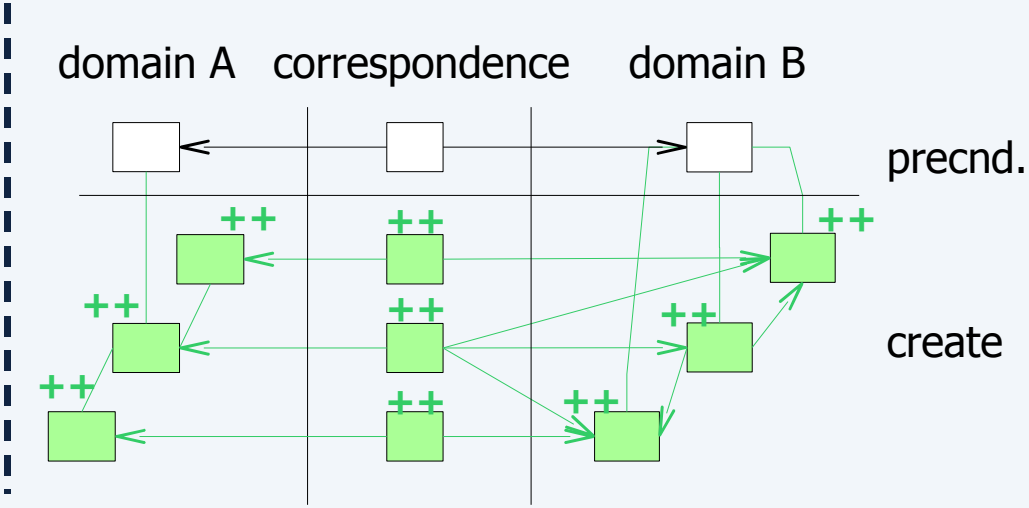
QVT-Core

```
map TrackToPlaceArcTransition{

  check ctools(project:Project){
     track:Track, portIn:Port|
     track.project = project;
     track.port = portIn;
     track.port = portOut;
  }

  check enforce pnet(petrinet:Petrinet){
     realize place:Place, ...
```

TGG



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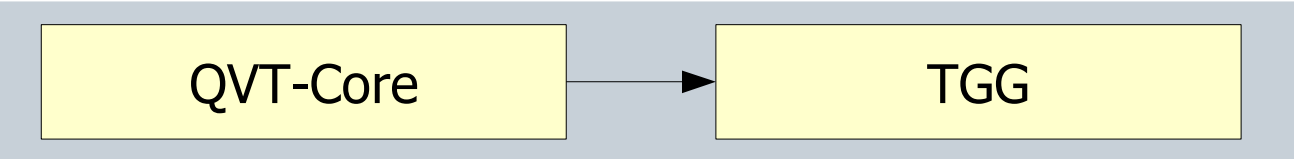
Mapping QVT to TGGs

- Main focus: Mapping QVT-Core to TGG
  - Realized through a TGG transformation
  - For fundamental pattern structure expressions



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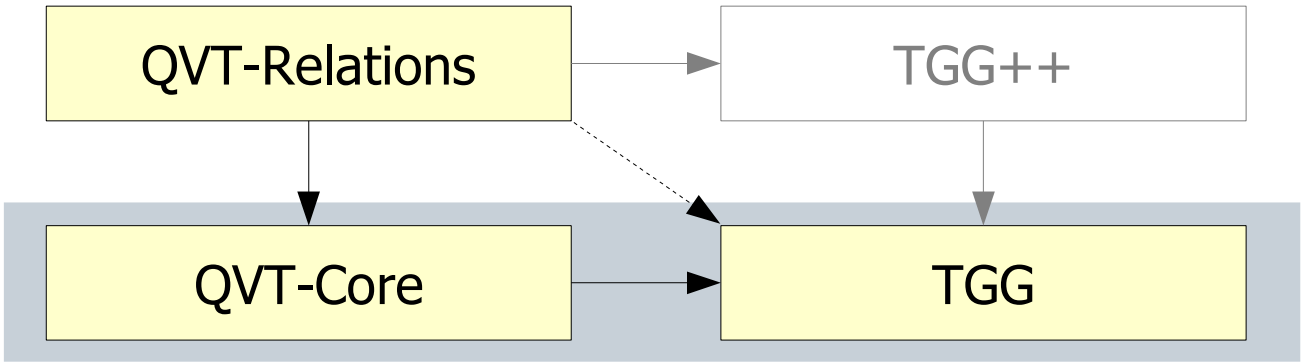
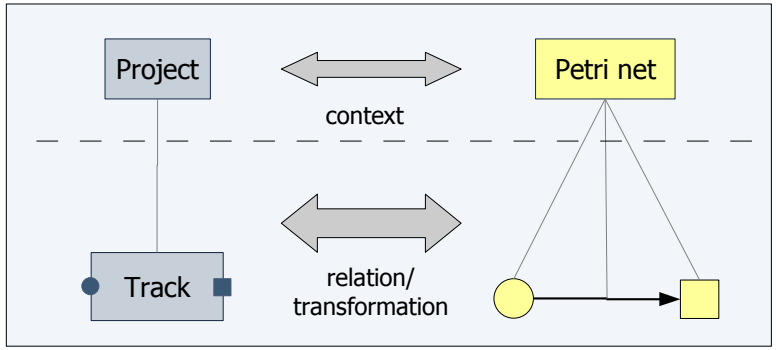
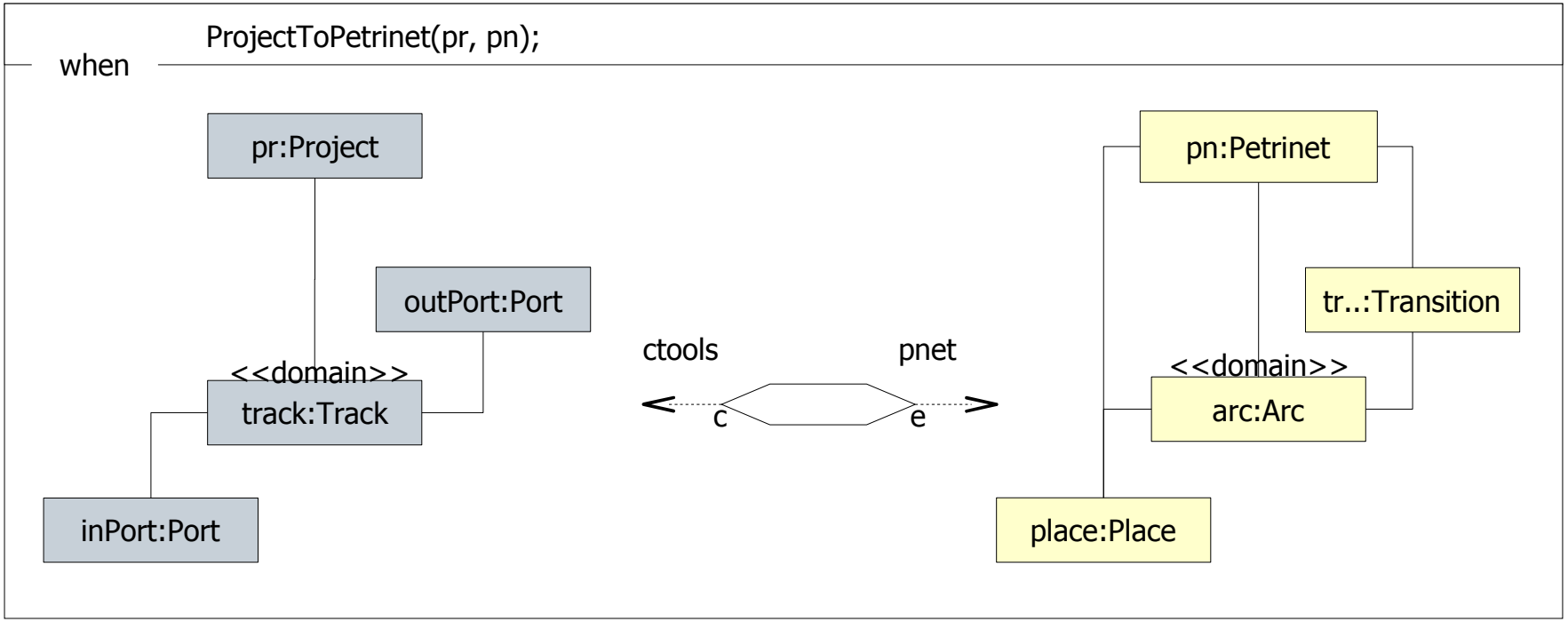


- Approach presented: QVT-Relations to TGG
- Learn from QVT: More usable "TGG++"?

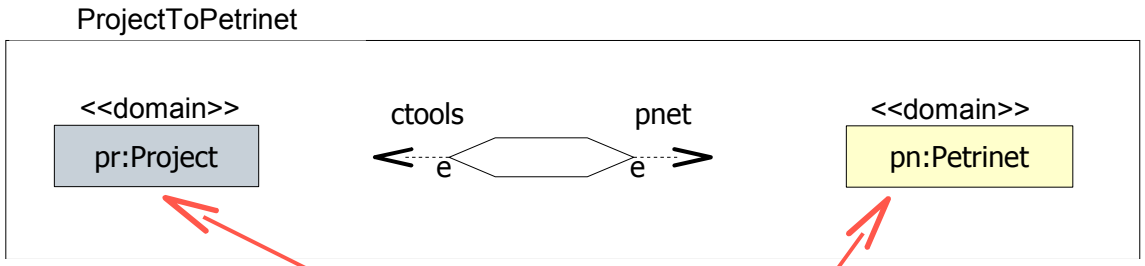
QVT Relation TrackToPlaceArcTransition

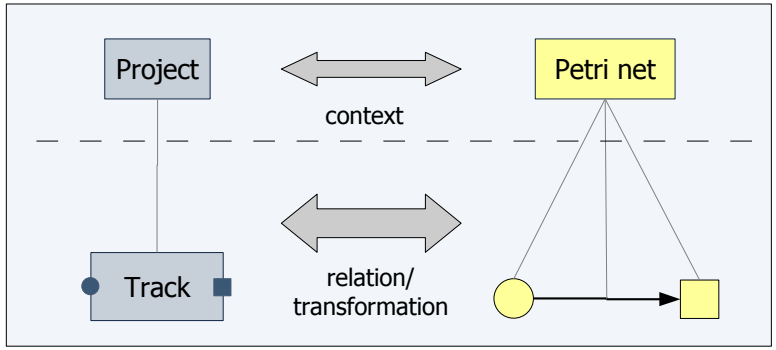


Relation TrackToPlaceArcTransition



QVT Relation TrackToPlaceArcTransition





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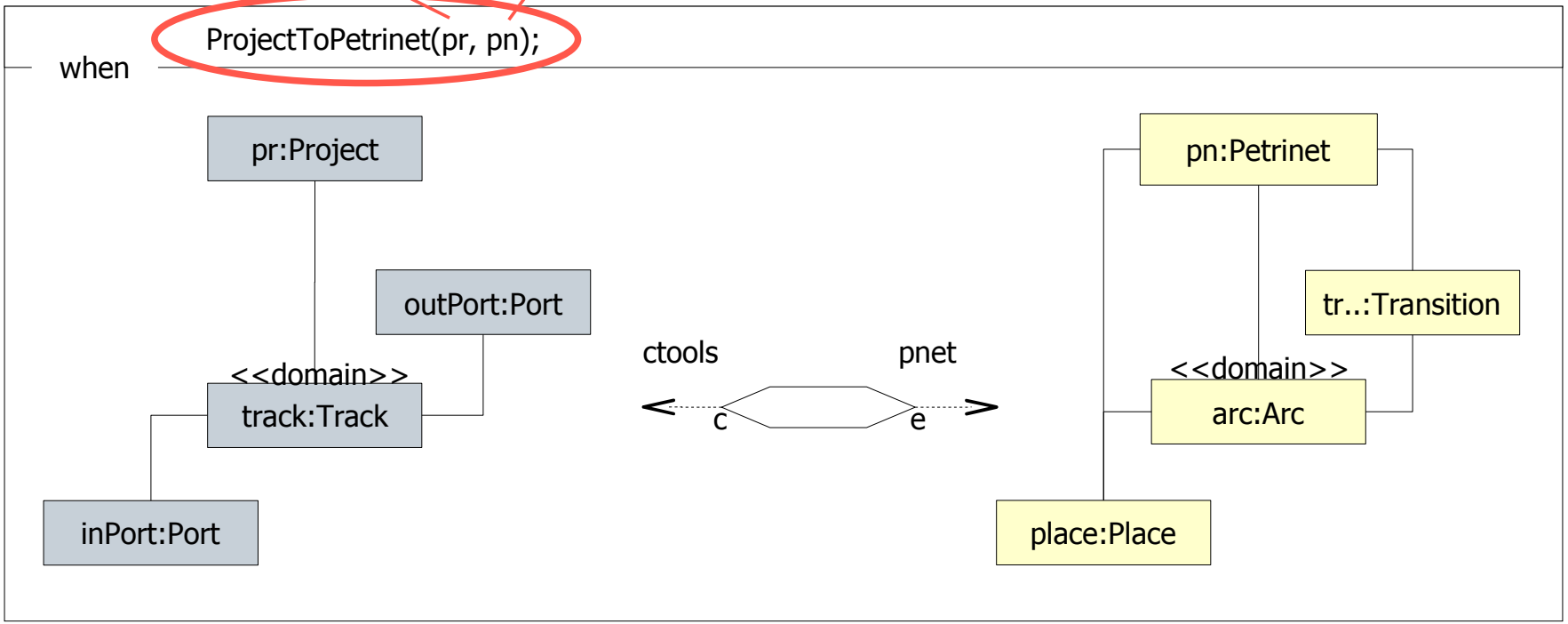
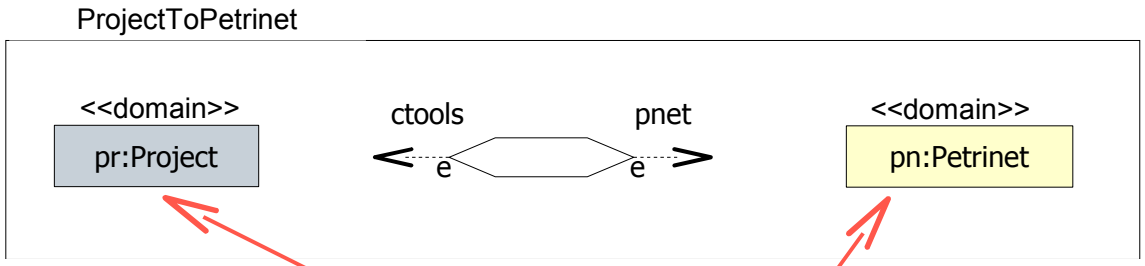
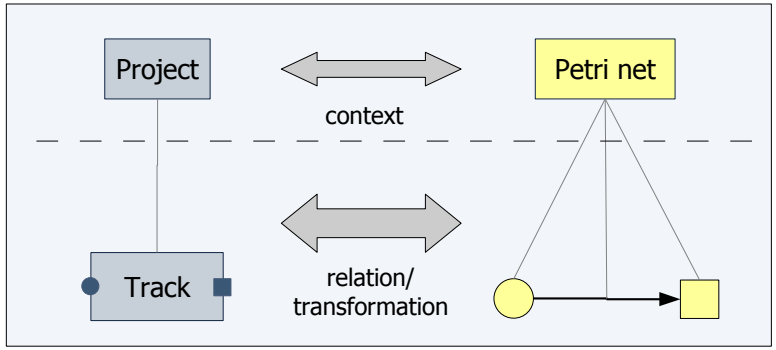


