Coordinating Interactions
The Event Coordination Notation

Ekkart Kindler

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Ekkart Kindler: Coordinating Interactions:
The Event Coordination Notation.
DTU Compute Technical Report 2014-05,
May 2014

http://www2.compute.dtu.dk/~ekki/projects/ECNO/

1. Motivation

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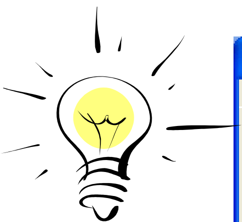

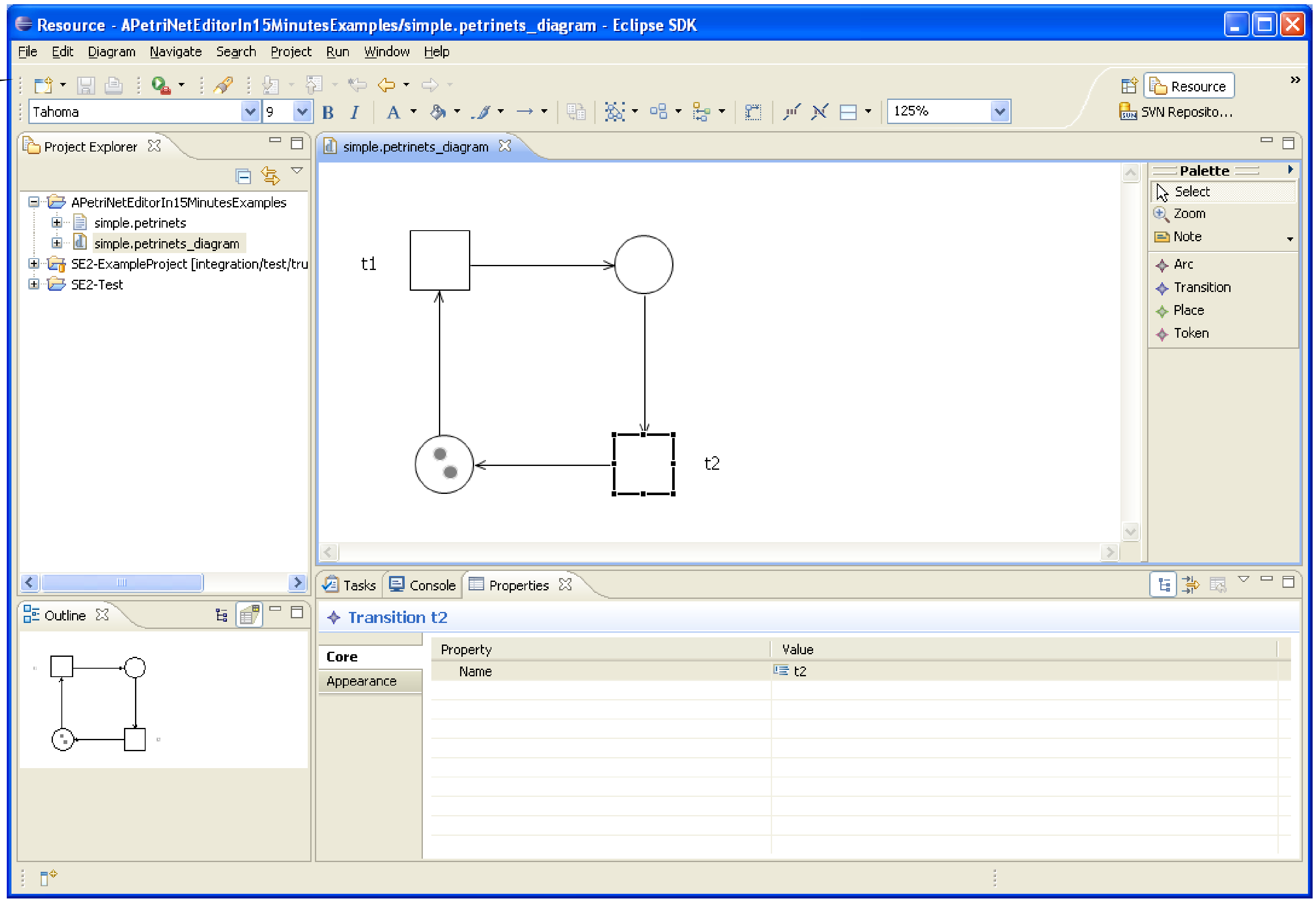

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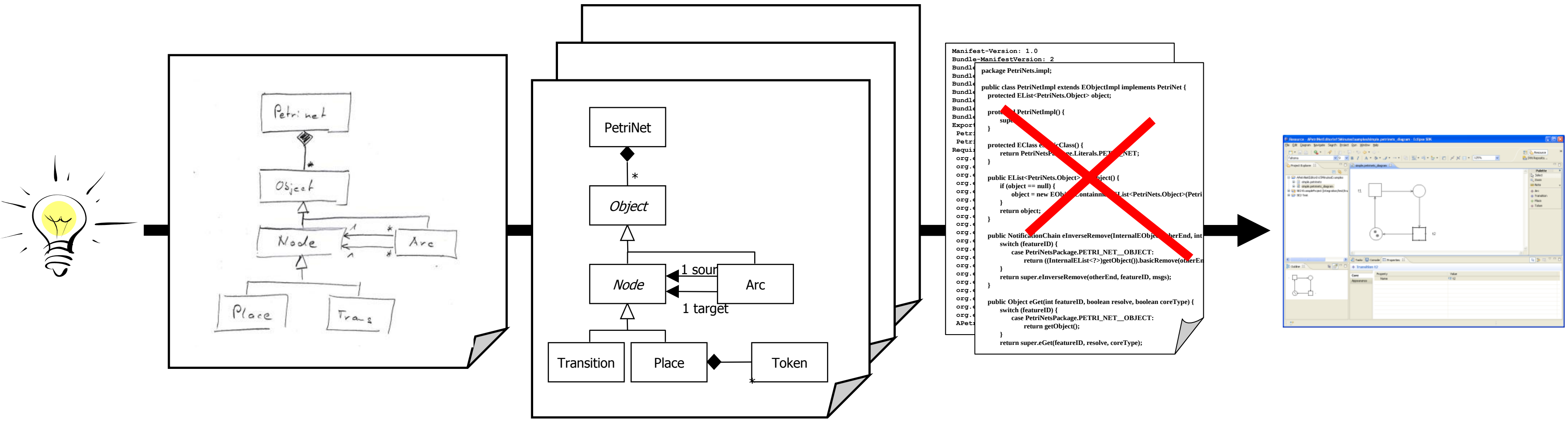
MBSE: Today

How about behaviour ?
(non-standard behaviour)



Analysis
Design
Implementation
Coding

Some code is generated

Modelling on domain level

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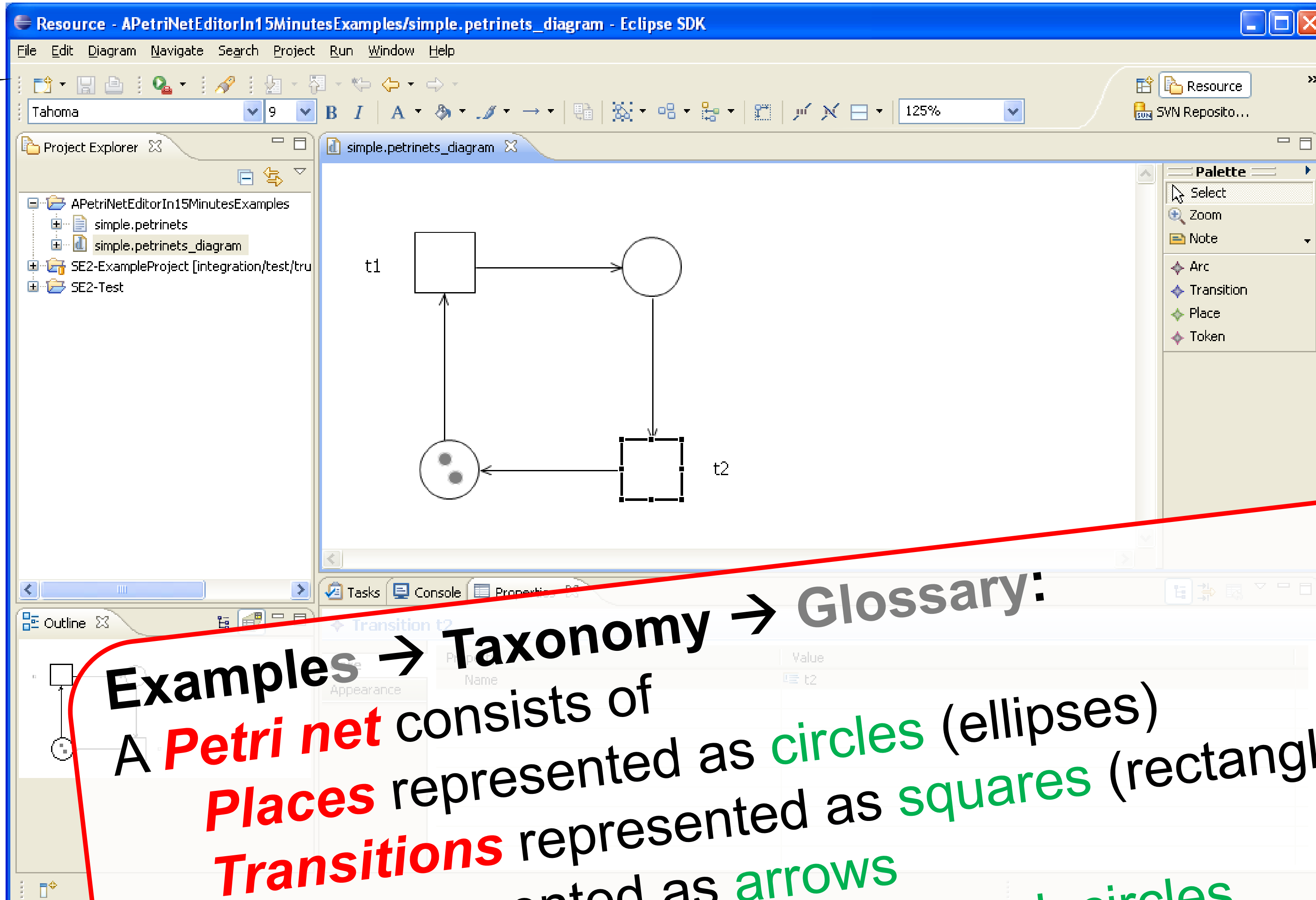

Examples → Taxonomy → Glossary:

A ***Petri net*** consists of

- ***Places*** represented as circles (ellipses)
- ***Transitions*** represented as squares (rectangles)
- ***Arcs*** represented as arrows
- ***Tokens*** represented as filled black circles

Domain model of PN

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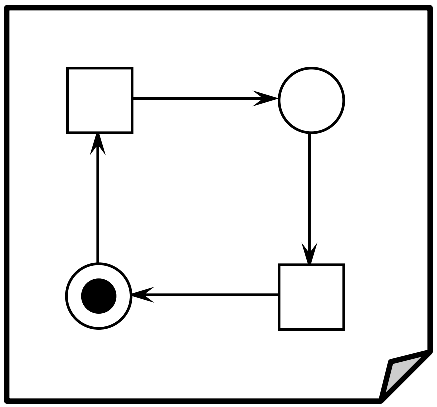
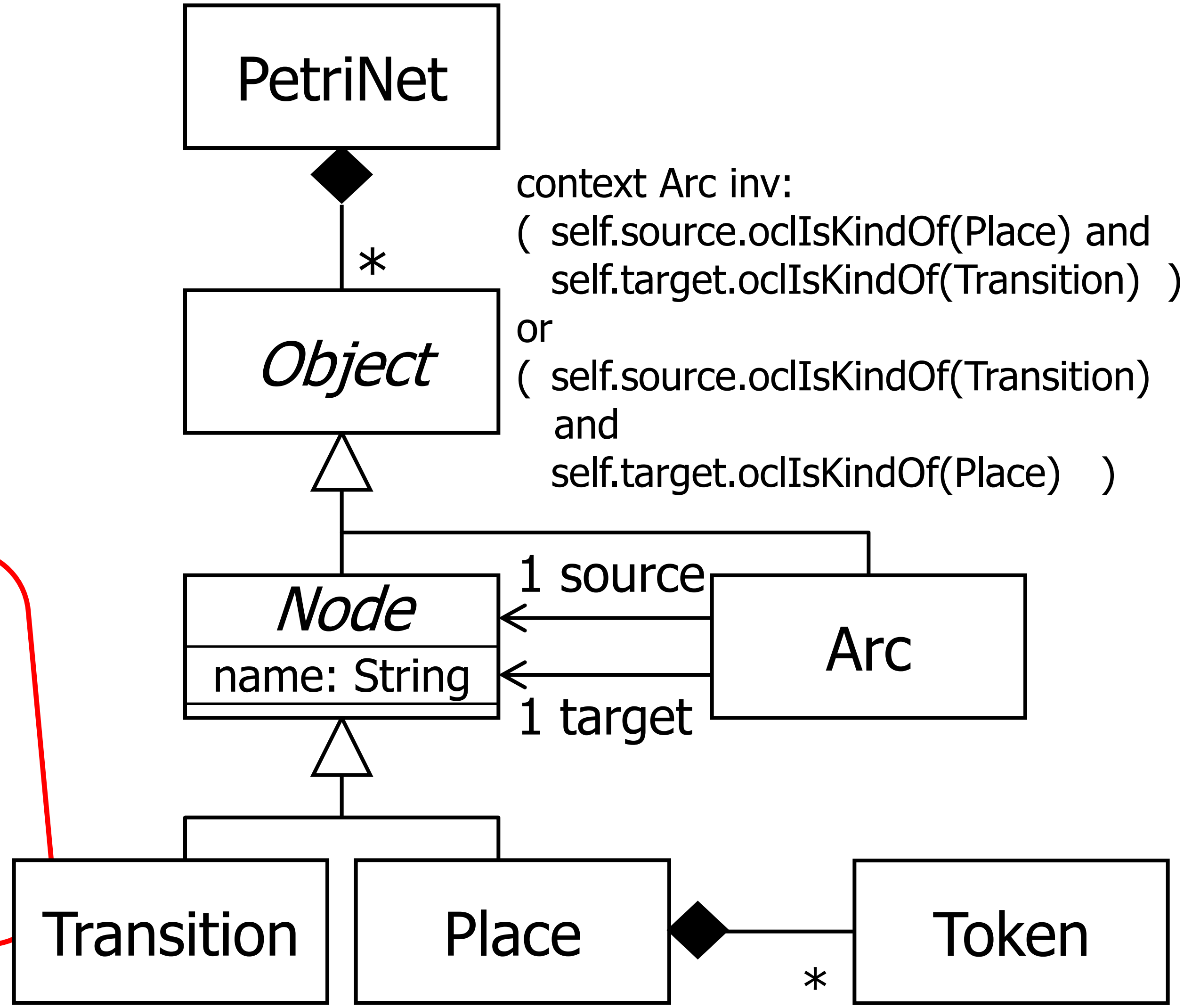