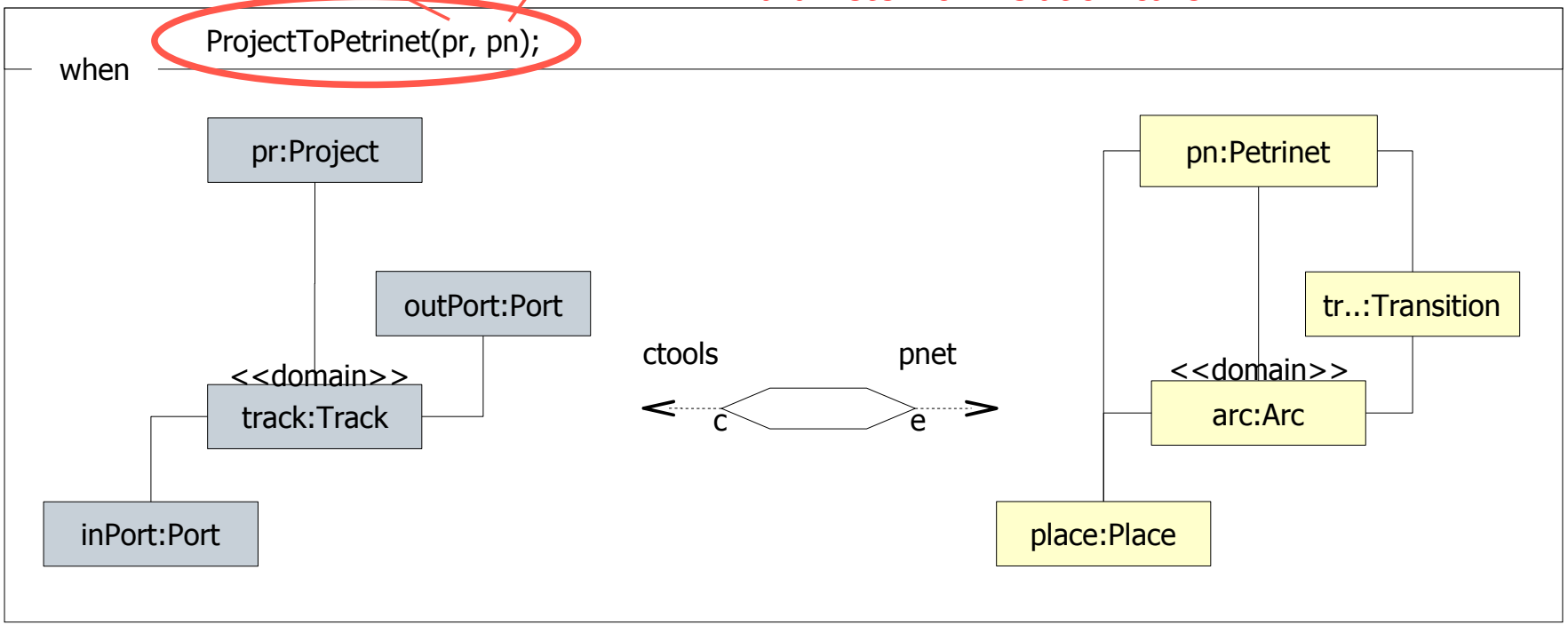
QVT Relation TrackToPlaceArcTransition





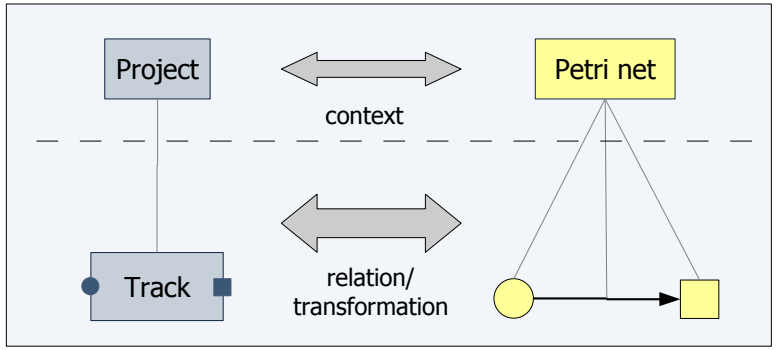
Domain-Element:
- "Root" of pattern
- Parameter for "relation calls"

Relation TrackToPlaceArcTransition

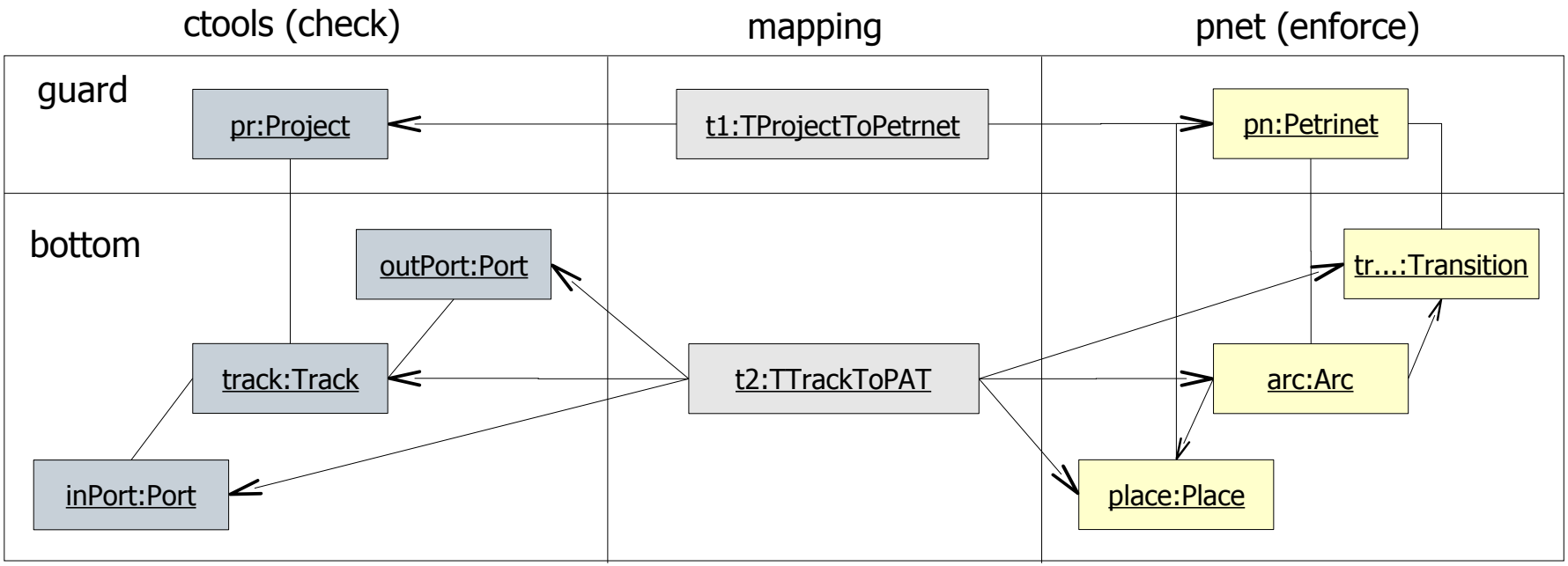


QVT-Core Mapping TrackToPlaceArcTransition

- Is transformed into a QVT-Core Mapping:

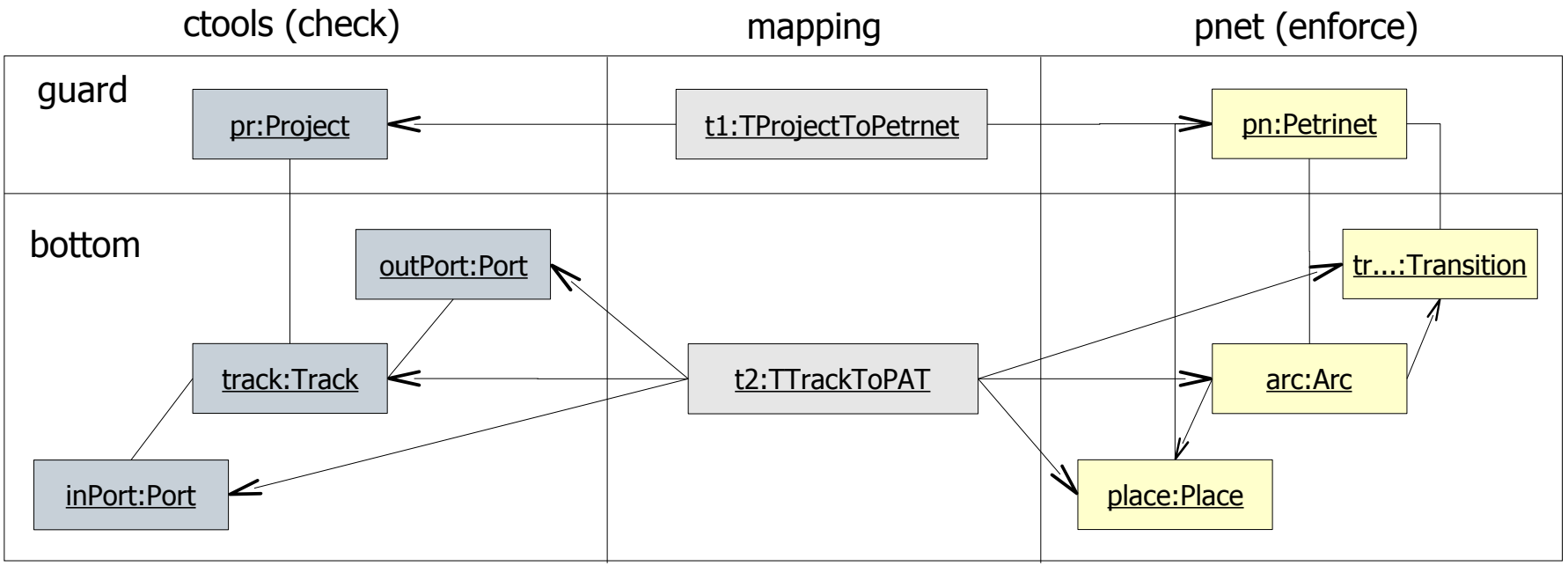


Mapping TrackToPlaceArcTransition



Semantics of a QVT-Core Mapping (fwd)

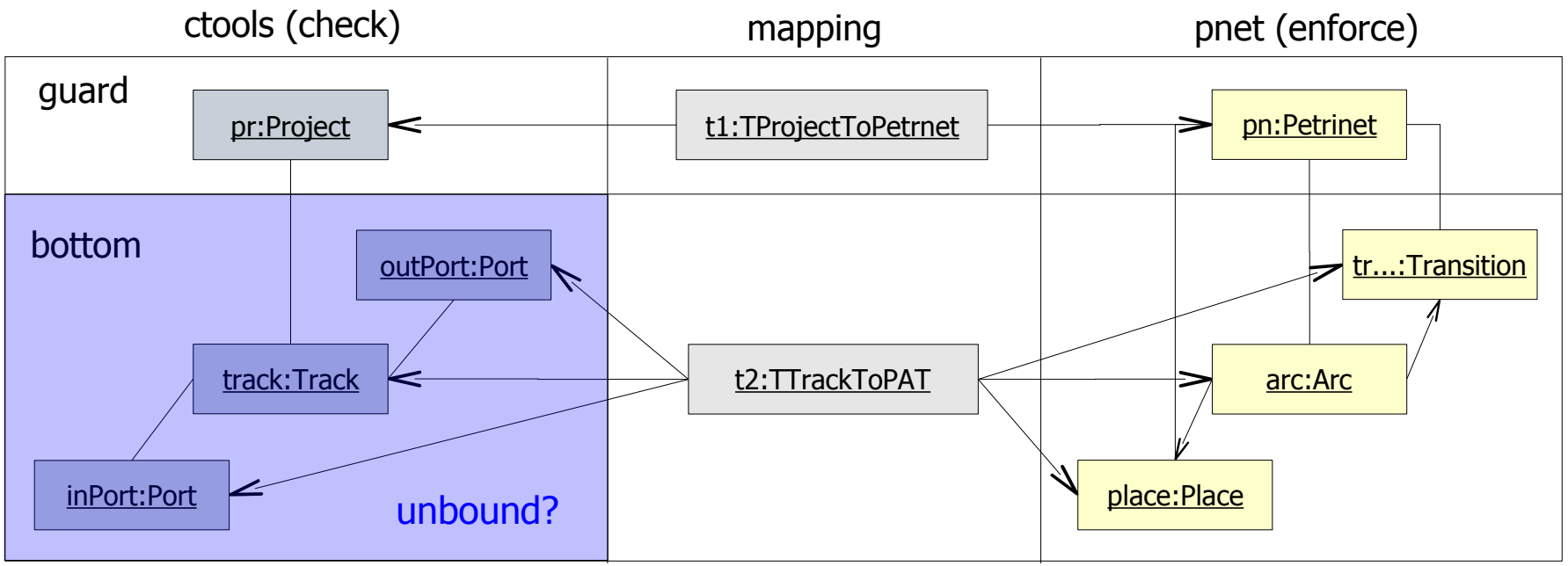
Mapping TrackToPlaceArcTransition



Semantics of a QVT-Core Mapping (fwd)

1) If Bottom Pattern found in unbound source model

Mapping TrackToPlaceArcTransition

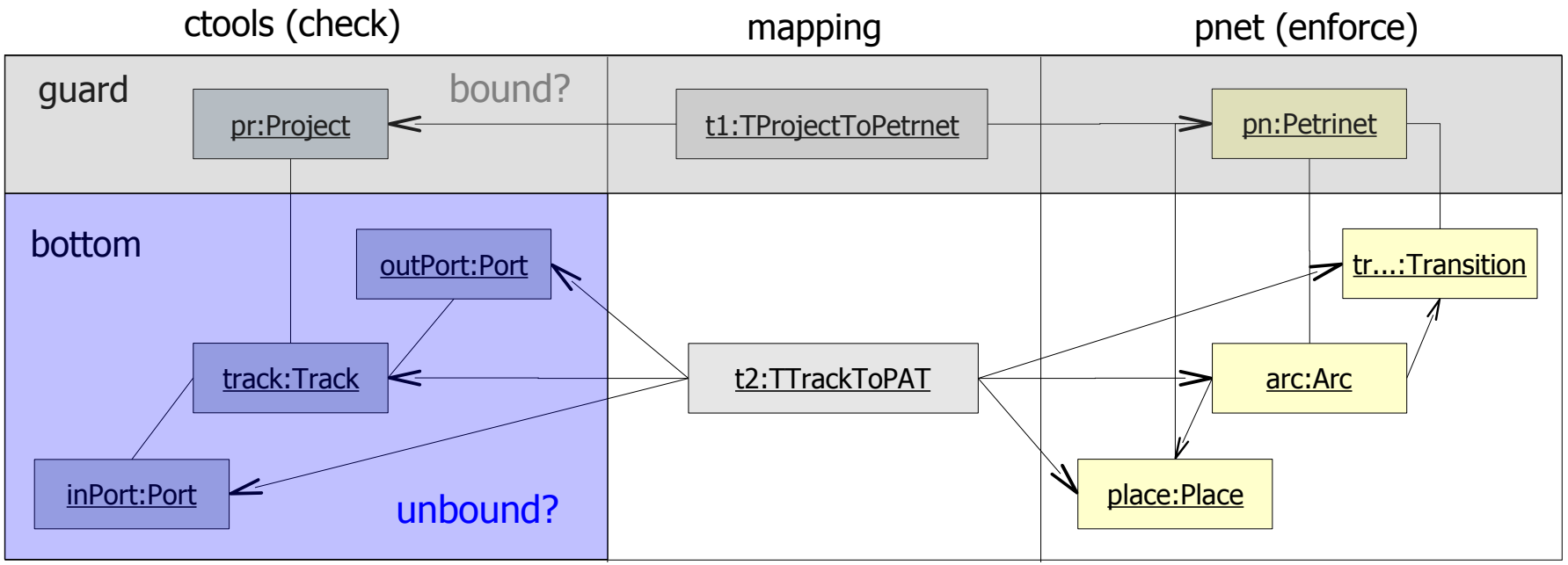


Semantics of a QVT-Core Mapping (fwd)

1) If Bottom Pattern found in unbound source model

2) & If Guard Pattern found in prev. bound model

Mapping TrackToPlaceArcTransition



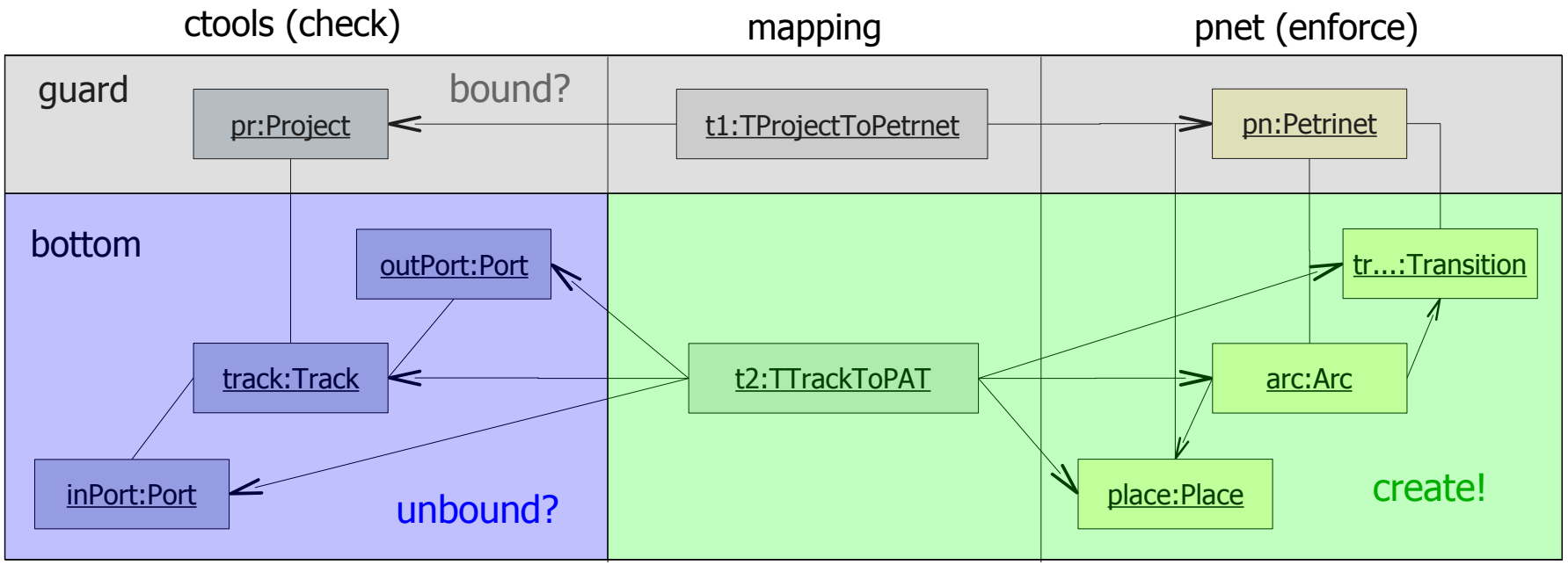
Semantics of a QVT-Core Mapping (fwd)

1) If Bottom Pattern found in unbound source model

2) & If Guard Pattern found in prev. bound model

3) Then create target model (and Trace Class)

Mapping TrackToPlaceArcTransition



Semantics of a QVT-Core Mapping (fwd)

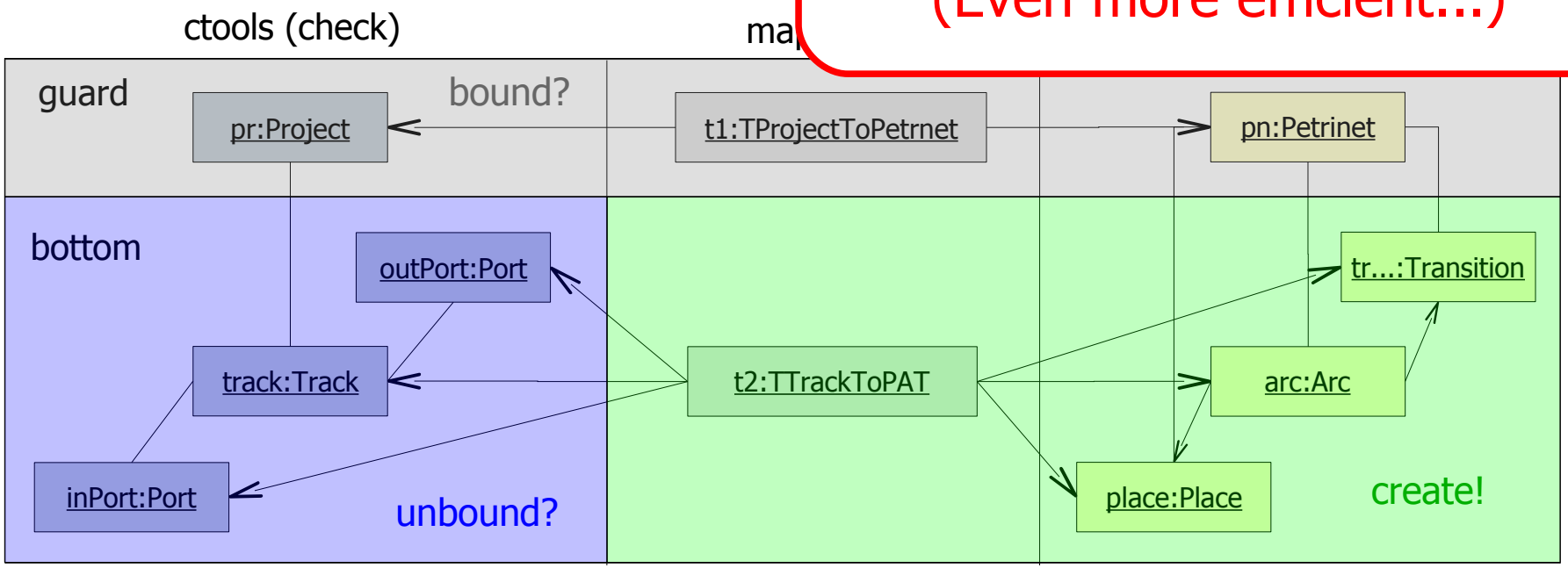
1) If Bottom Pattern found in unbound source model

2) & If Guard Pattern found in prev. bound model

3) Then create target mode

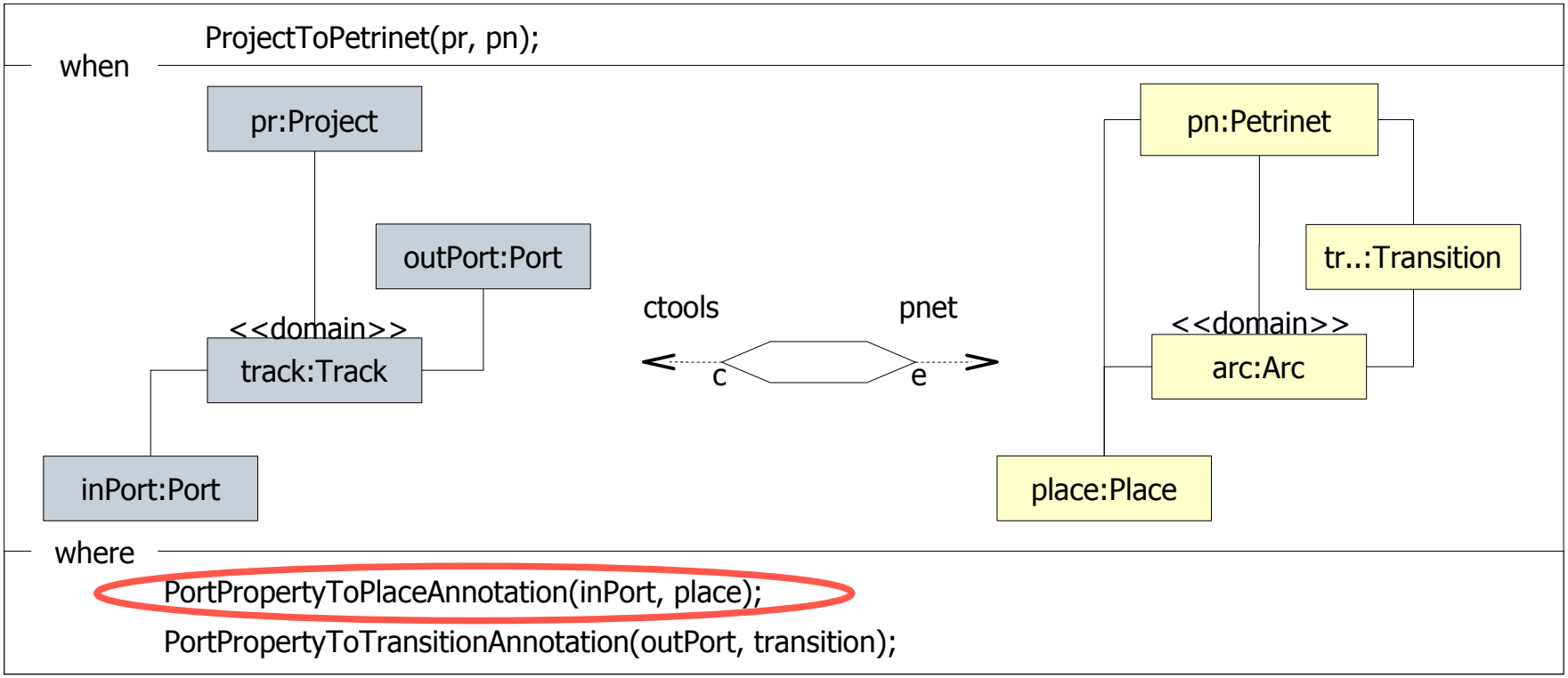
Different processing of TGGs,
but same result!
(Even more efficient...)

Mapping TrackToPlaceArcTransition



“where”-Relationships in QVT-Relations

Relation TrackToPlaceArcTransition



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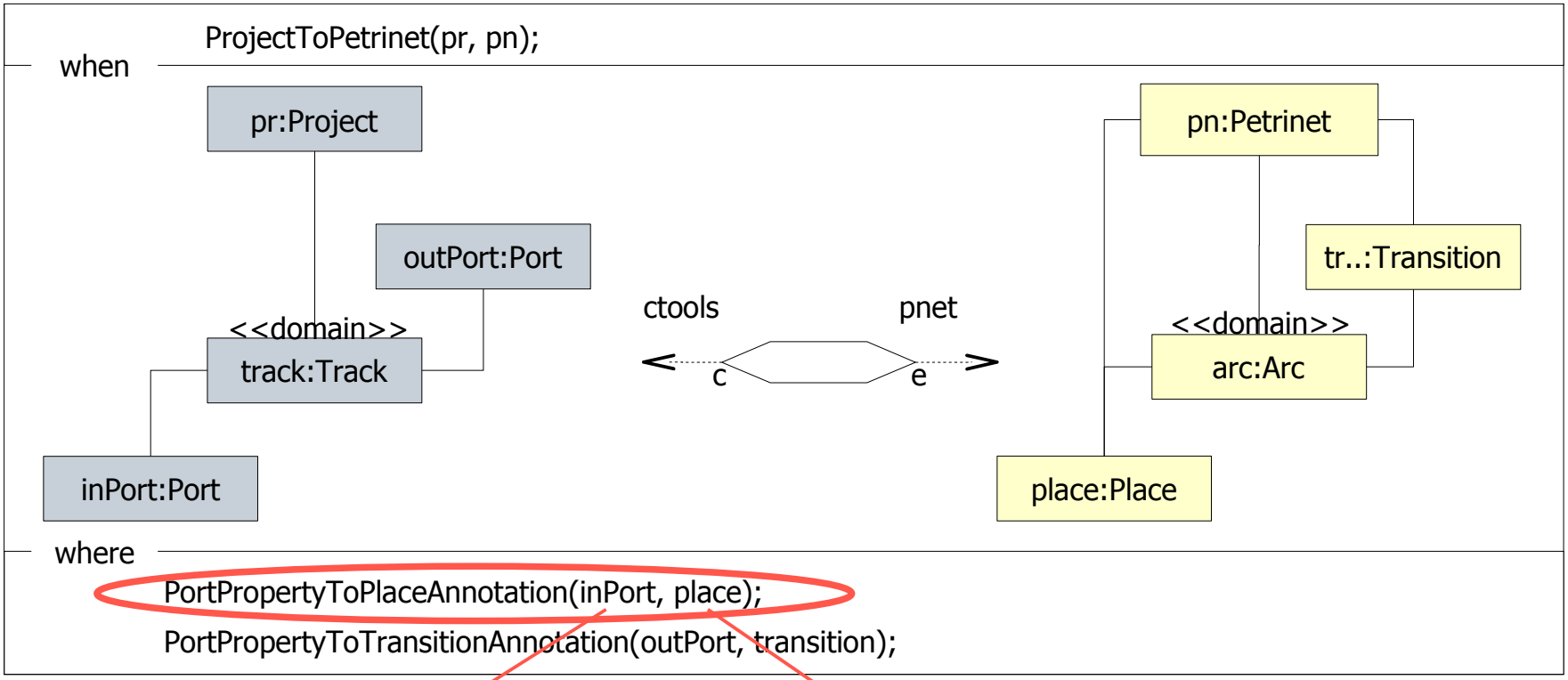
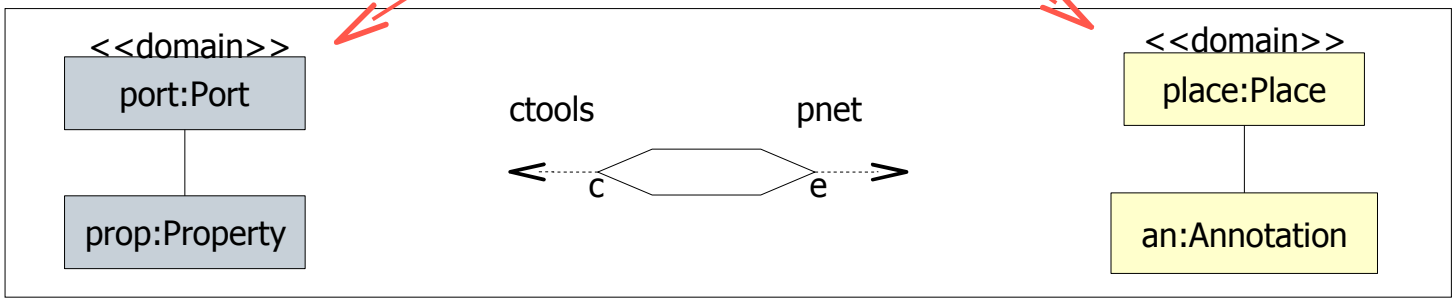
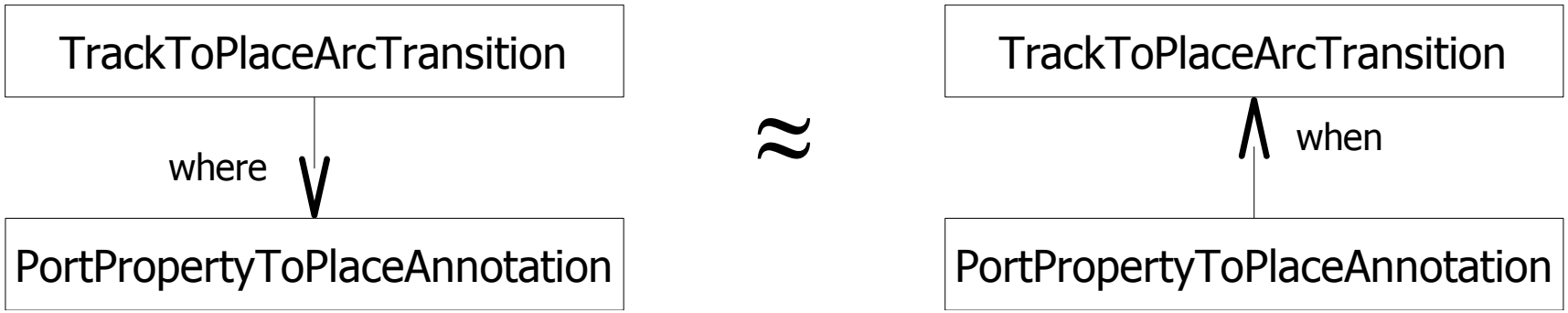