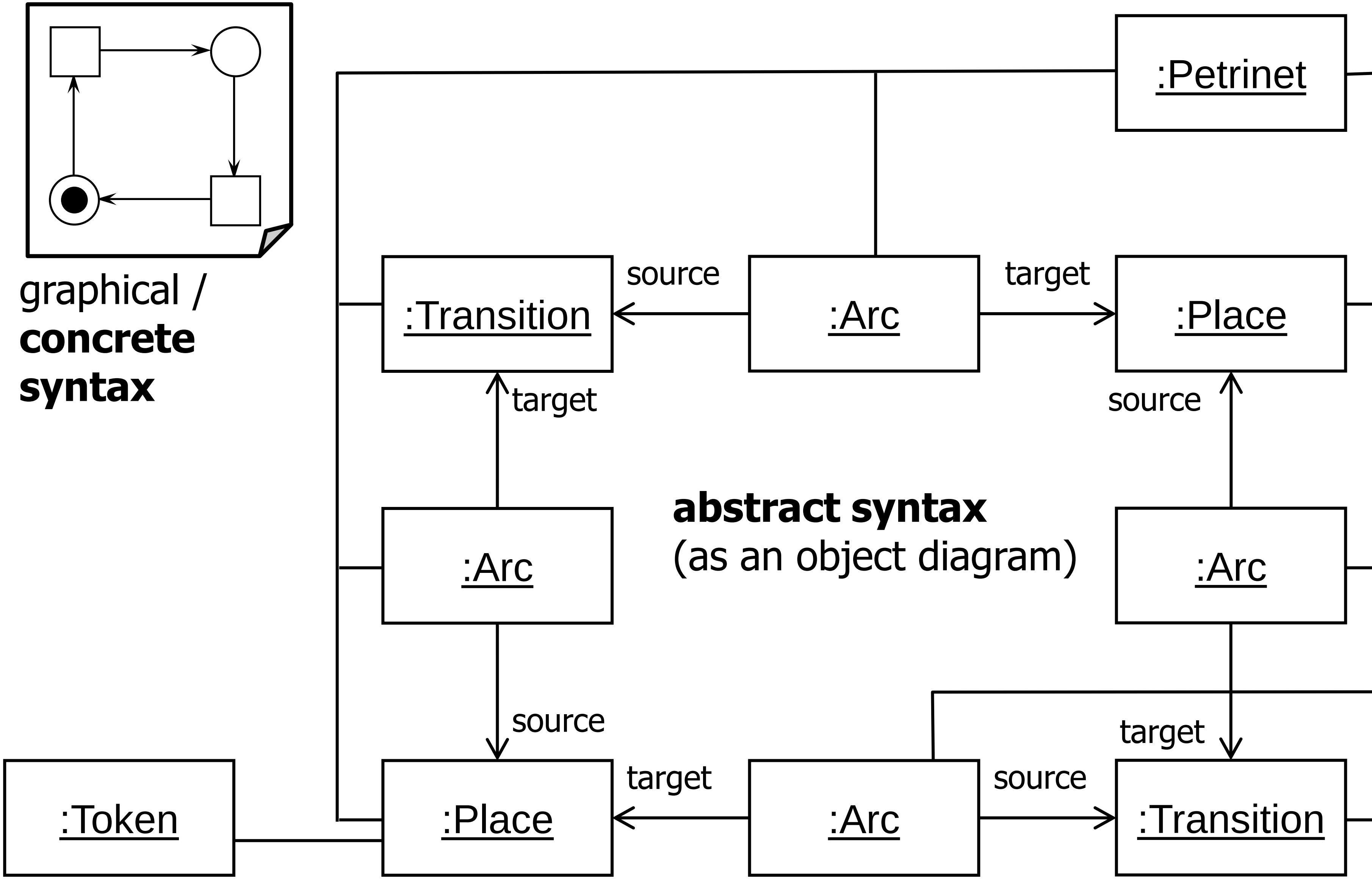
Petri net model

Glossary:
A ***Petri net*** consists of
Places
Transitions
Arcs
Tokens



"Meta model" for Petri nets
(as a UML class diagram + OCL)

Syntax (abstract and concrete)



Graphical Syntax/Editor?

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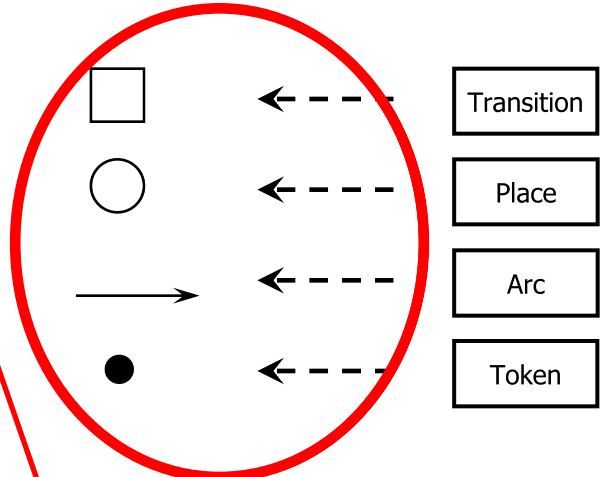
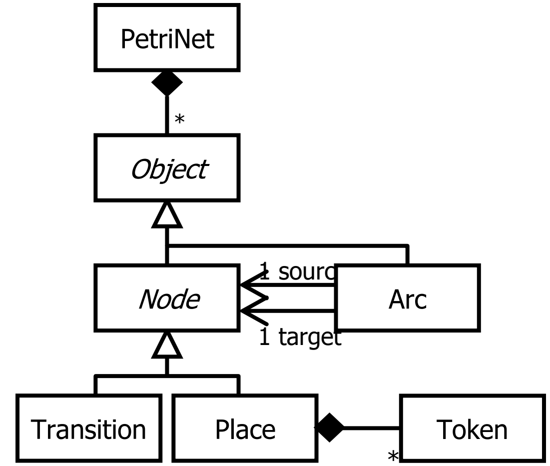
meta model



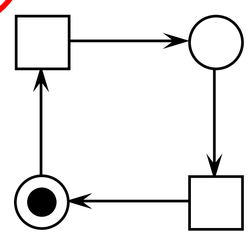


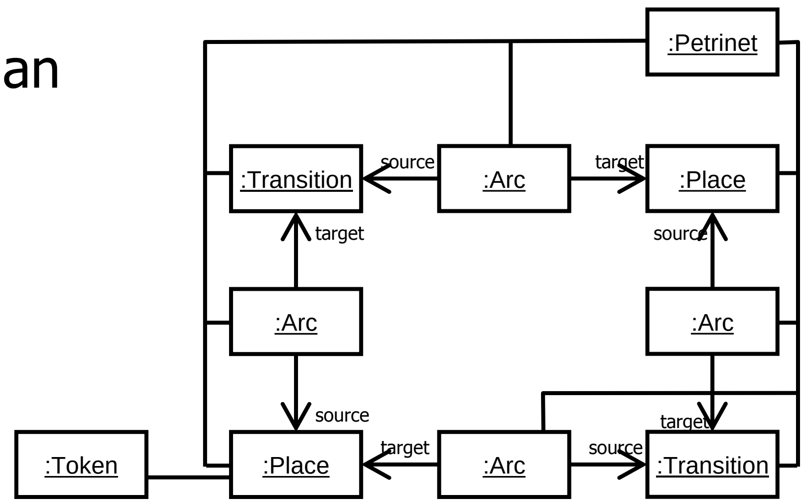
is instance of

This is about all there is to say about a Petri net editor – conceptually!

generate an editor

model





concrete syntax

abstract syntax

The Result

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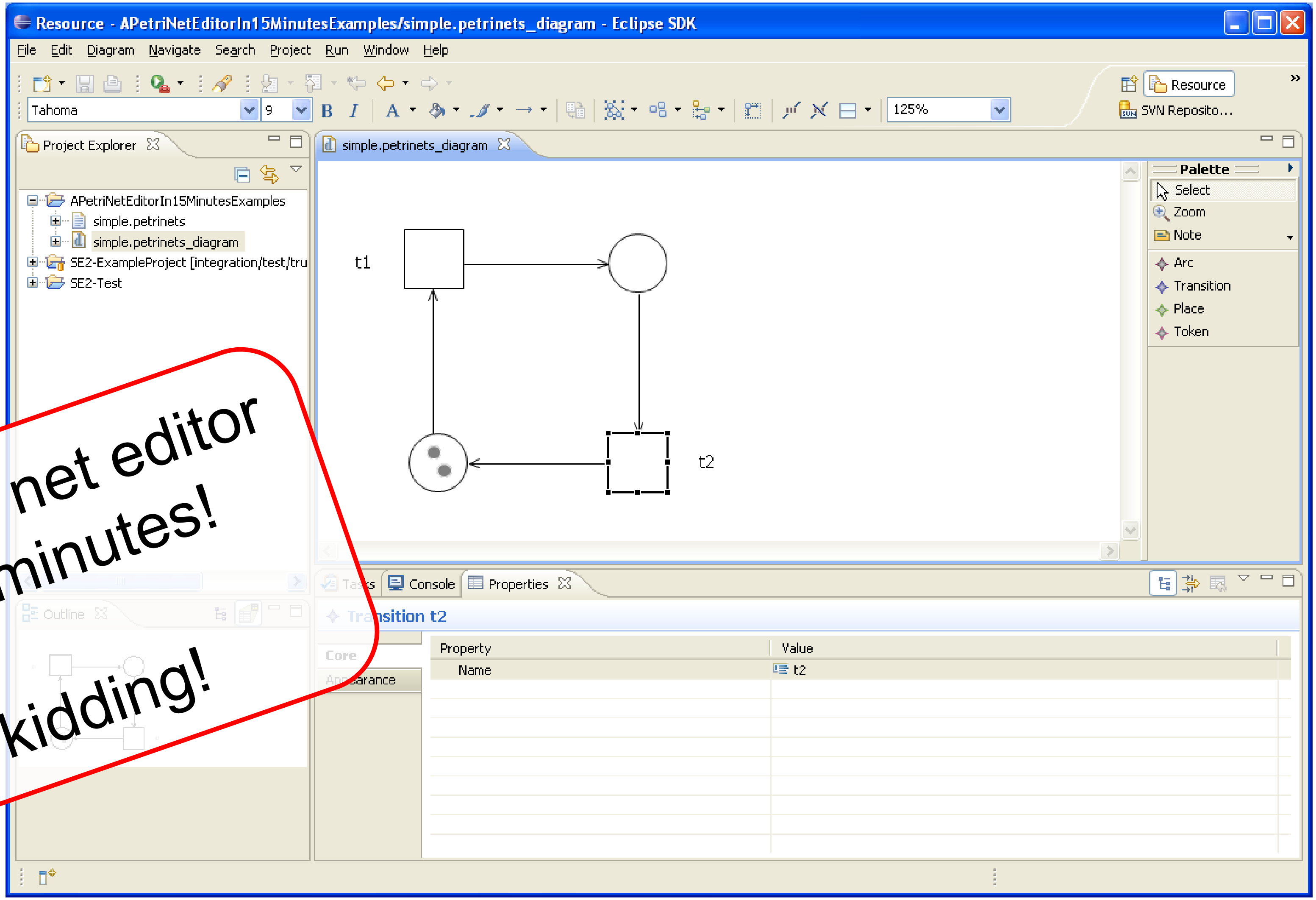
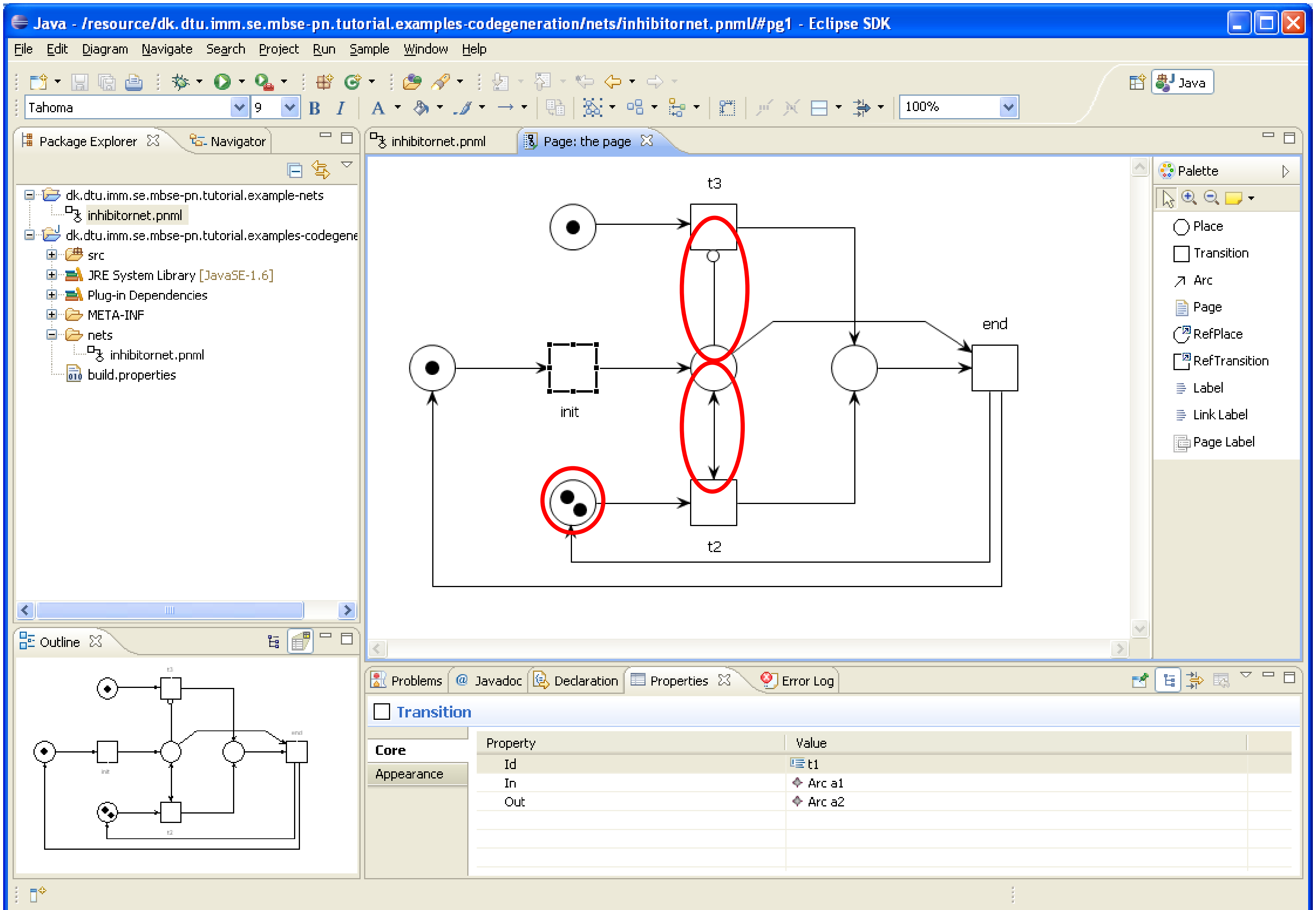