Relation TrackToPlaceArcTransition



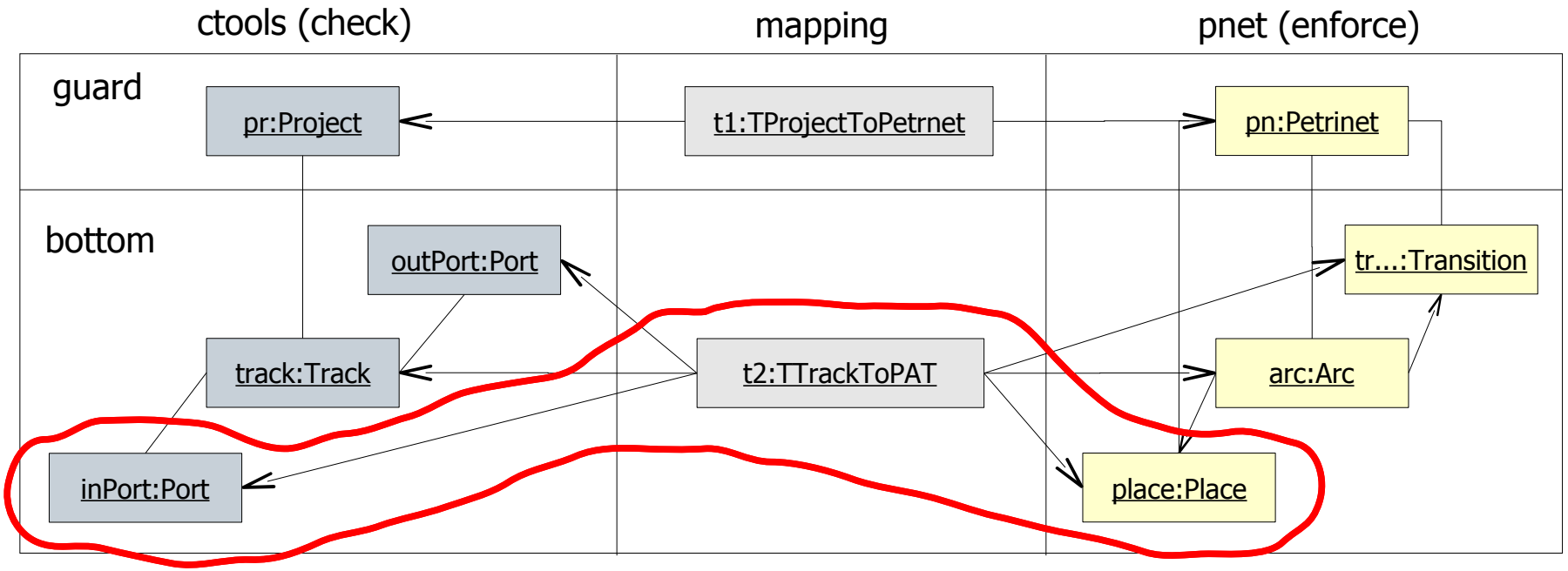
When vs. Where

- "Where" similar to a backward "When" of the invoked Relation:

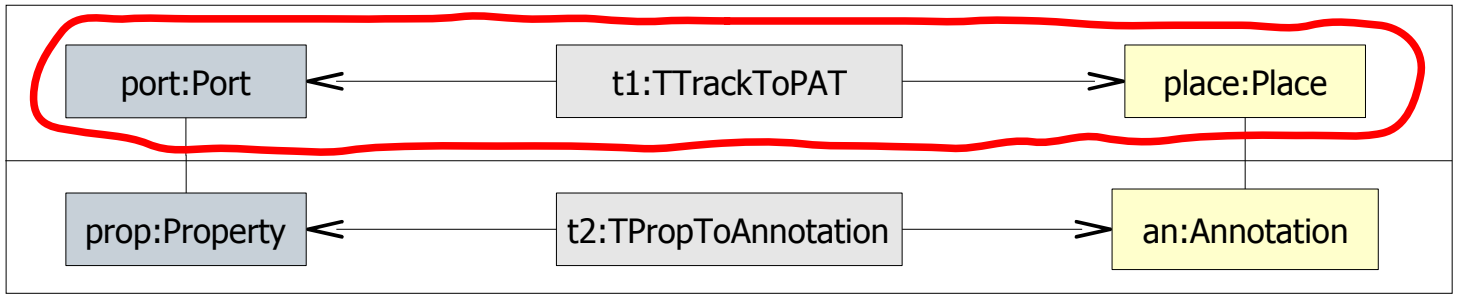


A "When"-Relationship in QVT-Core

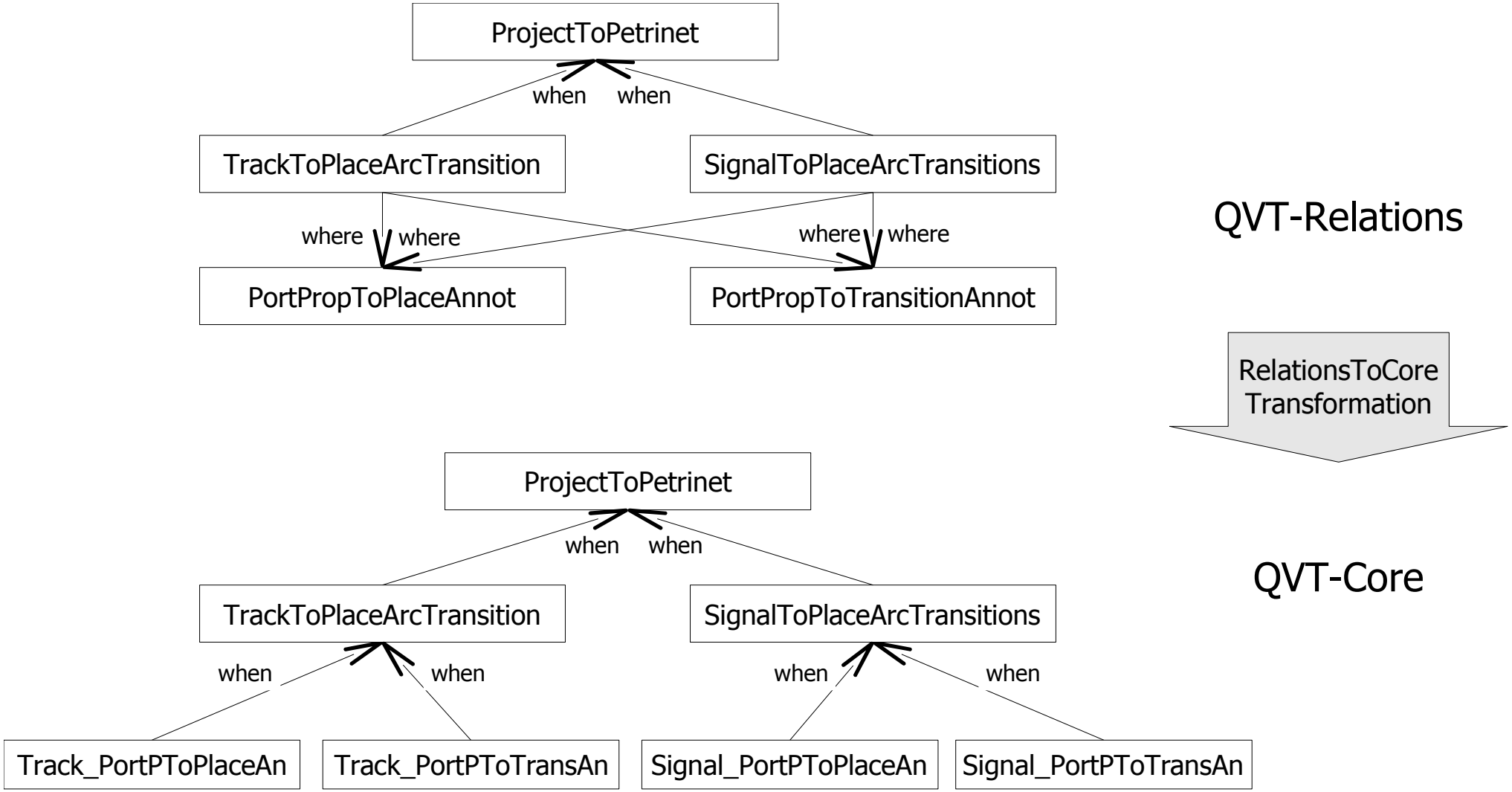
Mapping TrackToPlaceArcTransition



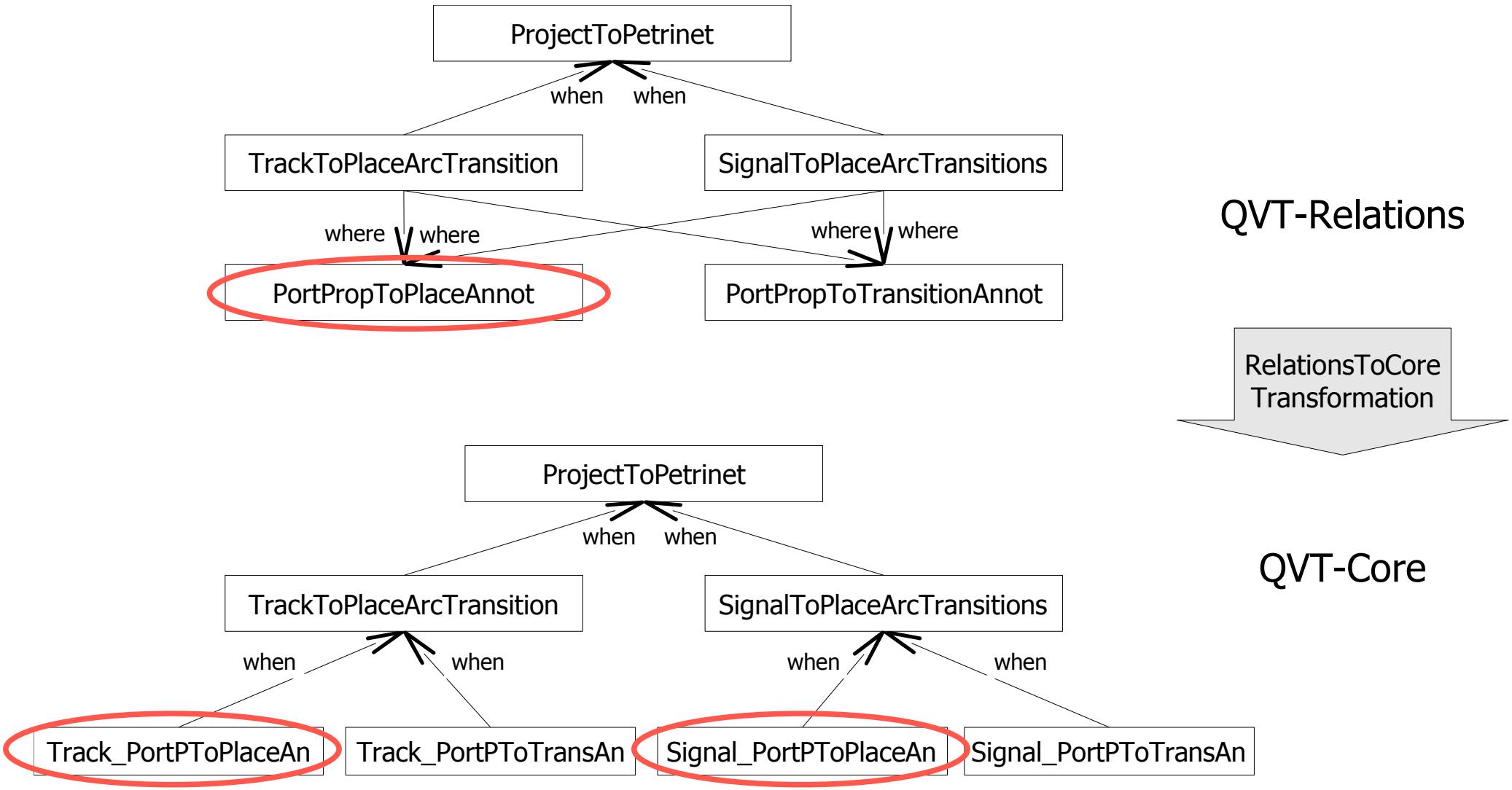
Mapping PortPropertyToPlaceAnnotation



when&where Relationships in QVT-Core

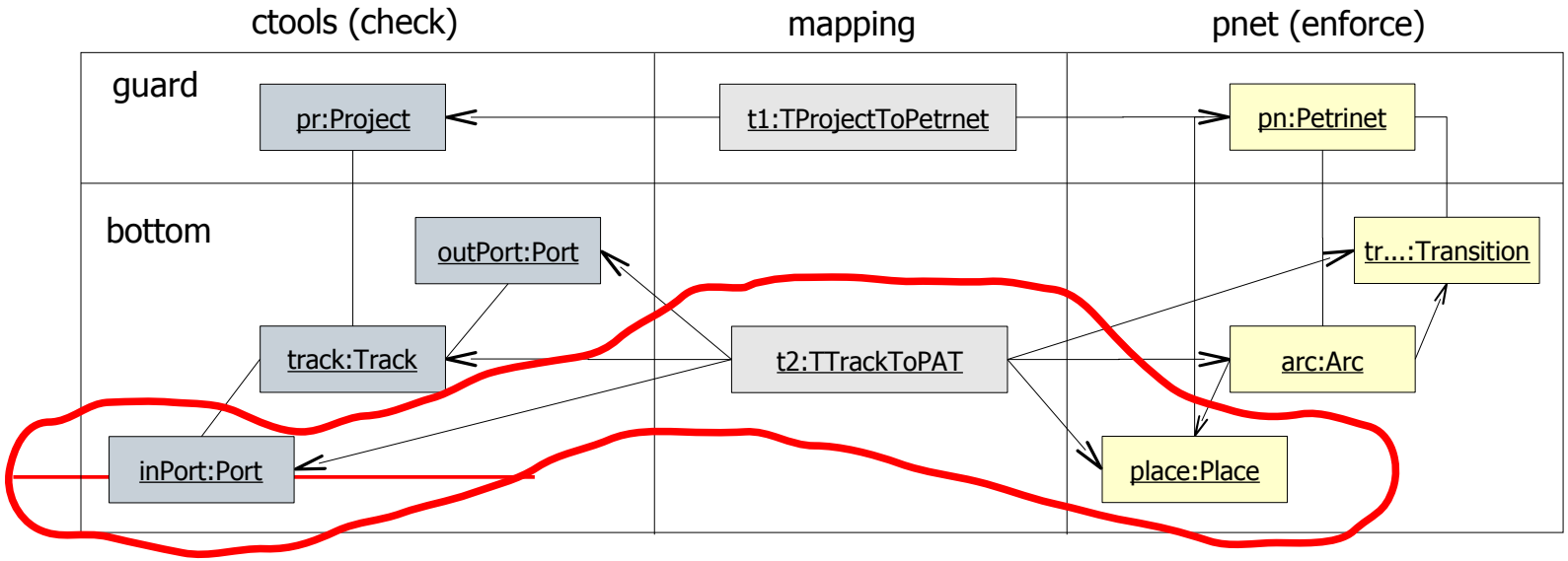


when&where Relationships in QVT-Core

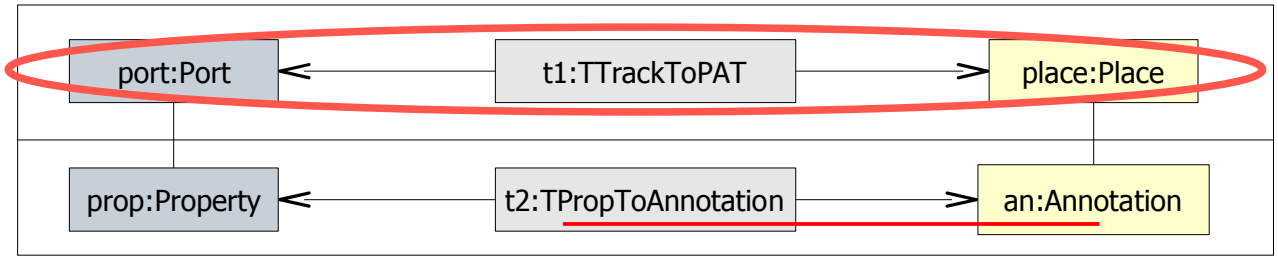


“Unfolded” Mappings

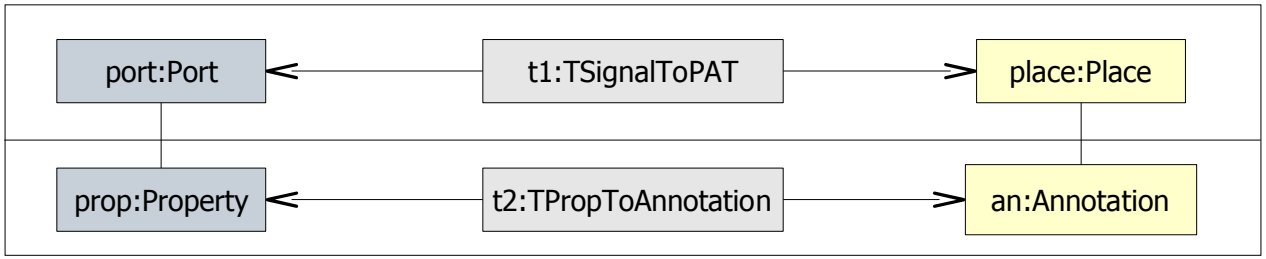
Mapping TrackToPlaceArcTransition



Mapping TrackToPlaceArcTransition_PortPropertyToPlaceAnnotation

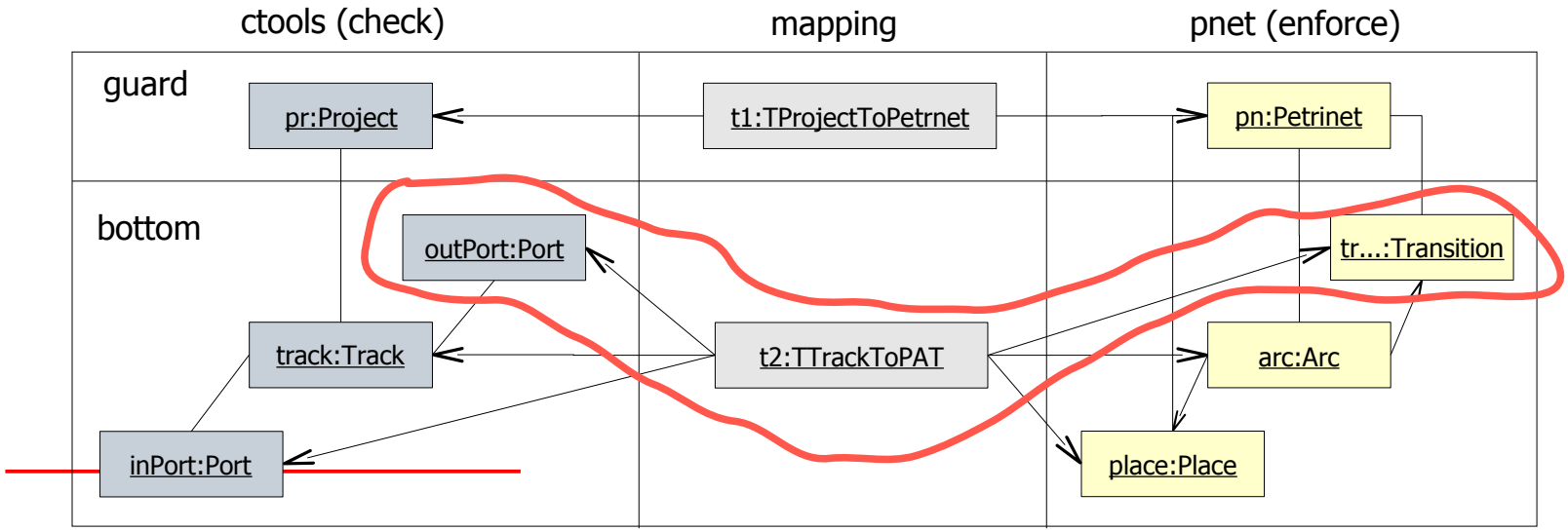


Mapping SignalToPlaceArcTransition_PortPropertyToPlaceAnnotation



"Unfolded" Mappings

Mapping TrackToPlaceArcTransition



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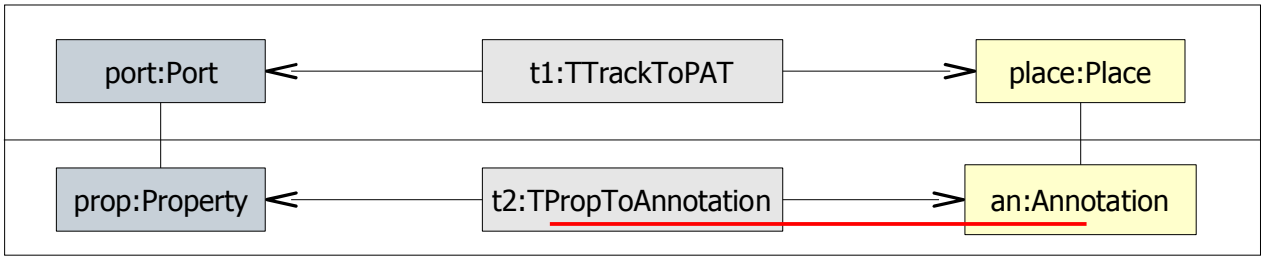

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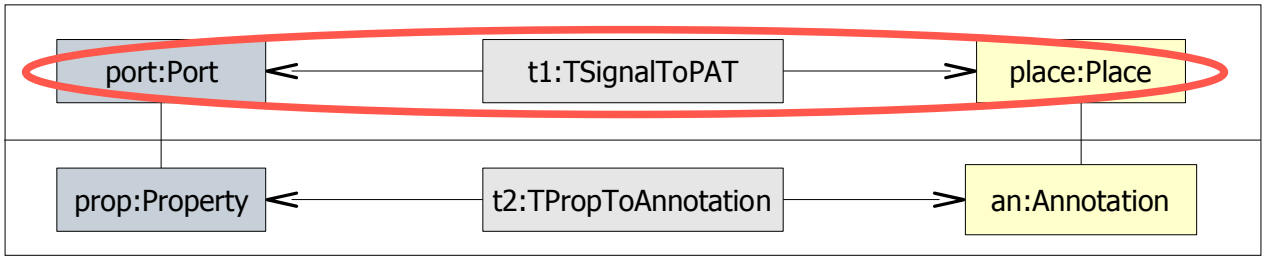
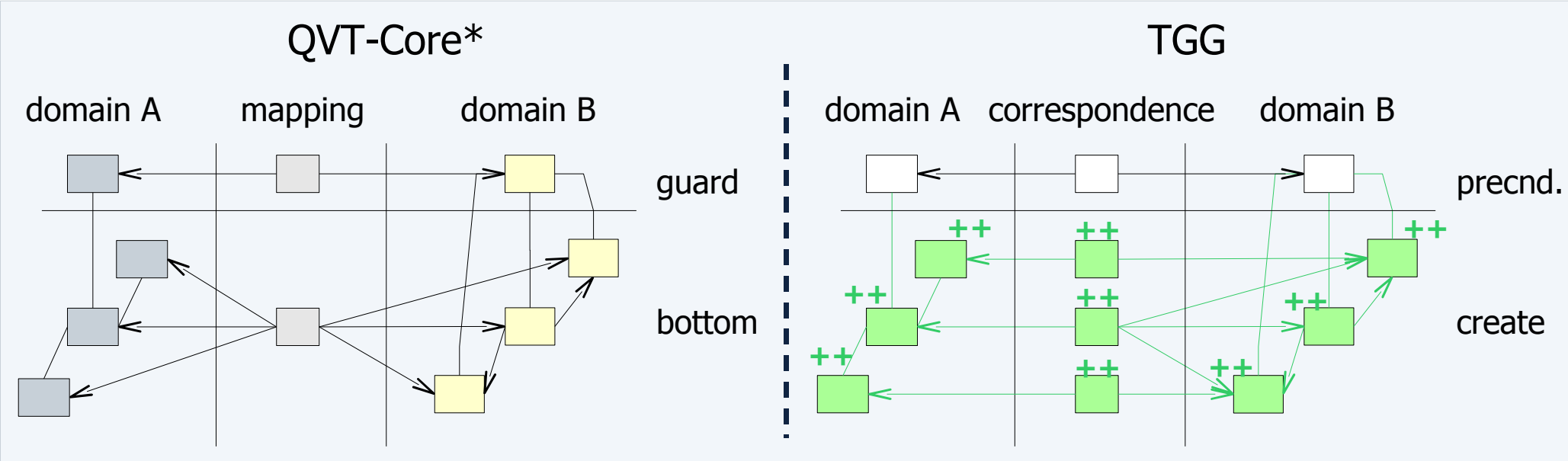


QVT-Core vs. TGGs – Short Comparison

- Structurally similar rules



- Graph structure: Variables and OCL-Predicates
- One *Trace Class*

- Graph structure: Nodes and Edges
- Multiple *Correspondence Nodes*

*:QVT-Core does not specify a graphical notation

QVT-Core vs. TGGs – Short Comparison

- Structurally similar rules

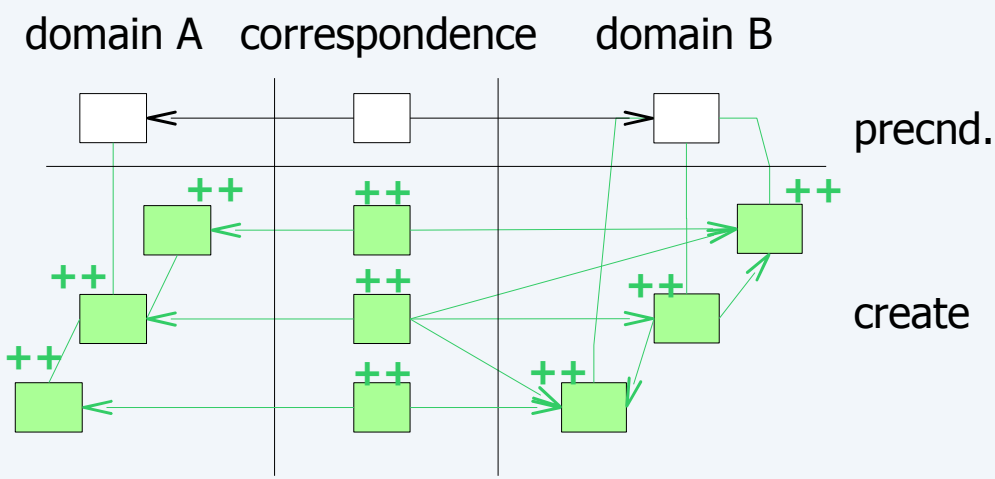
QVT-Core

```
map TrackToPlaceArcTransition{

  check ctools(project:Project){
     track:Track, portIn:Port|
     track.project = project;
     track.port = portIn;
     track.port = portOut;
  }

  check enforce pnet(petrinet:Petrinet){
     realize place:Place, ...
```

TGG



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QVT-Core vs. TGGs – Short Comparison

QVT-Core	TGG
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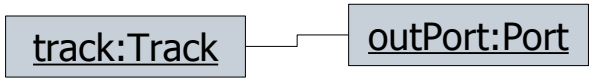
Reference Predicate (==) or Reference Assignment (:=) `track.port:=outPort;`	Edge 