A Petri net editor in 15 minutes!

Not kidding!

In the large: ePNK



Define a Petri Net Type

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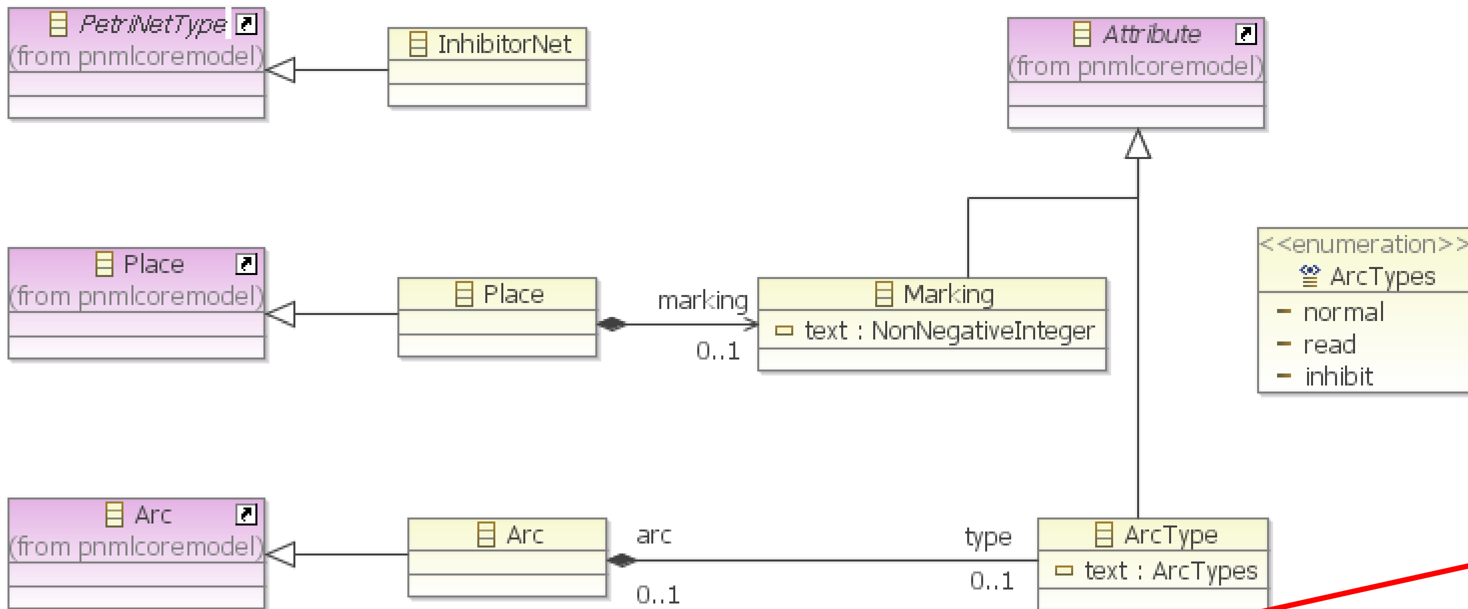

Additional constraints of inhibitor nets (defined in OLC).

```
( self.source.oclIsKindOf(pnmlcoremodel::PlaceNode) and
  self.target.oclIsKindOf(pnmlcoremodel::TransitionNode) )
or
( self.source.oclIsKindOf(pnmlcoremodel::TransitionNode) and
  self.target.oclIsKindOf(pnmlcoremodel::PlaceNode) and
  not ( self.type.text = ArcTypes::inhibit ) )
```

Program Graphics

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```
public class InhibitornetsArcFigure extends ArcFigure {
[...]
  private void setGraphics() {
    RotatableDecoration targetDecorator = null;
    RotatableDecoration sourceDecorator = null;

    if (type.equals(ArcTypes.NORMAL)) {
      targetDecorator = new ReisigsArrowHeadDecoration();

    } else if (type.equals(ArcTypes.INHIBIT)) {
      CircleDecoration circleDecoration =
        new CircleDecoration();
      circleDecoration.setLineWidth(this.getLineWidth());
      targetDecorator = circleDecoration;

    } else if (type.equals(ArcTypes.READ)) {
      targetDecorator = new ReisigsArrowHeadDecoration();
      sourceDecorator = new ReisigsArrowHeadDecoration();
[...]
```

Just a glimpse!

Benefits of Modelling

- Better understanding
- Mapping of instances to XML syntax (XMI) (canonical exchange format for instances)
- Automatic code generation for
  - API for creating, deleting and modifying model
  - Methods for loading and saving models (in XMI)
  - Standard mechanisms for keeping track of changes (observers)
  - Transactional changes (ACI)
  - Database access / persistence (D)
  - Graphical editors

BUT:
All this is "standard functionality"!
How about "real" functionality or behaviour?

e.g. a Petri net simulator?

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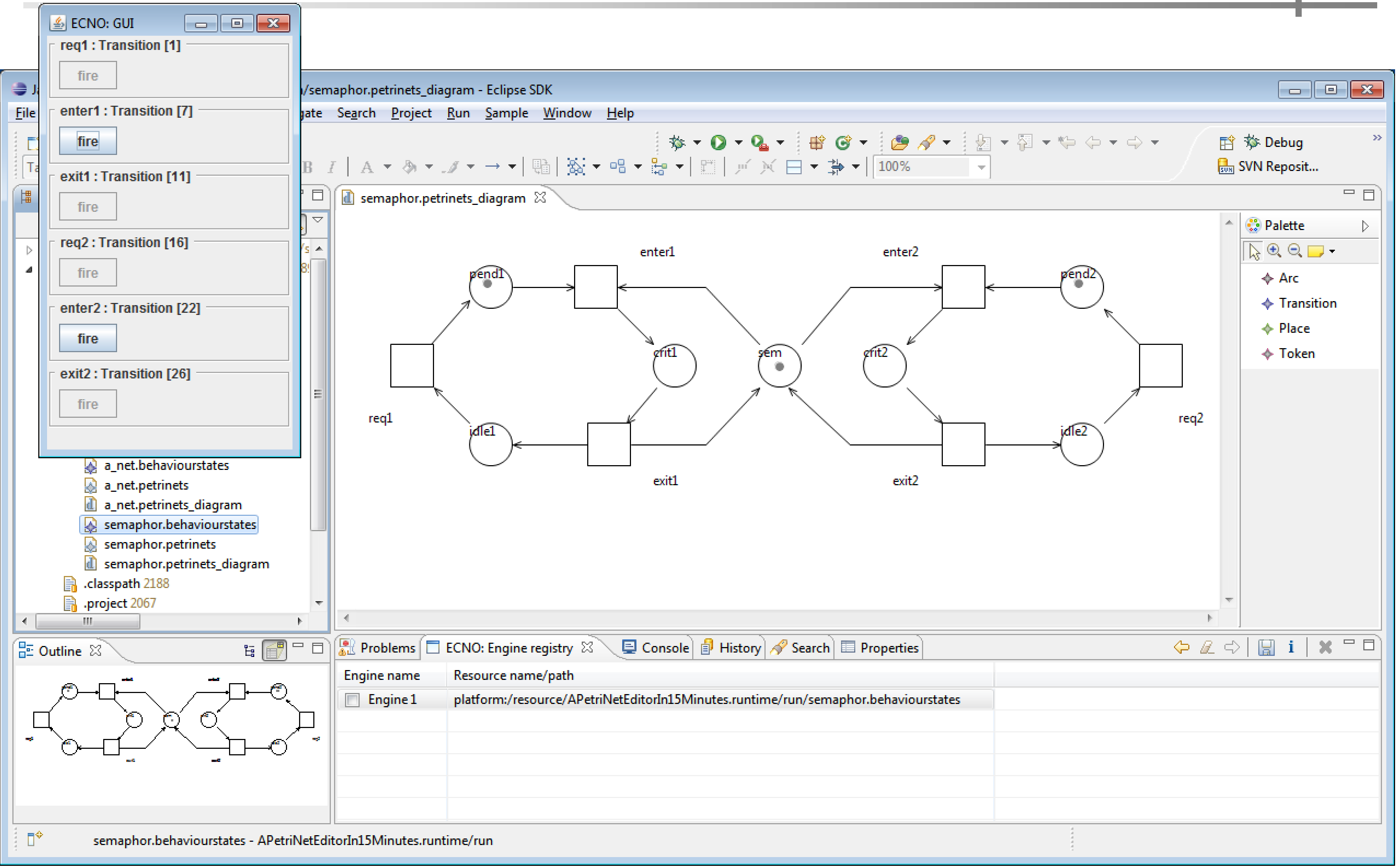

Challenges

~~There are no notations for modelling behaviour!~~

This claim is actually as wrong as it can get!
There are (too?) many such notations!

Challenges

- Adequate modelling methodologies
  - Coarse grain behaviour
  - Fine grain behaviour

- Mechanism for integrating and coordinating behaviour beyond invocation (calls of procedure, function, method, or service)

- Integration with
  - existing software (legacy, manually created, generated)
  - other models (structural & behavioural)

- Change mentality (change culture)
  - Stuck with thread- and invocation-based thinking
  - Software engineering is programming thinking (→ model interpretation vs. code generation)

Moreover: Today's modelling technologies are not very "agile"!

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Motivation

- Given some object oriented software with (or without) explicit domain model