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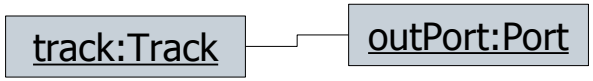
Reference Predicate (==) or Reference Assignment (:=) `track.port:=outPort;`	Edge 
(Simple) Attribute Value Predicate or Attribute Value Assignment	Attribute Value Constraint

QVT-Core vs. TGGs – Short Comparison

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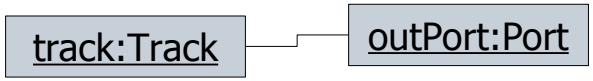
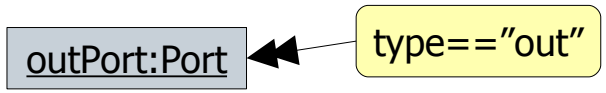
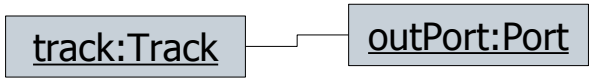
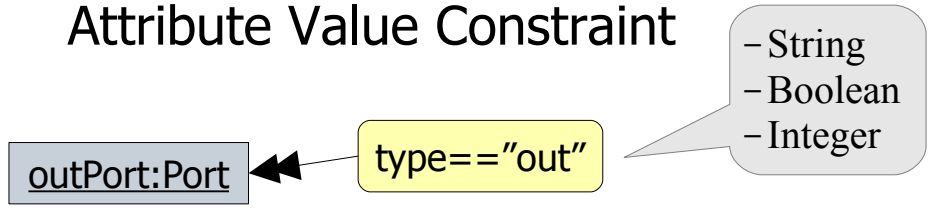
Variable	Node
Reference Predicate (==) or Reference Assignment (:=) `track.port:=outPort;`	Edge 
(Simple) Attribute Value Predicate or Attribute Value Assignment `outPort.type=="out";`	Attribute Value Constraint 

QVT-Core vs. TGGs – Short Comparison

QVT-Core	TGG
Variable	Node
Reference Predicate (==) or Reference Assignment (:=) `track.port:=outPort;`	Edge 
(Simple) Attribute Value Predicate or Attribute Value Assignment `outPort.type=="out";`	Attribute Value Constraint 

QVT-Core vs. TGGs – Short Comparison

QVT-Core	TGG
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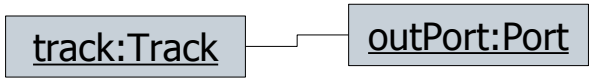
Reference Predicate (==) or Reference Assignment (:=) `track.port:=outPort;`	Edge 

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	 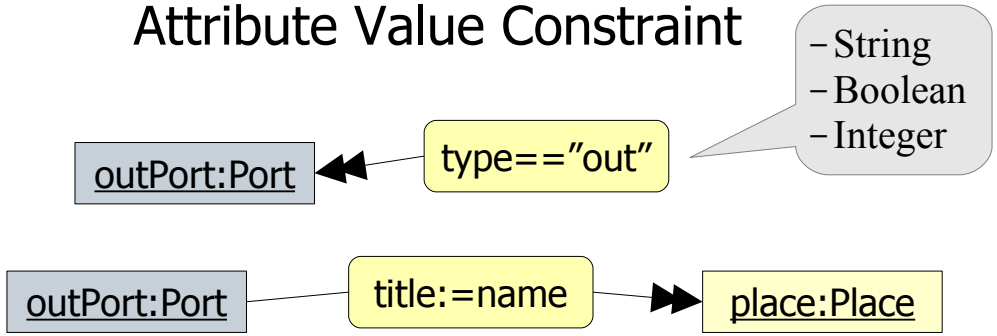

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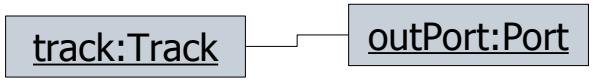
Reference Predicate (==) or Reference Assignment (:=) `track.port:=outPort;`	Edge 

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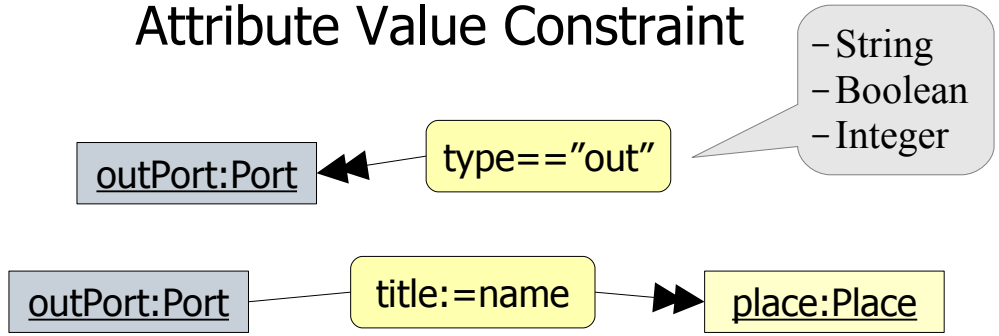
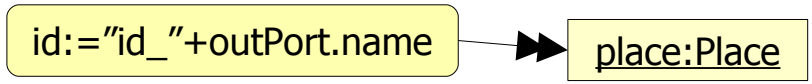
	 

(Complex) Attribute Value Predicate/Assignment `place.id:="id_"+outPort.name;`	OCL Attribute Value Constraint 

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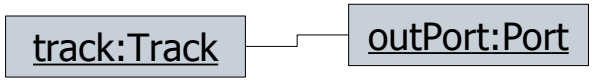
Variable	Node
Reference Predicate (==) or Reference Assignment (:=) `track.port:=outPort;`	Edge 

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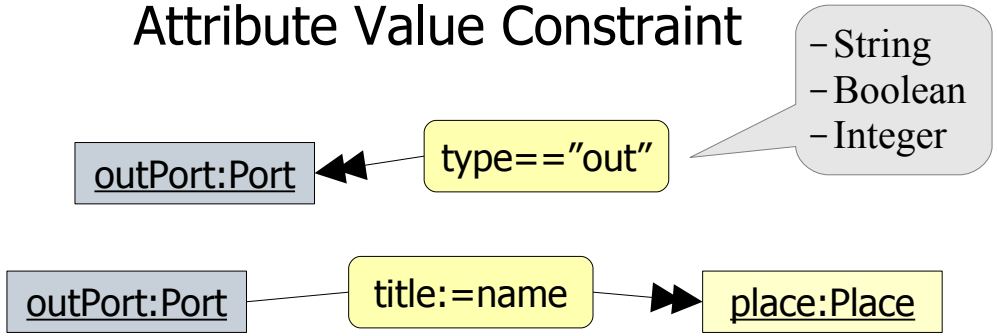
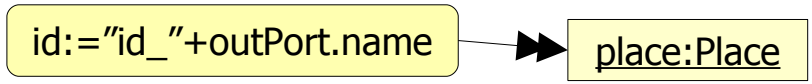
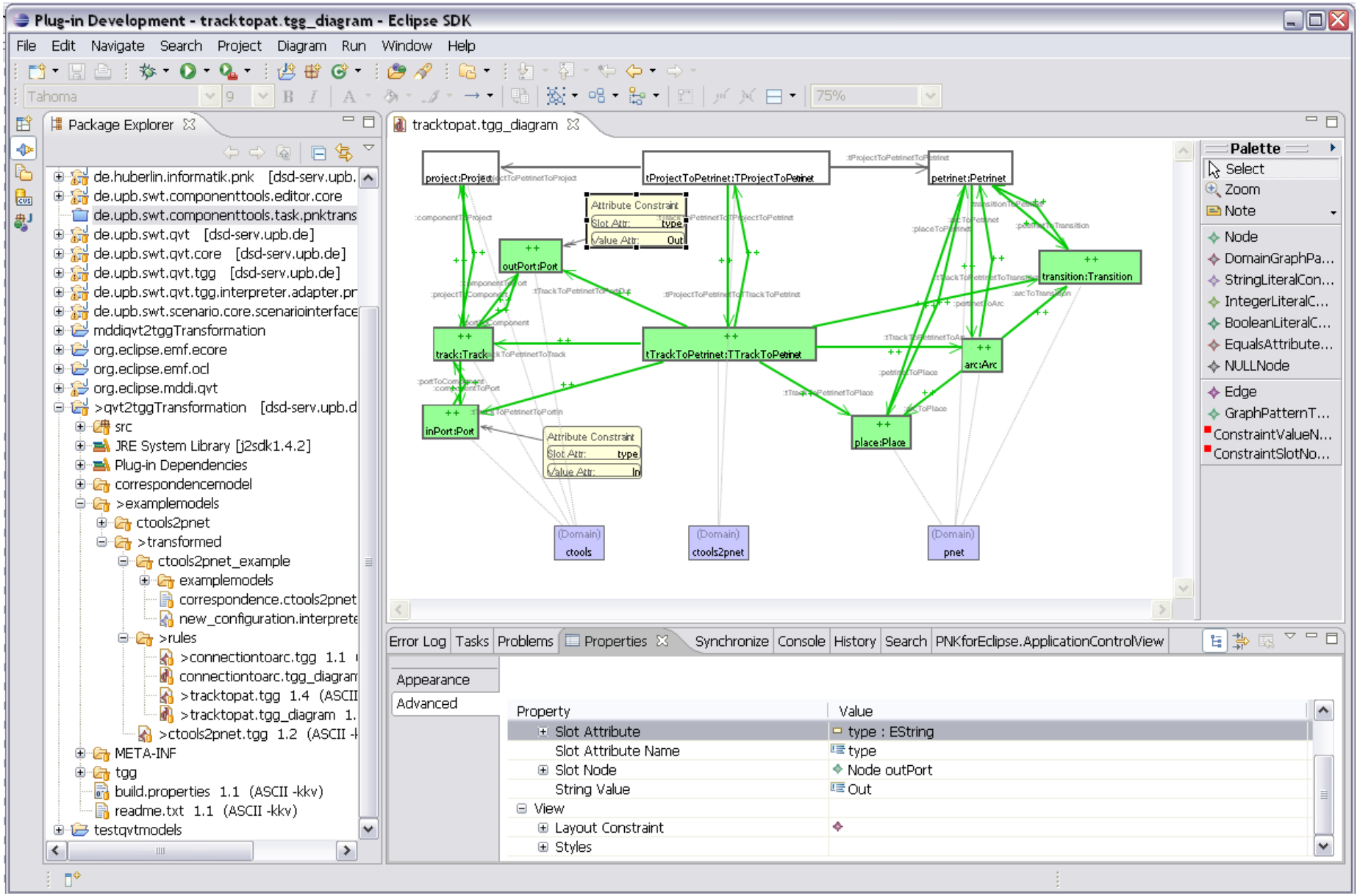
	 

(Complex) Attribute Value Predicate/Assignment `place.id:="id_"+outPort.name;`	OCL Attribute Value Constraint Outlook 

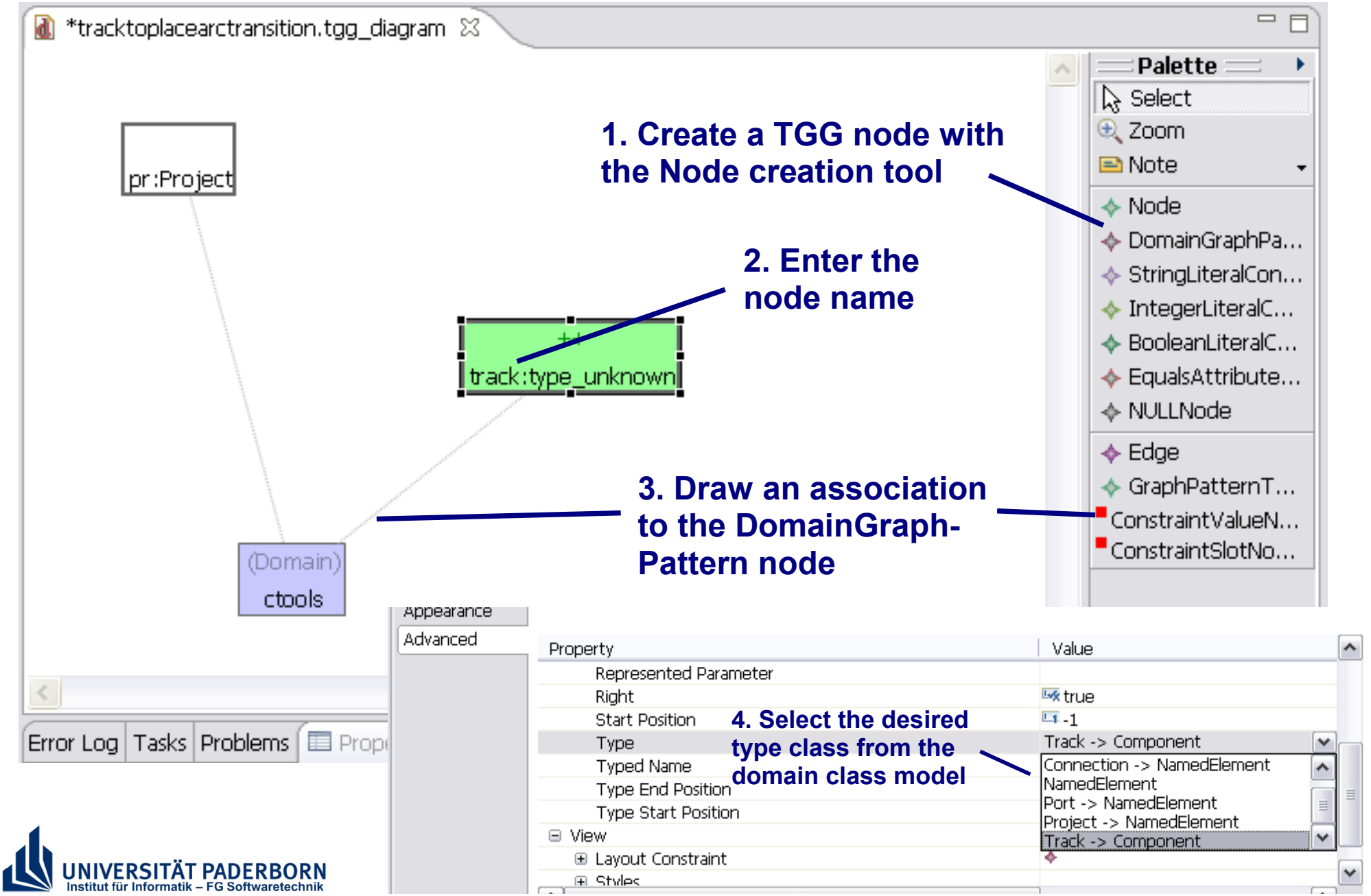
Summary

- QVT and TGGs are very similar
- TGGs still have advantages
  - Multiple Correspondence Nodes
  - Formal theory, e.g. to support verification
- Flexible, extendable Interpreter
  - Effectively used
  - For popular meta-modelling facility EMF (and also other Java models)
  - Flexible, e.g. n:m model transformations
- TGGs could be a valueable input for QVT