- Model the behaviour on top of it – and make these models executable
- Model behaviour on a high level of abstraction (domain level): coordination of behaviour

Meta-modelling / domain modelling **including behaviour!**

→ Integrate behaviour models with structural models
→ Integrate different structural models and manually written code (or code generated by different technologies)

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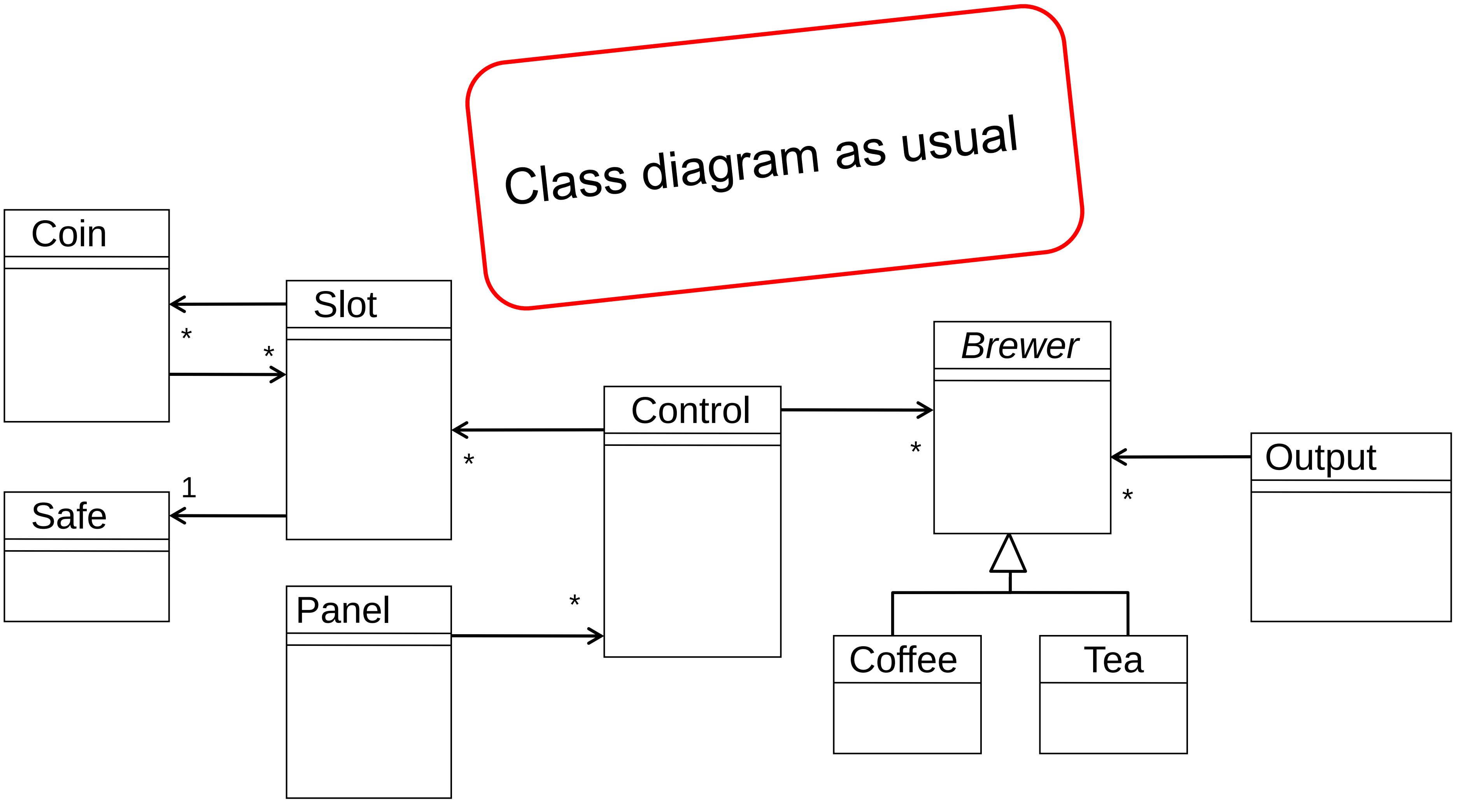
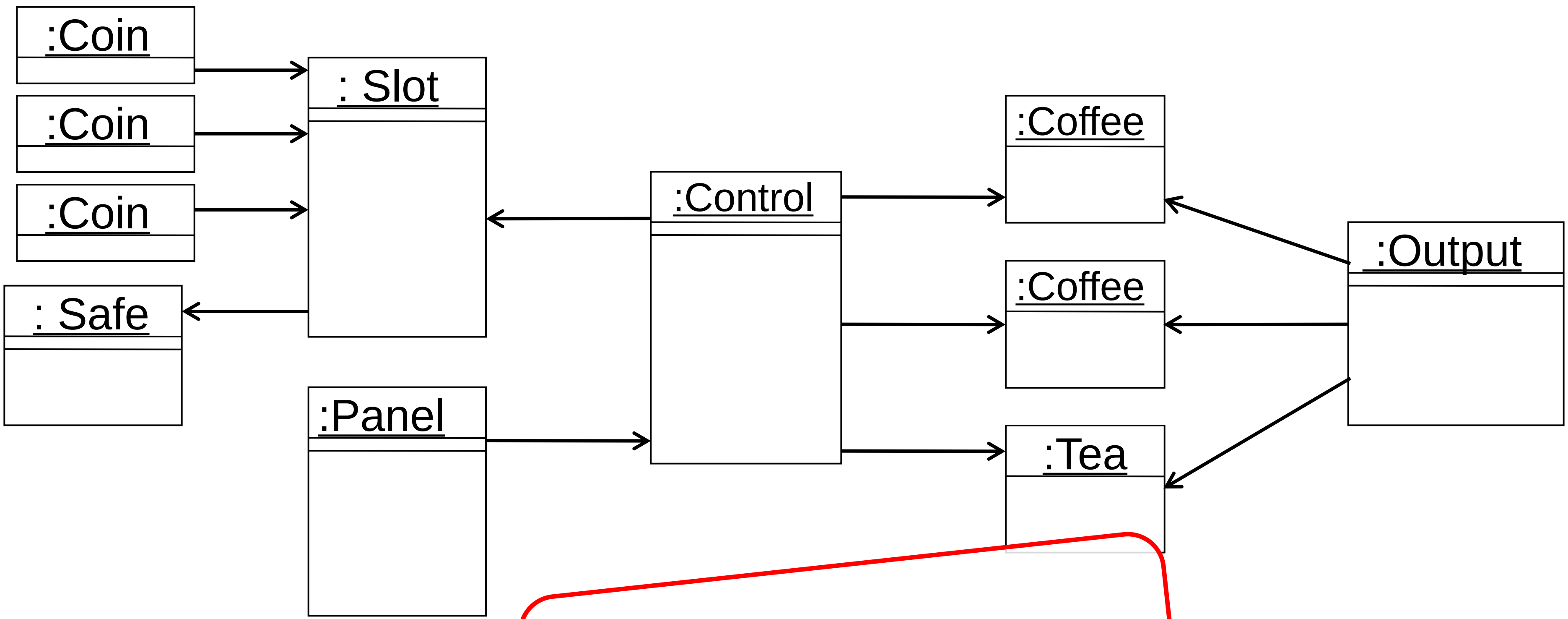


Instance: Object Diagram

Initial configuration, current situation

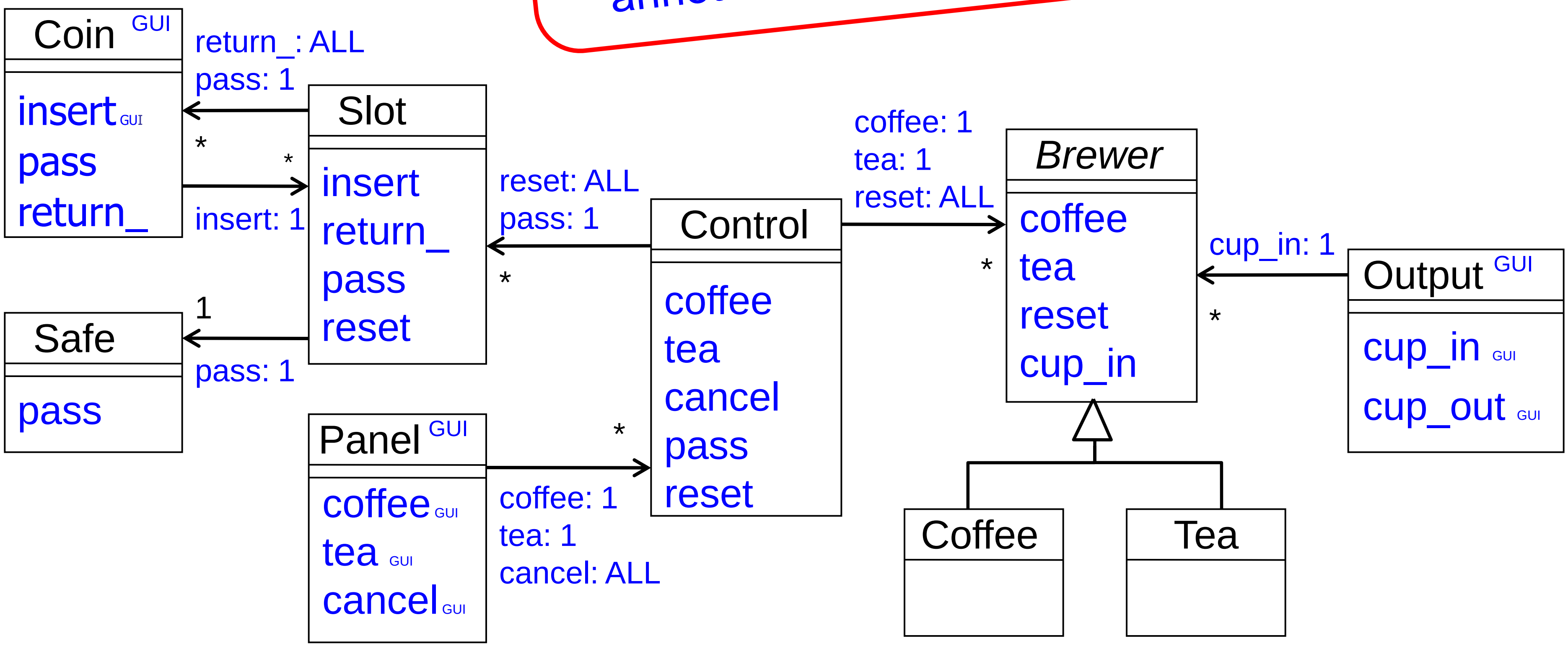


Object diagram as usual

Coordination Diagram

- We call objects elements now!

- Events (event types)
- Coordination annotations: event type + quantification annotation



... + Event declaration

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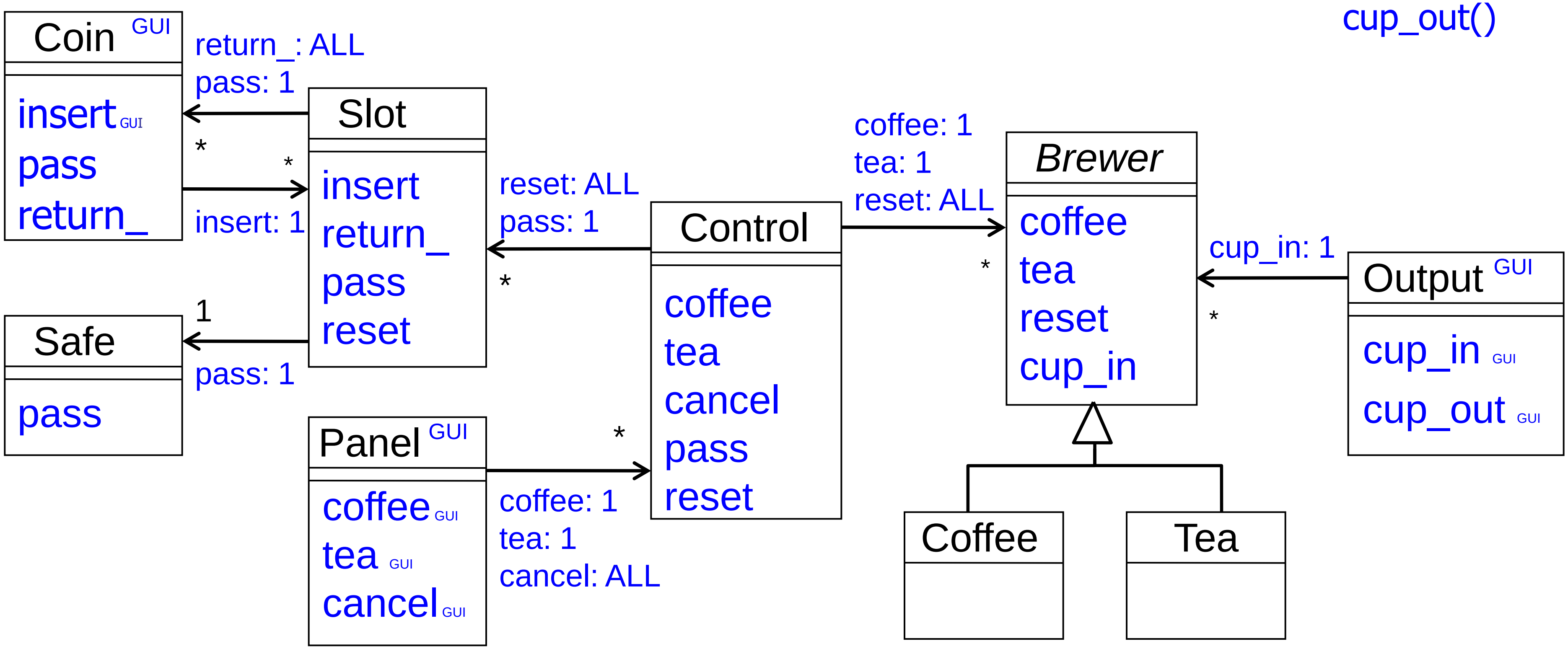
- Event (type) declaration
- Parameters

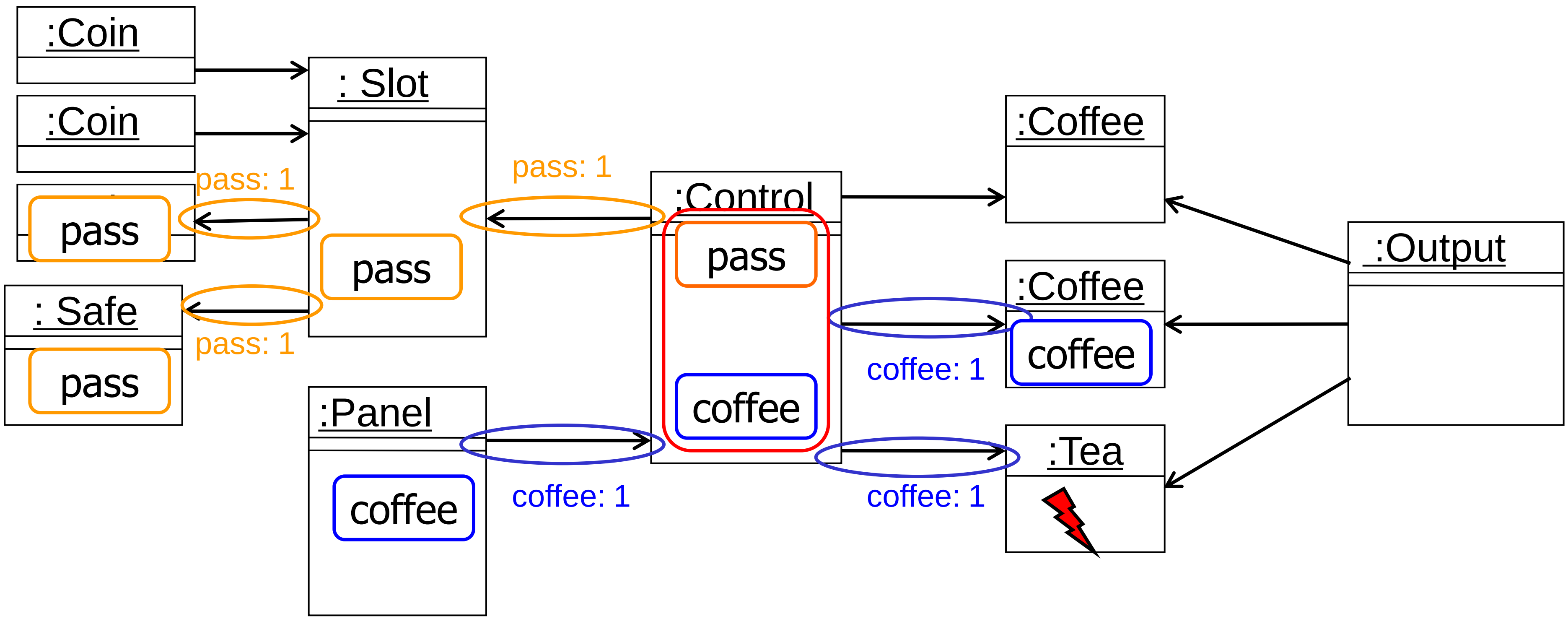
insert(Coin coin, Slot slot)
pass(Coin coin, Slot slot)
return(Slot slot)
reset_()

coffee()
tea()
cancel()

cup_in()
cup_out()

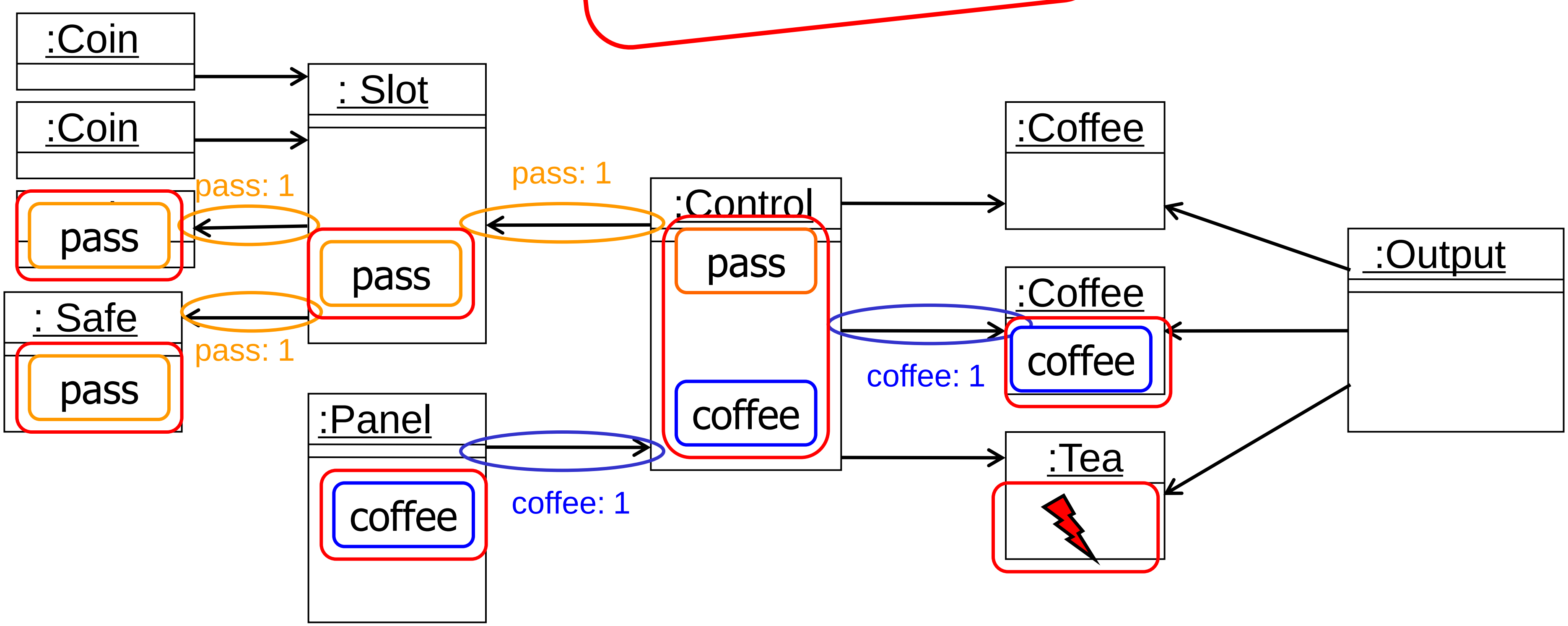


Interactions



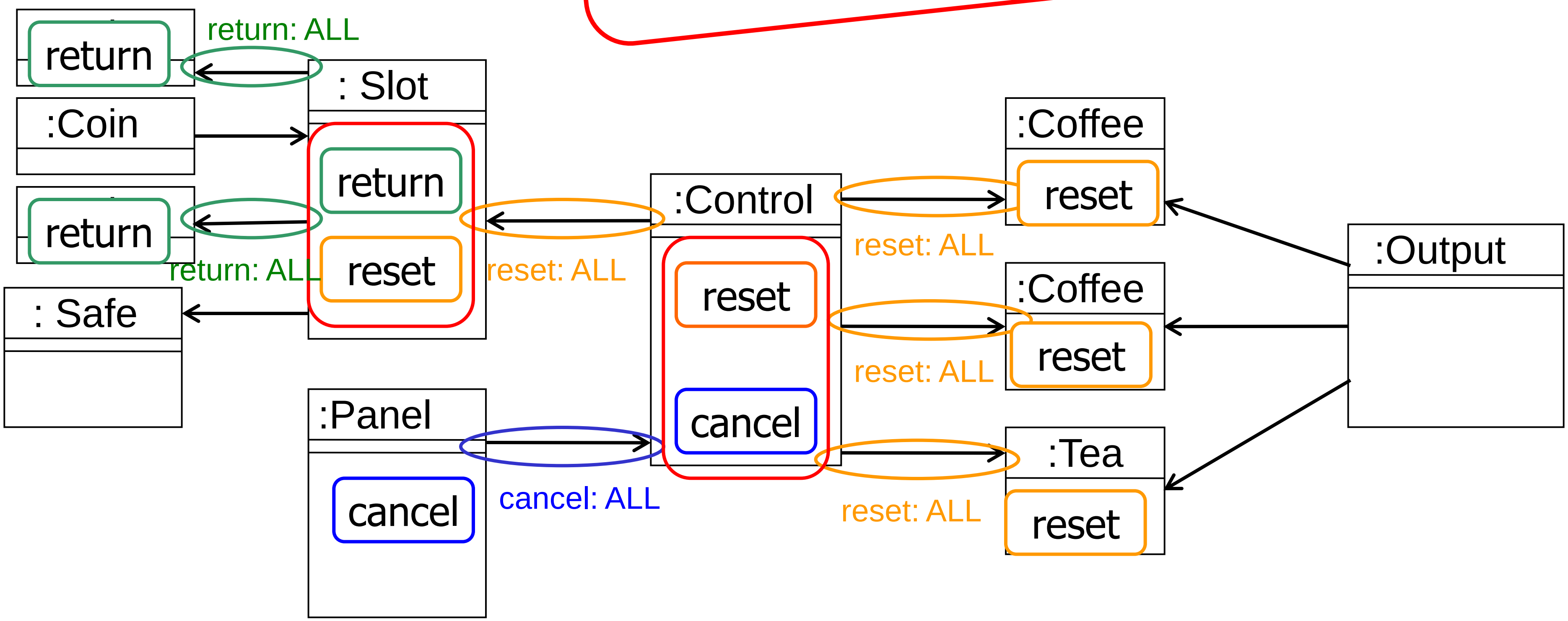
Interactions

Interaction =
local behavior +
coordination



Another Interaction

Interaction =
local behavior +
coordination



Local behaviour: Coffee

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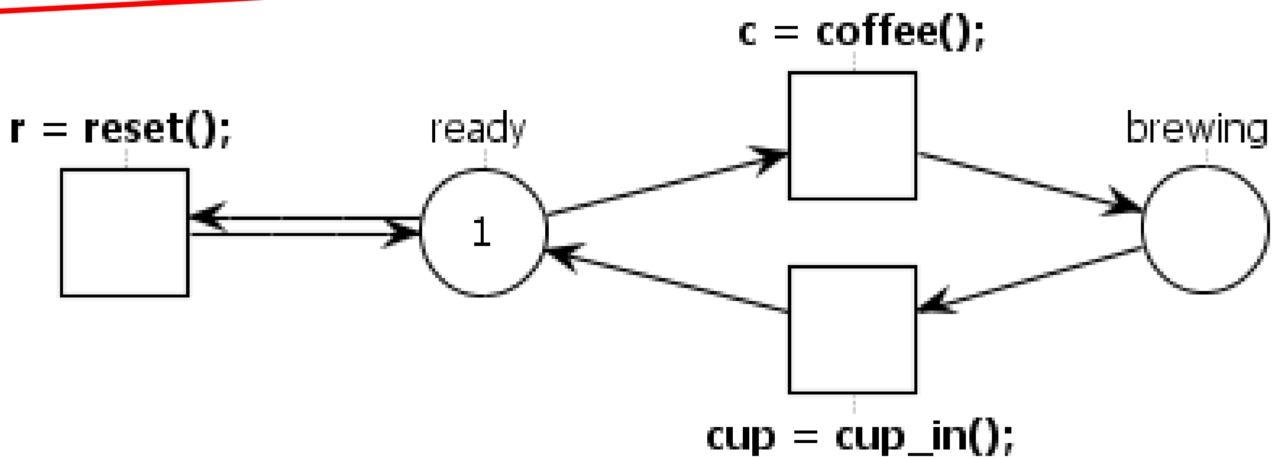
Elements are objects with an explicitly modelled **life-cycle**

Event binding



Local behaviour: Coin

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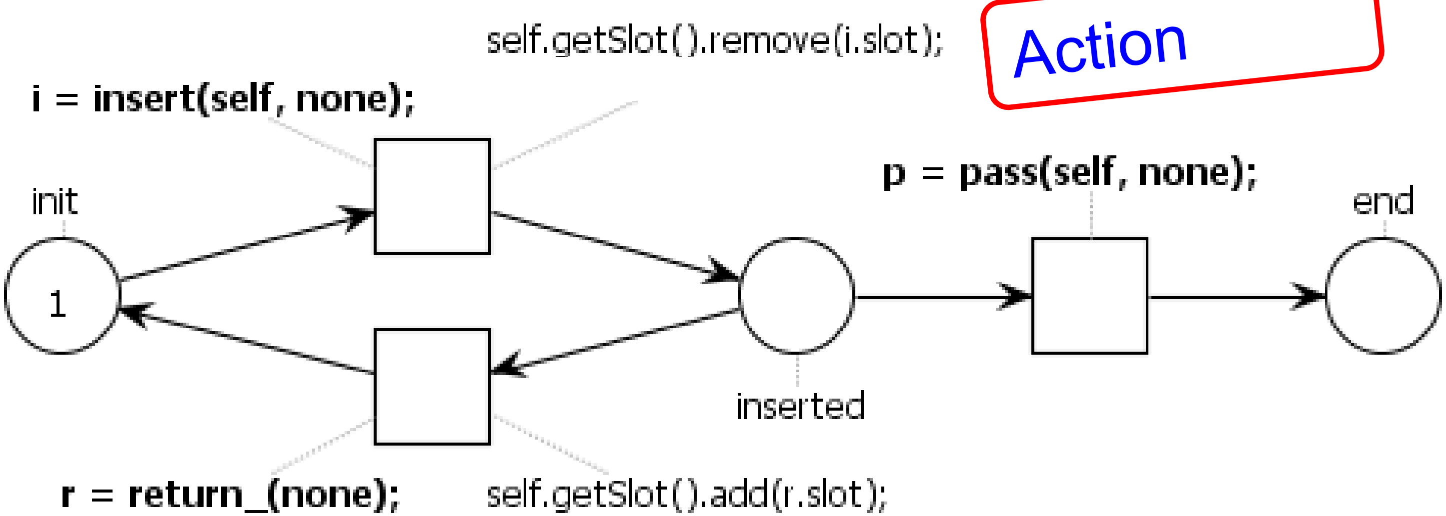
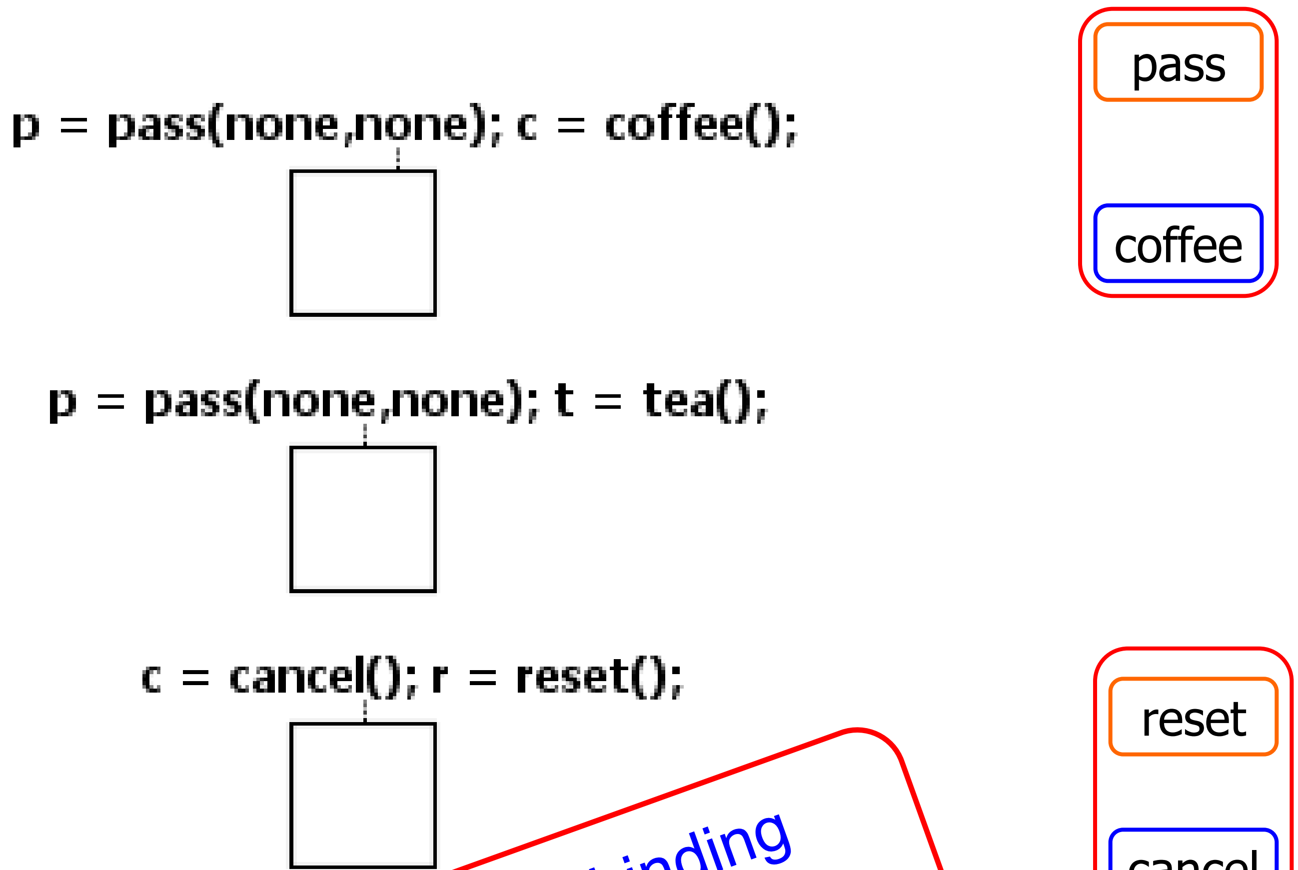
```
import dk.dtu.imm.se.ecno.engine.ExecutionEngine;