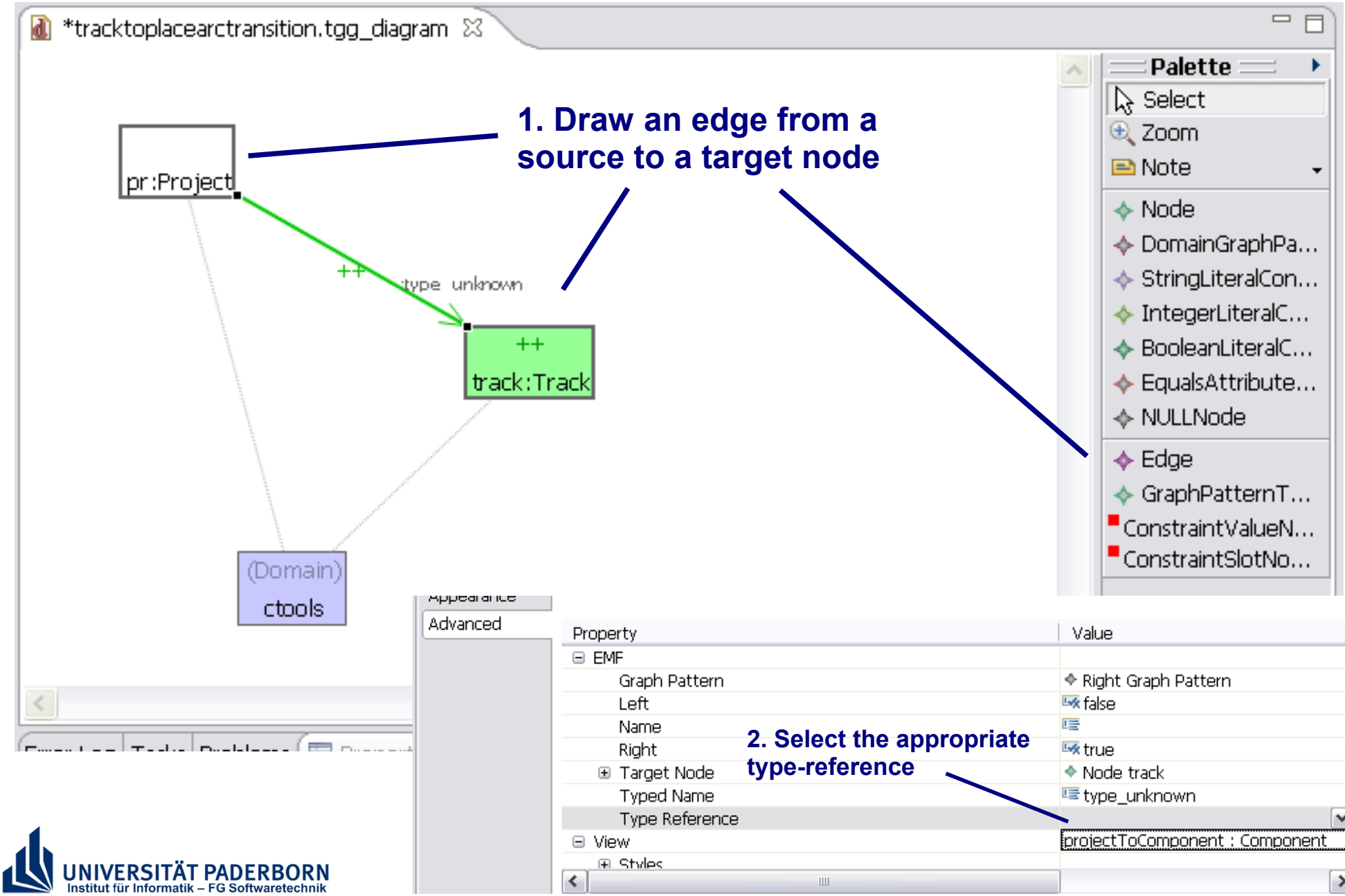
TGG Editor Screenshot



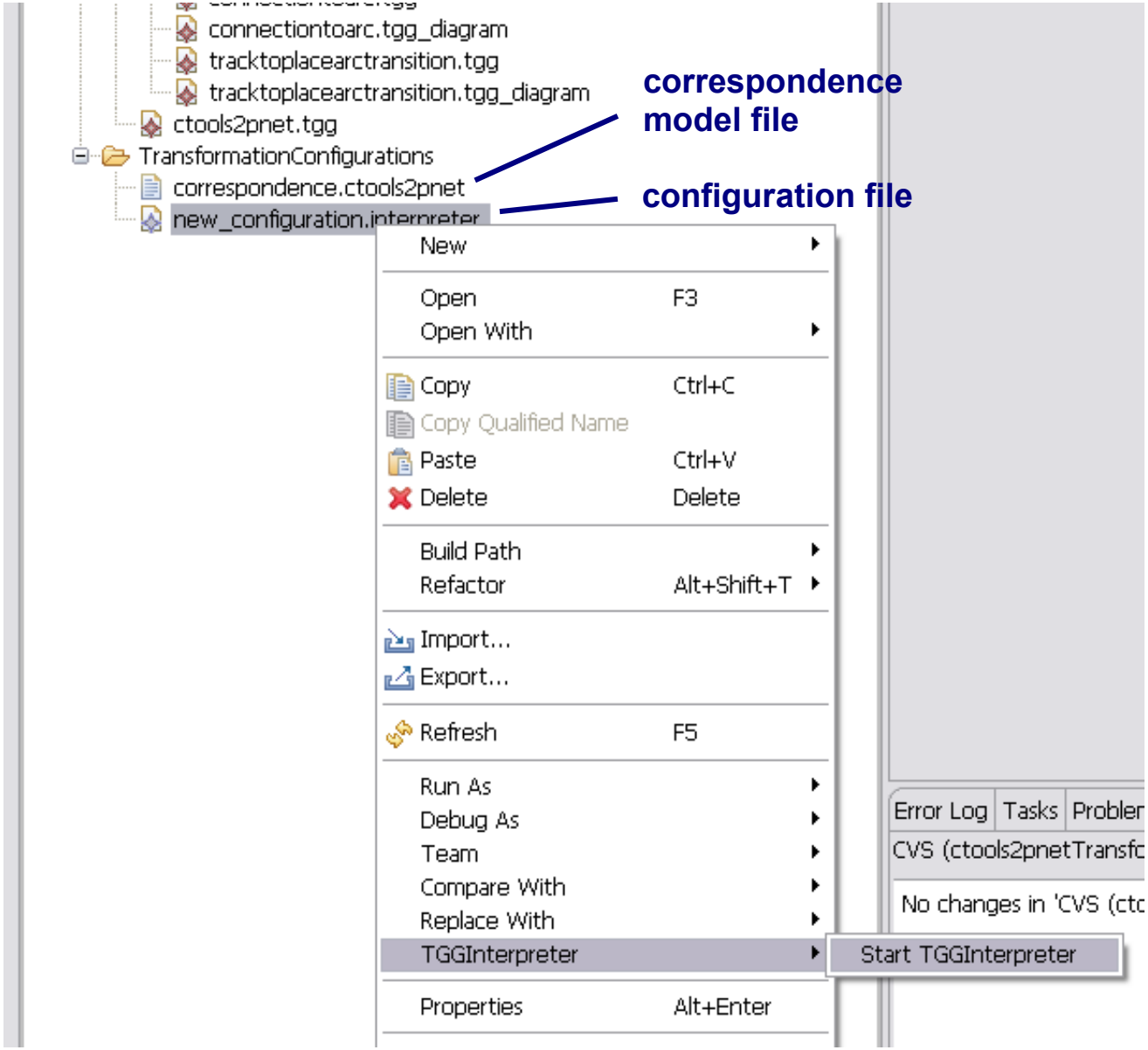
TGG Editor – Creating a Node



TGG Editor – Creating an Edge

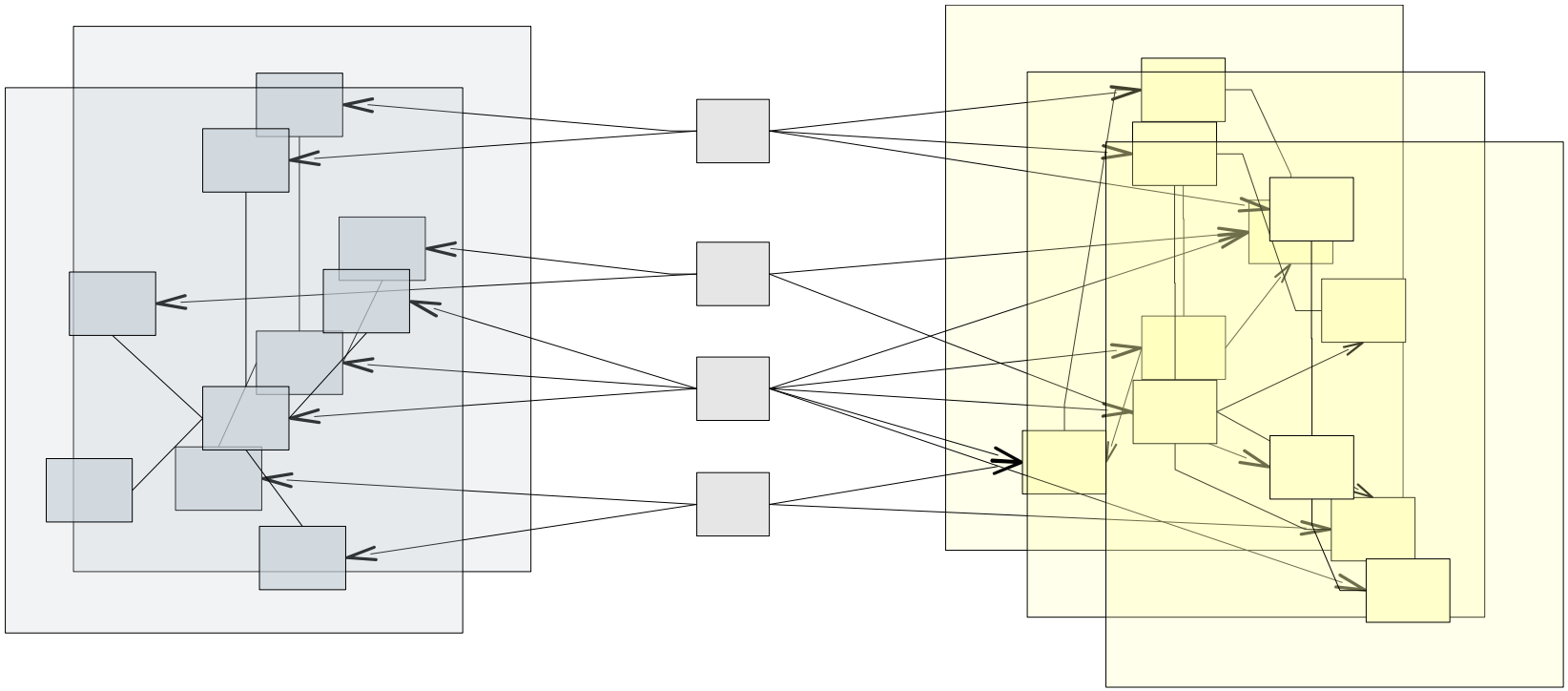


Starting a Transformation



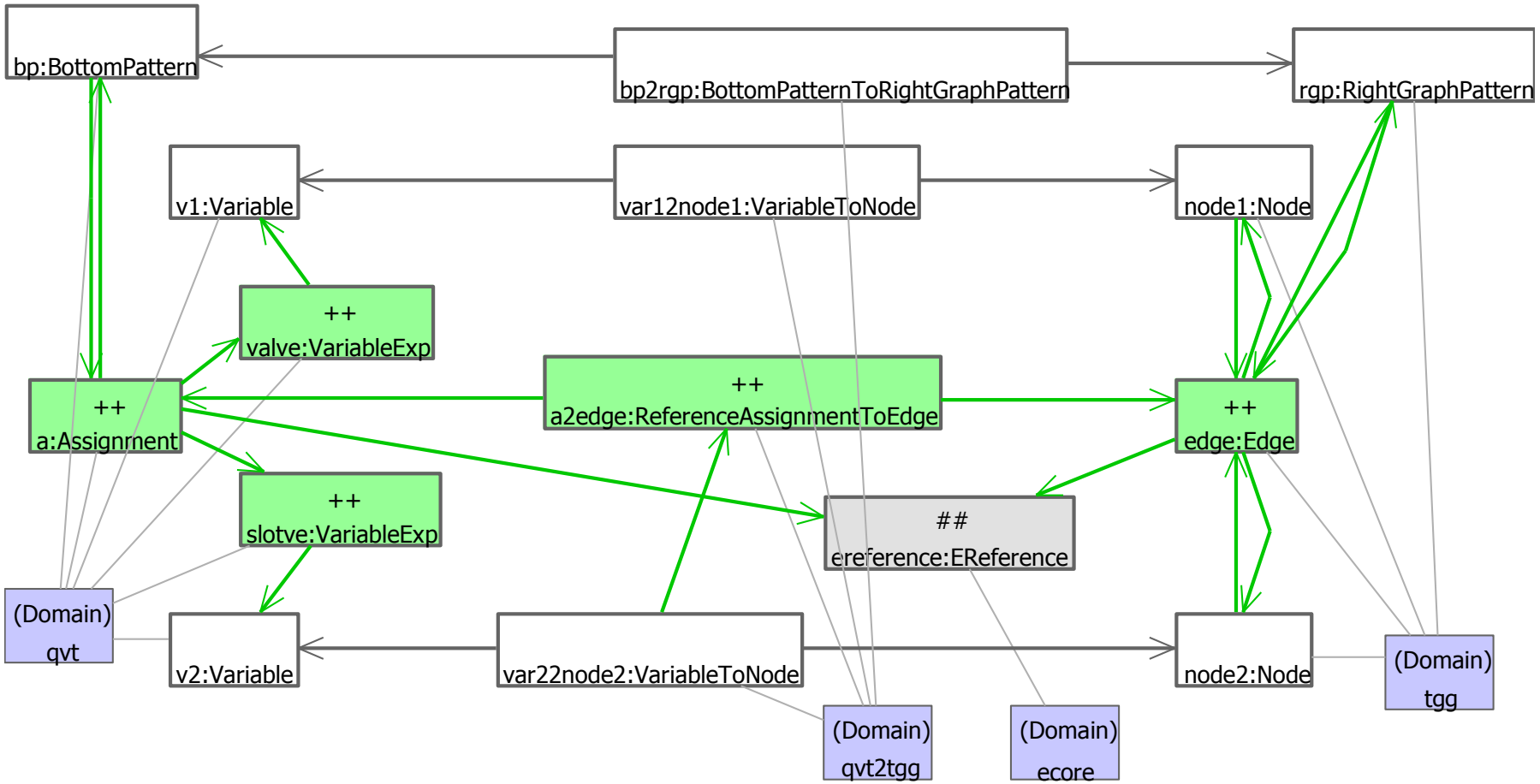
Further TGG-Interpreter Features

- n-to-m model transformations
- Multi Graph Grammars (“MGGs”)