final ExecutionEngine engine = ExecutionEngine.getInstance();
```



Action

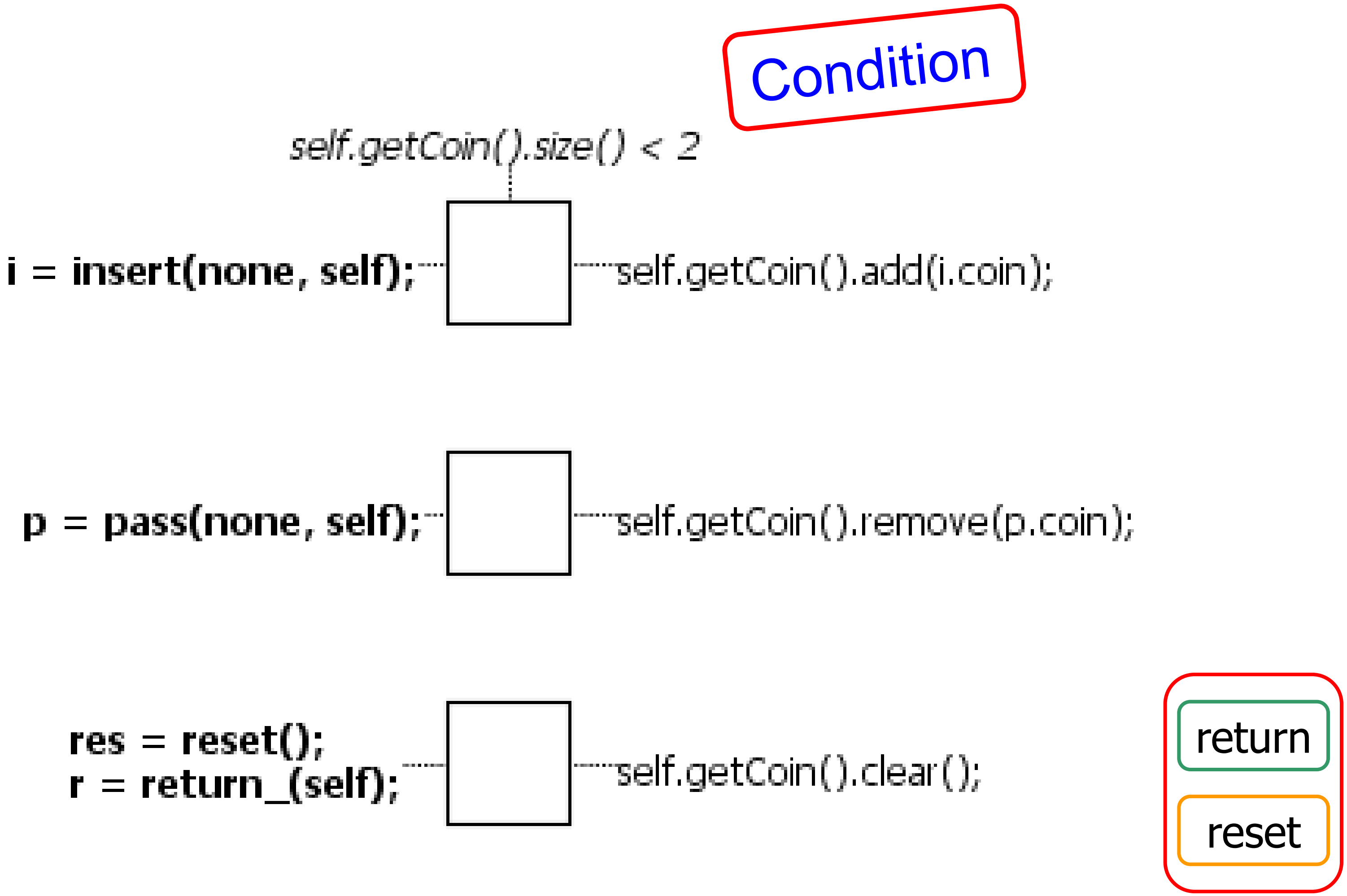
- Event binding
- Parameter assignment

Local behaviour: Control



- Event binding with multiple event types!

Local behaviour: Slot



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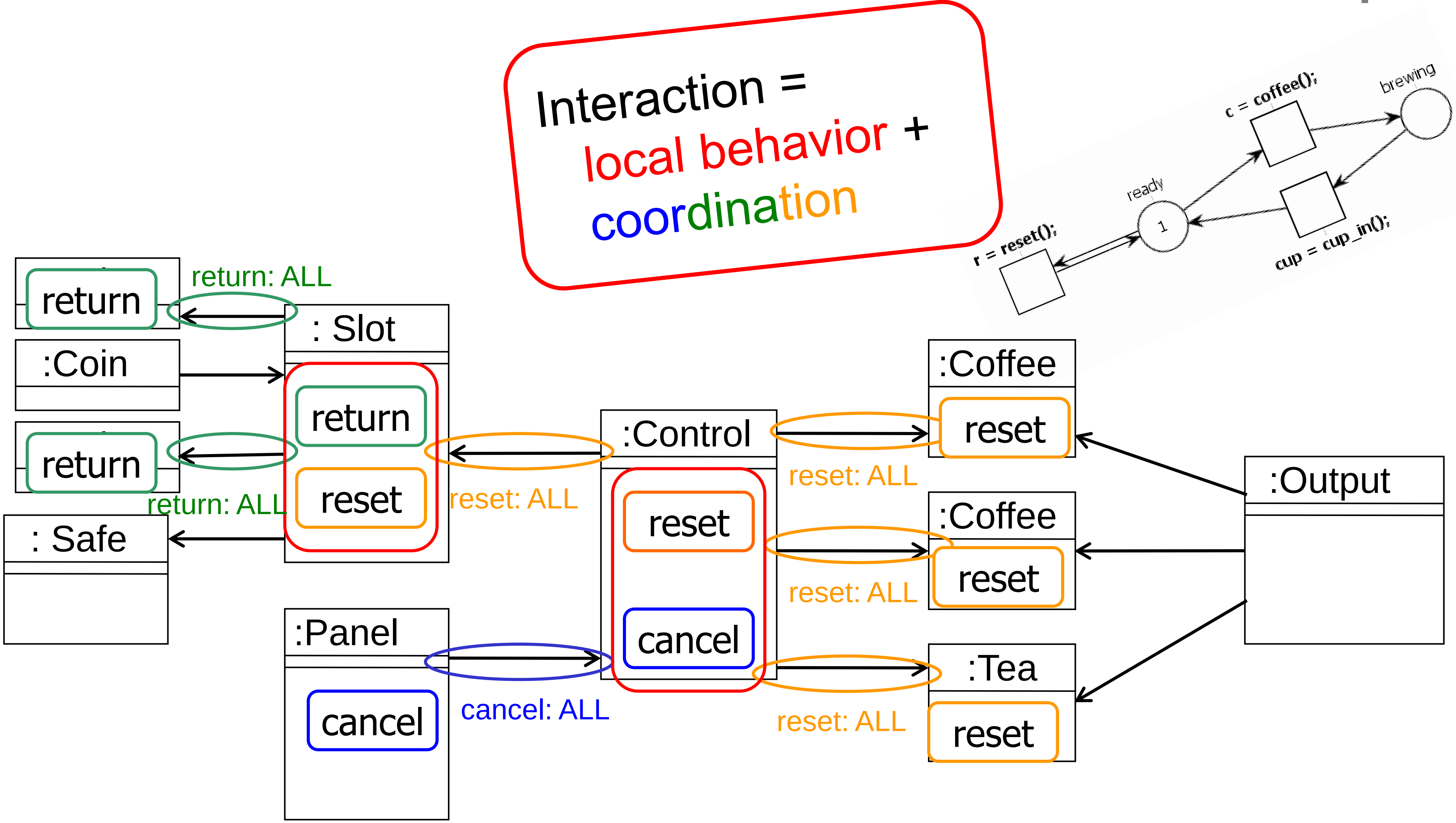
Interaction =
local behavior +
coordination



2.2 ECNO: Basic Concepts

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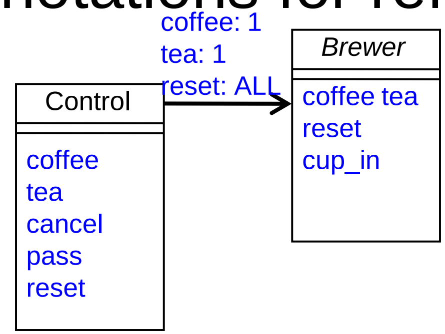
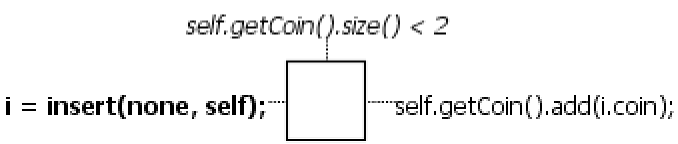
- ElementTypes (Classes)
- EventTypes with
  - parameters

insert(Coin coin, Slot slot)

- Global Behaviour: Coordination annotations for references
  - Event type
  - Quantification (1 or ALL)



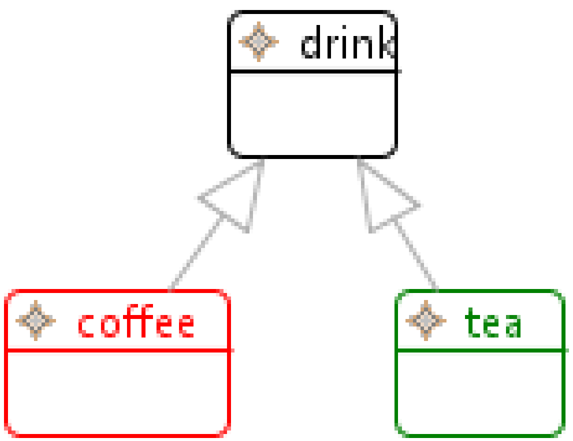
- Local behaviour (life-cycle): ECNO nets (or something else)
  - Event binding (with parameter assignment)
  - Condition
  - Action



2.3 Extensions (cntd.)

ECNO with its basic concepts has some limitations, which makes modelling things **in an adequate way** a bit painful.

- Sometimes, we want to extend event types later