Further TGG-Interpreter Features

- No start node needed
- Navigating backwards on Edges



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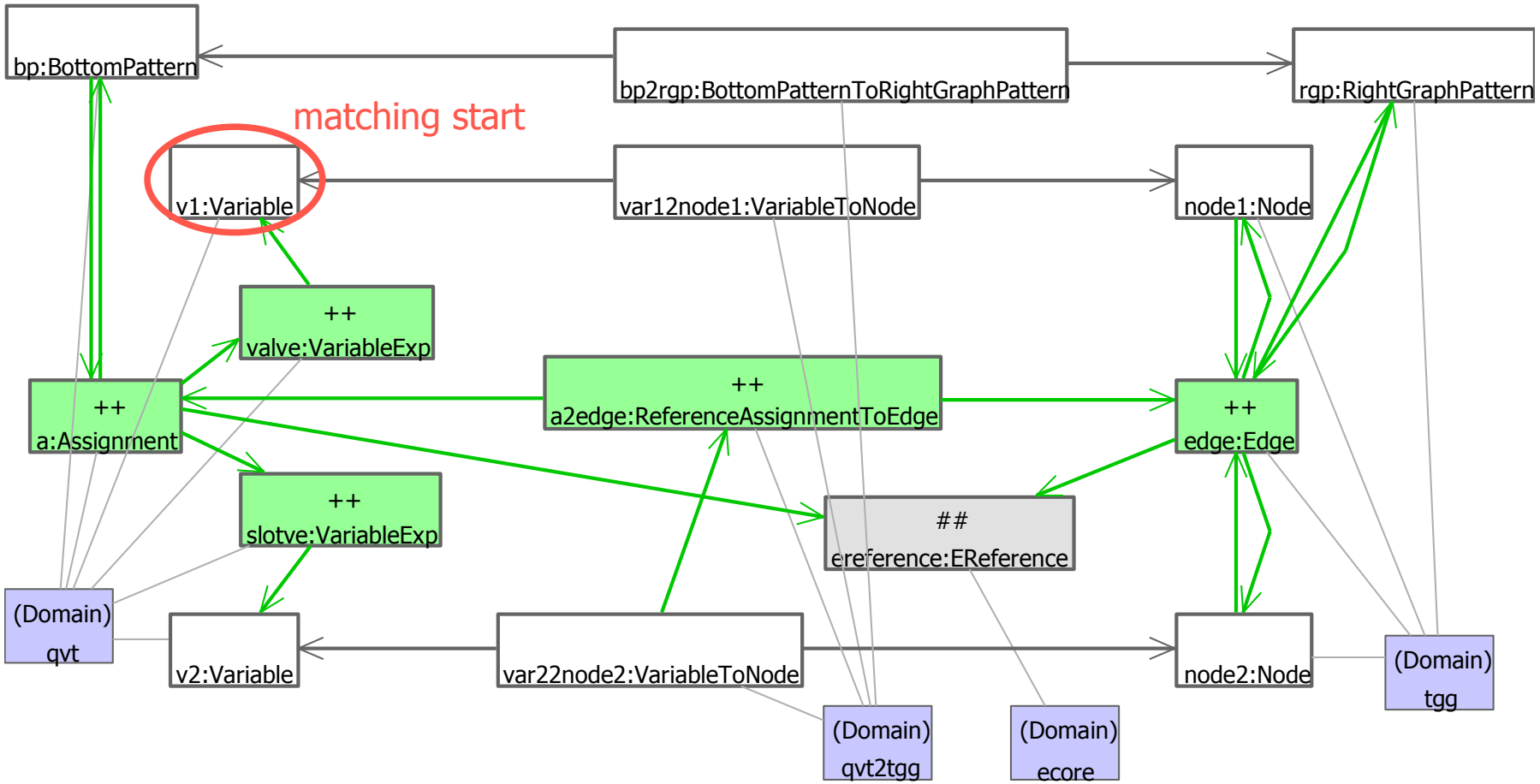

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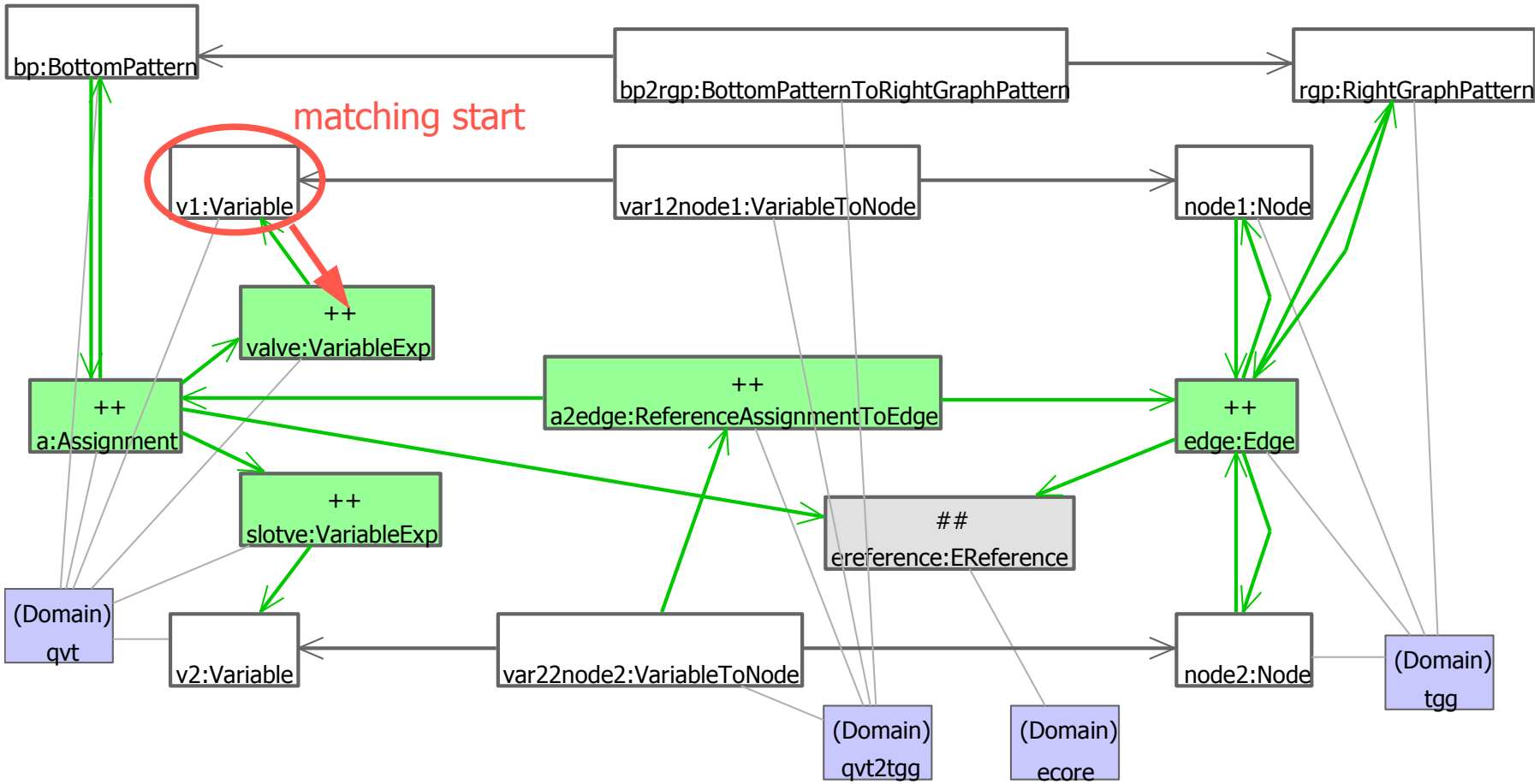

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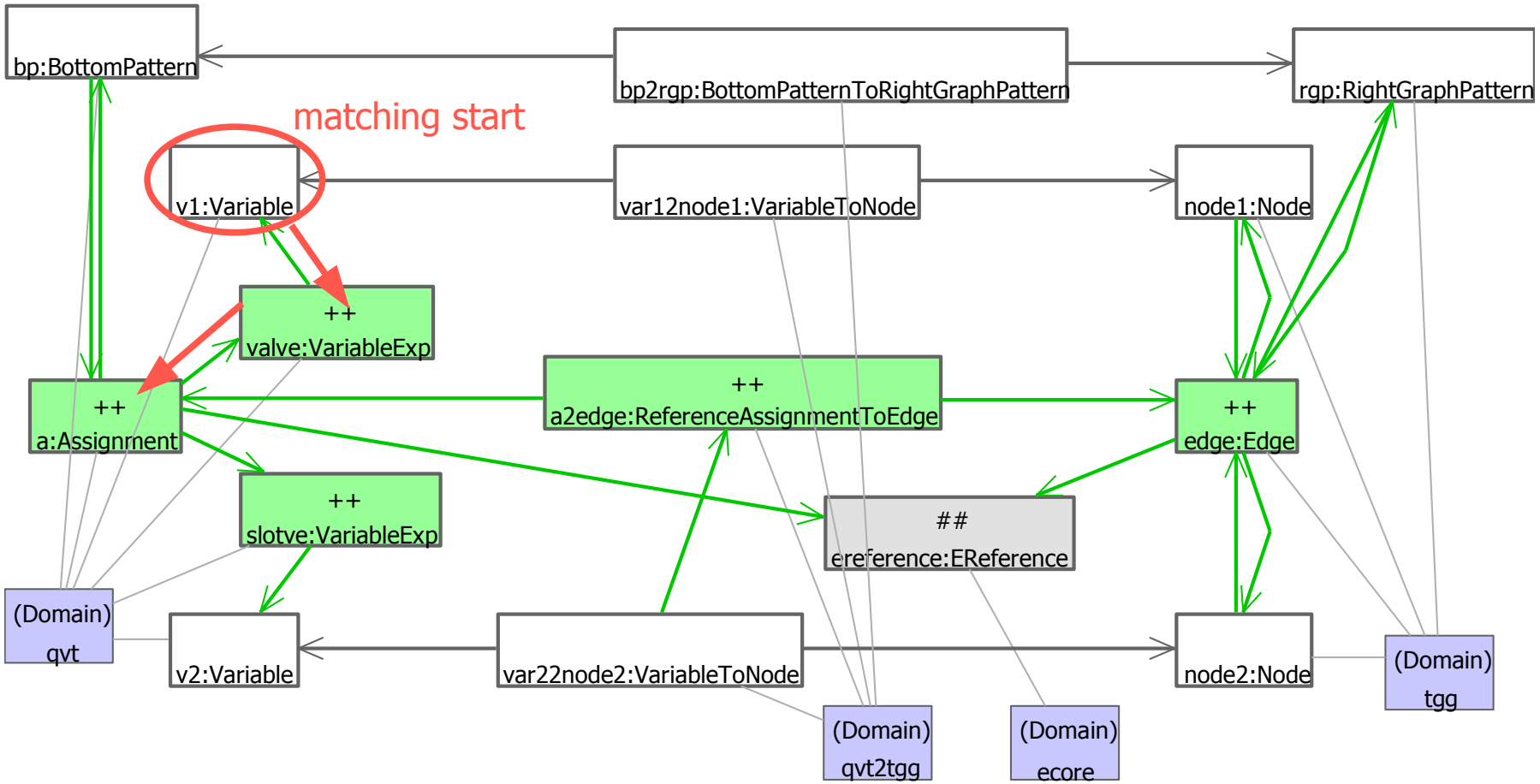

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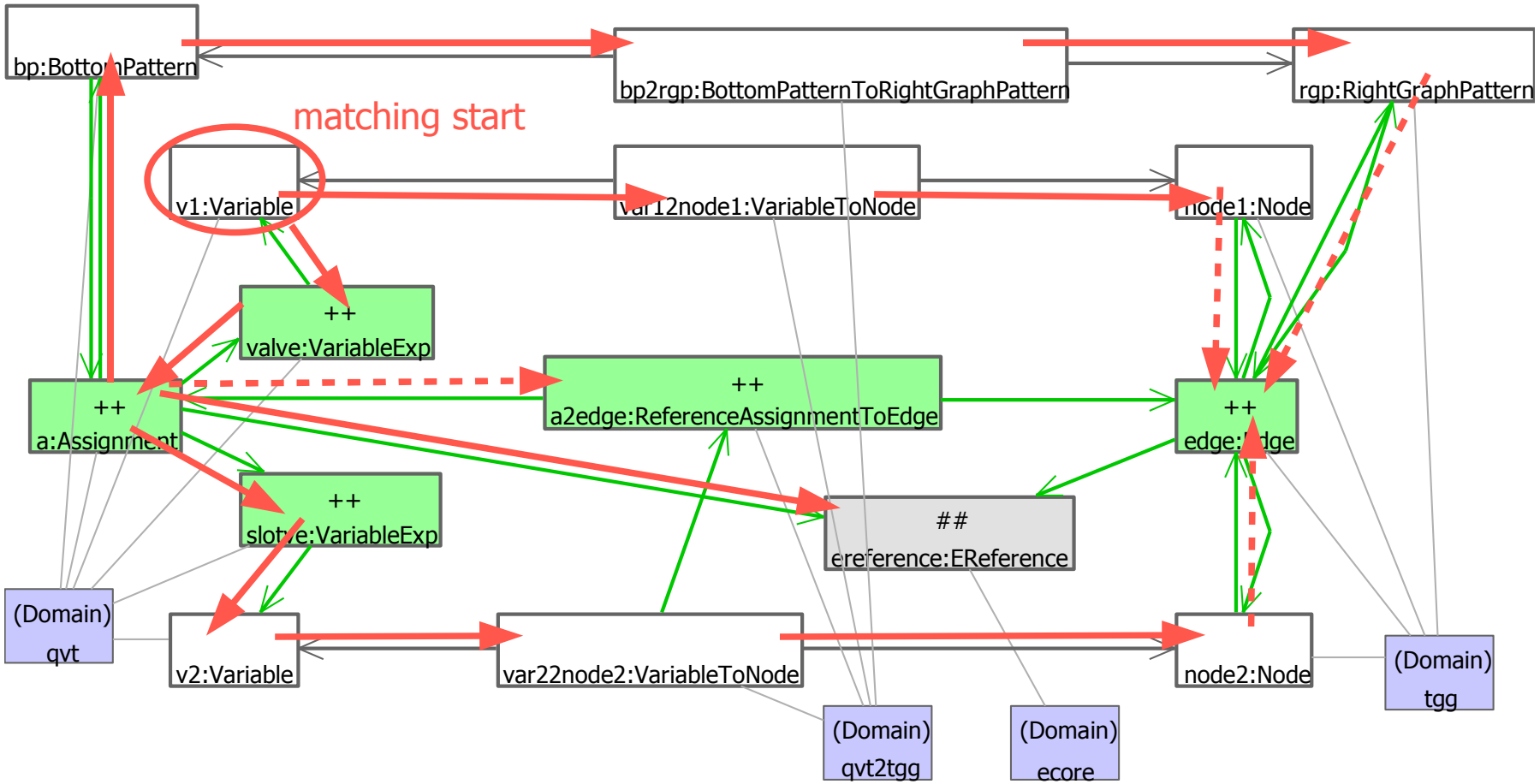

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