Behaviour inheritance

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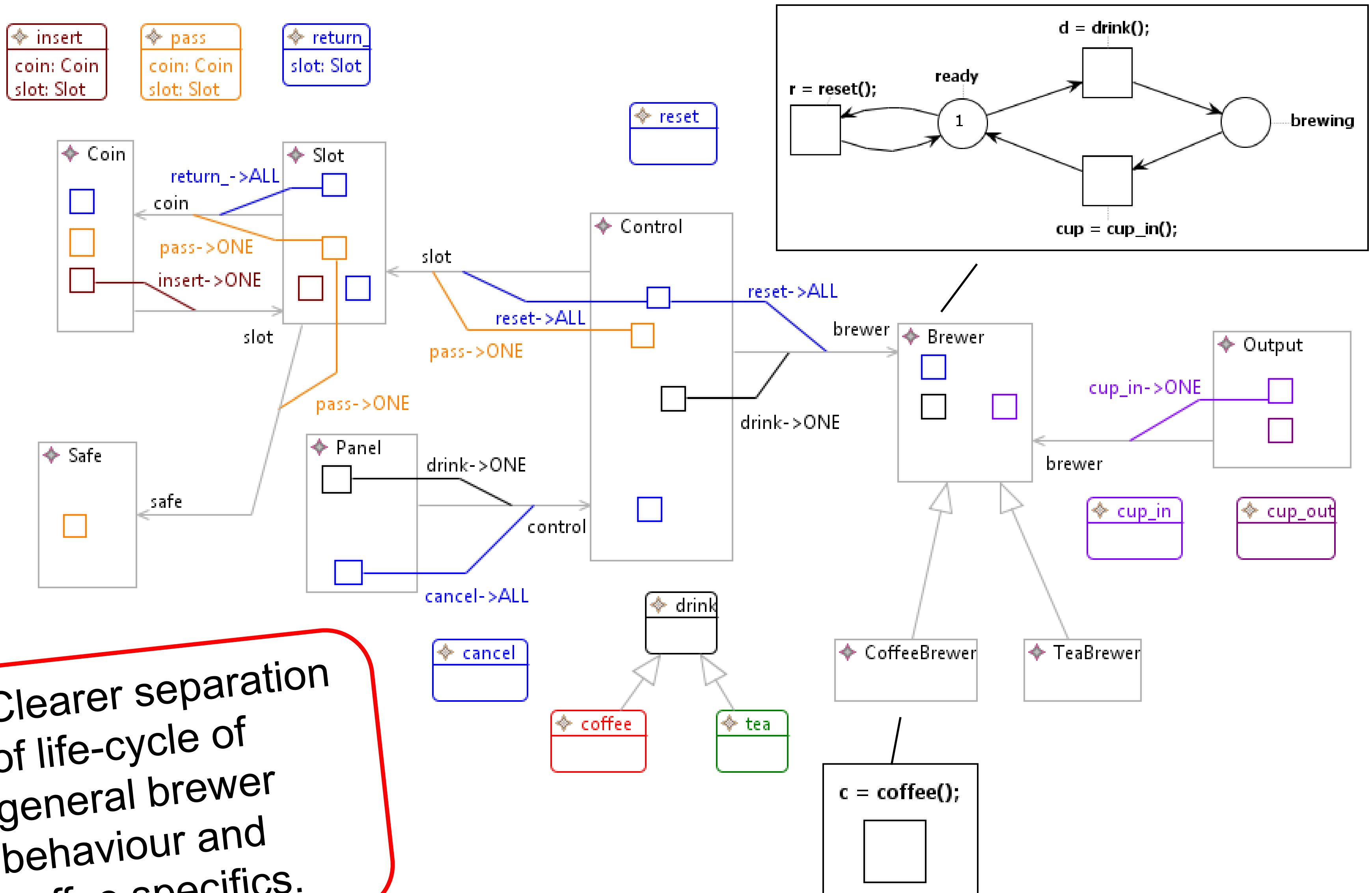


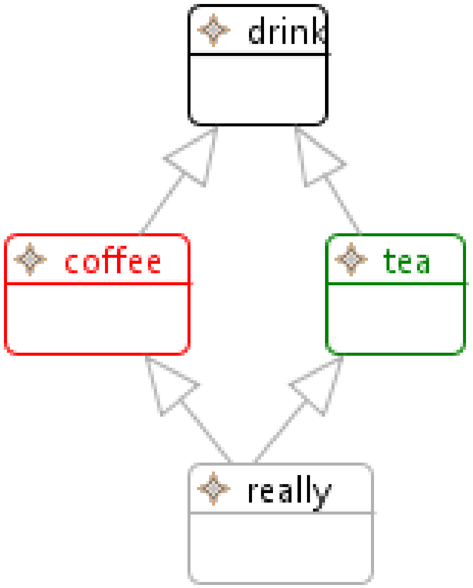
Clearer separation of life-cycle of general brewer behaviour and coffee specifics.

Event Inheritance

Question: Would we like to have multiple inheritance on event types?

Problems:

- We could never be sure that two event types that were meant to be different are different!
- We would not know which event type an instance of subtype would represent!



Avoid confusion! Without a really compelling argument, do not introduce multiple inheritance on event types.

Event Extension

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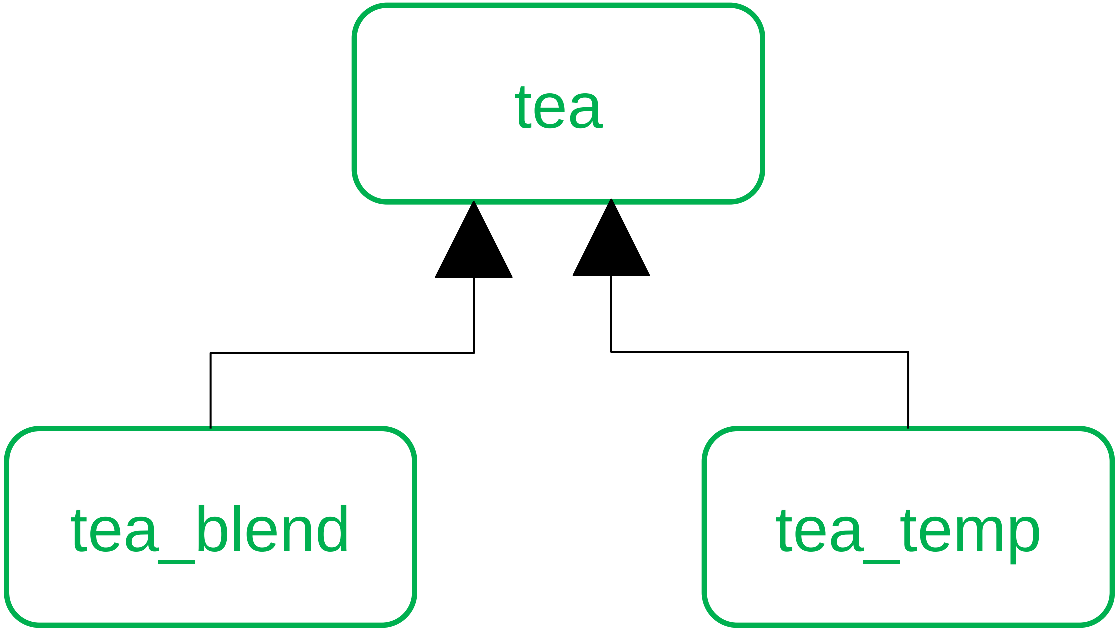
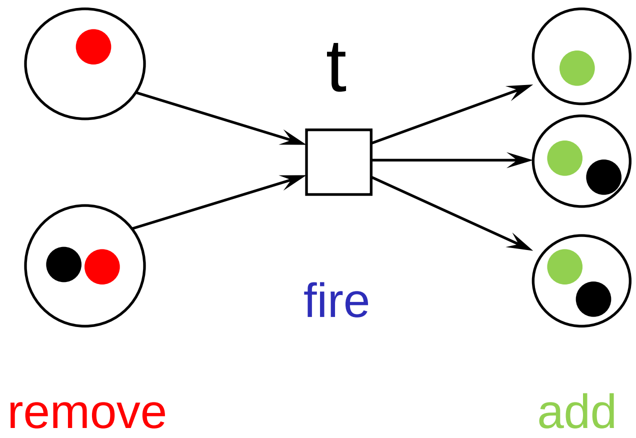


=> Two forms of inheritance on event types!

2.4 Example2: Petri nets



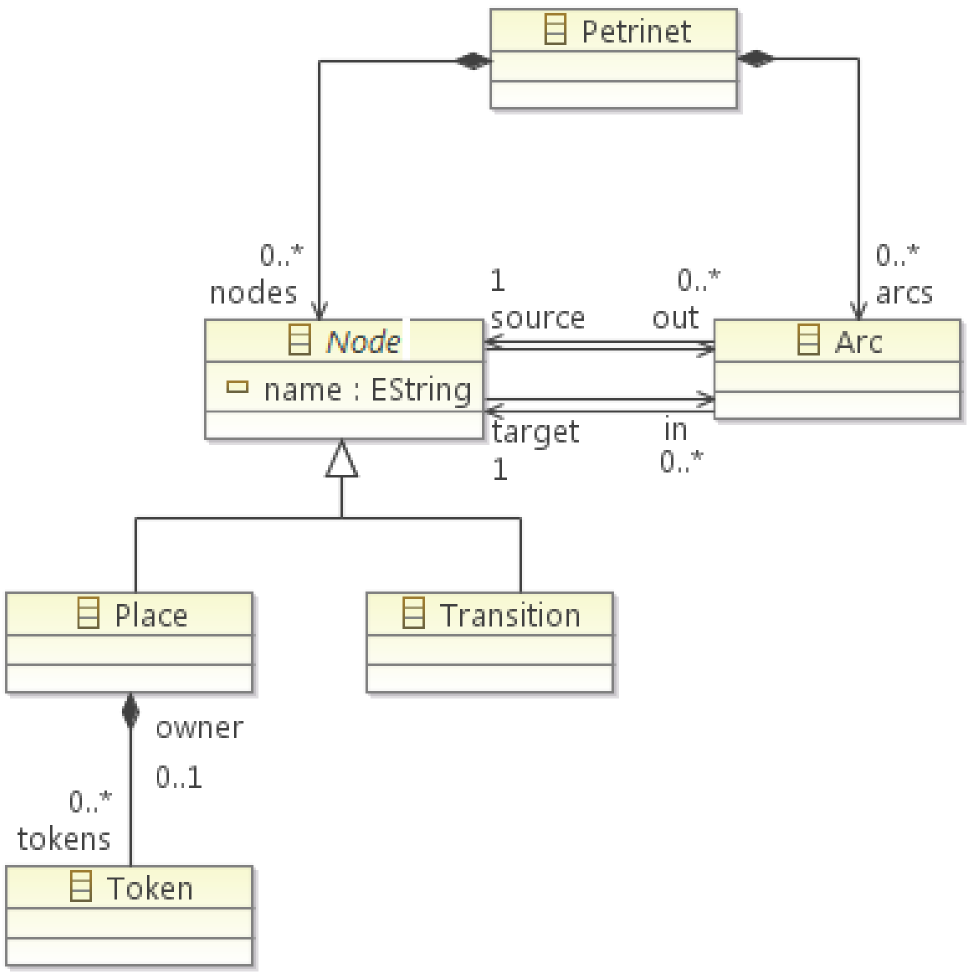
How can we model that behaviour in ECNOs?

Transition t **enabled**:
  for ALL incoming Arcs a:
    for ONE source Place p of Arc a:
      find a token

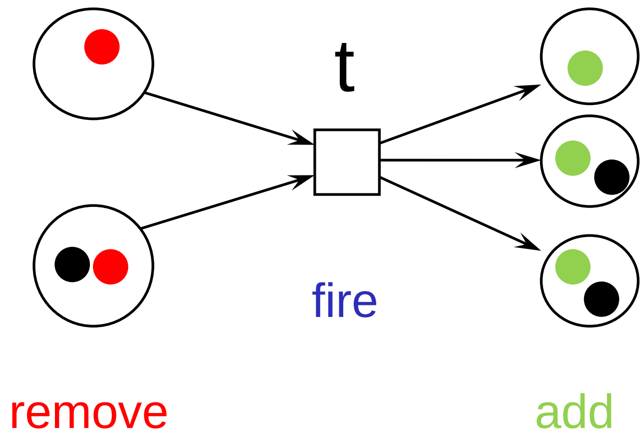
Fire Transition t:
  for ALL incoming Arcs a:
    for ONE source Place p of Arc a:
      find a token and remove it

  for ALL outgoing arcs a:
    for ONE target Place p of Arc a:
      add a new Token

Petri net: Abstract Syntax



Example2: Petri nets



Transition t **enabled**:
  for **ALL** incoming Arcs a:
    for **ONE** source Place p of Arc a:
      find a token

Fire Transition t:
  for **ALL** incoming Arcs a:
    for **ONE** source Place p of Arc a:
      find a token and **remove** it

  for **ALL** outgoing arcs a:
    for **ONE** target Place p of Arc a:
      add a **new** Token

ECNO Semantics of PN

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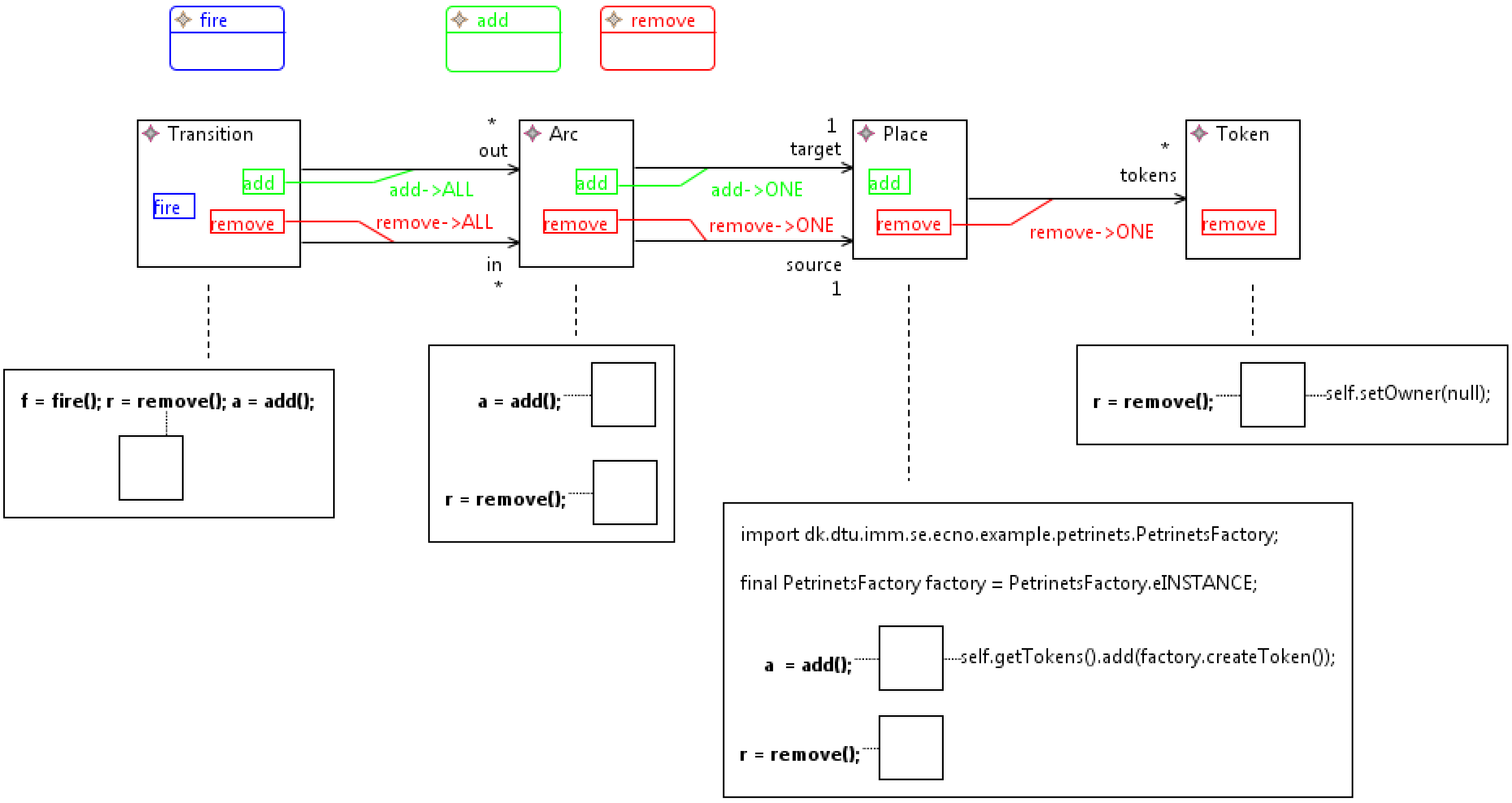

Result

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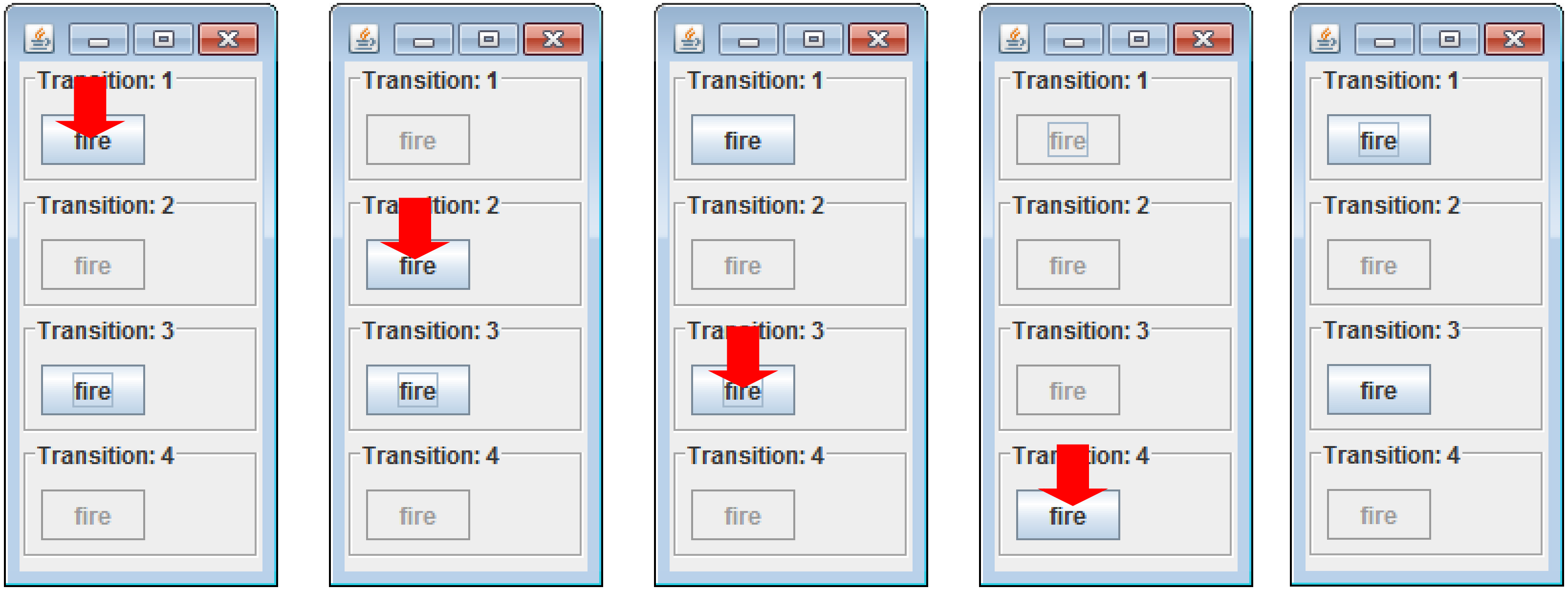

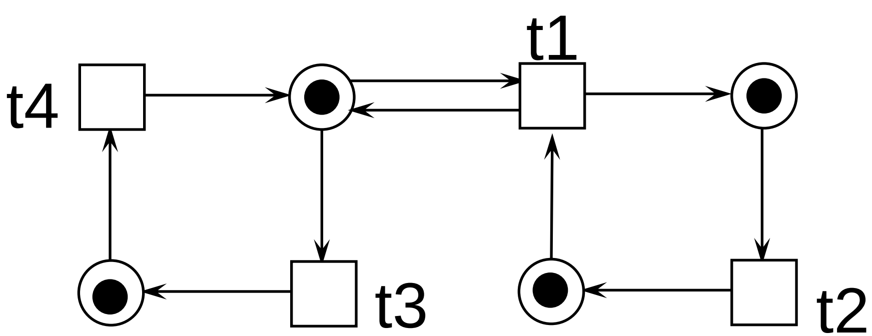

Petri net simulator

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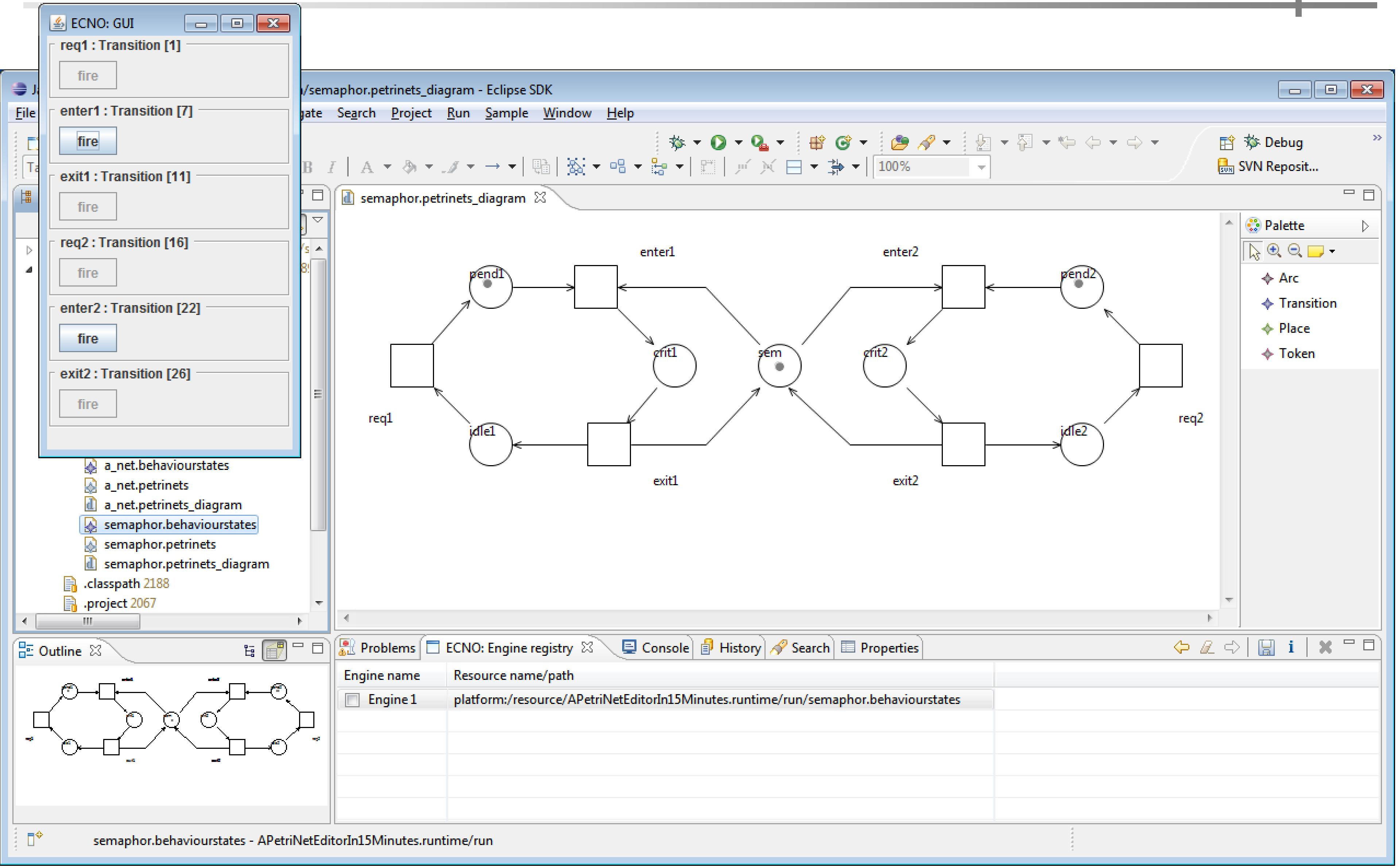
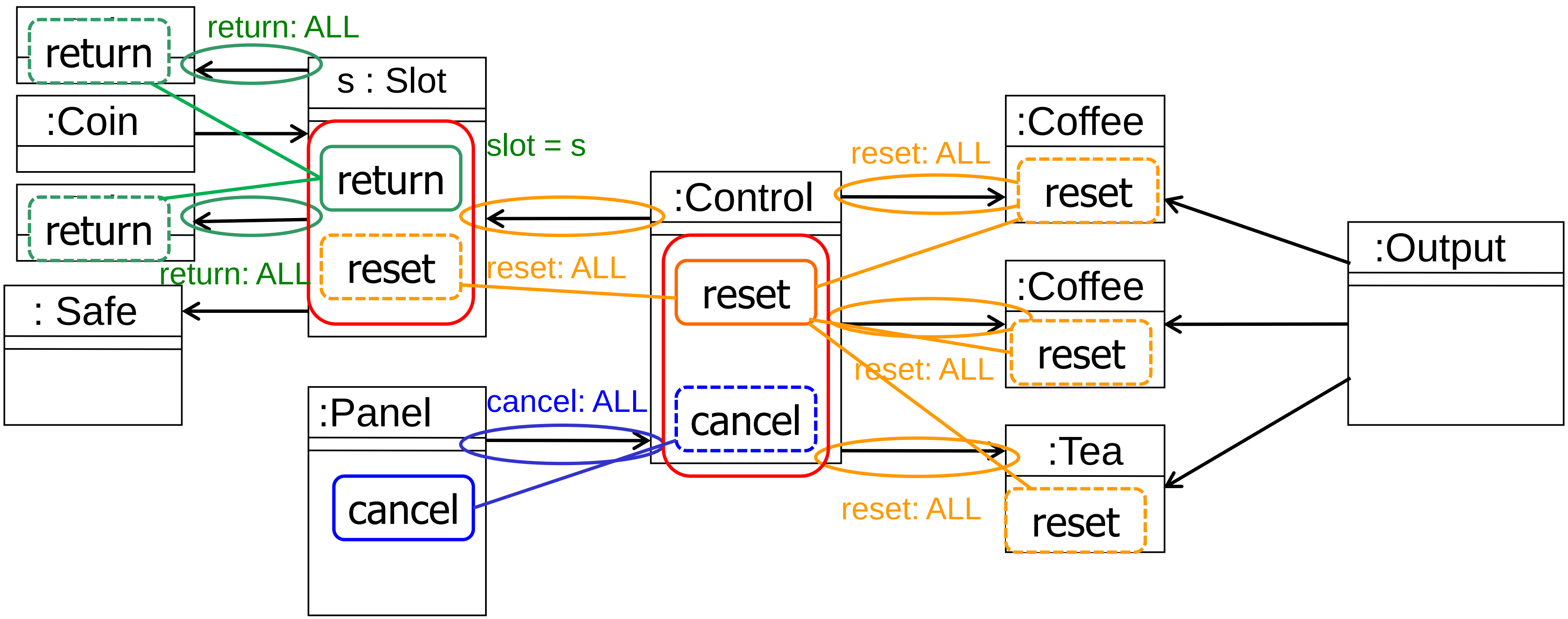


3. ECNO: Semantics

- Can be formalized in mathematics
  (done for core concepts → ECNO Technical Report)



"Meta ECNO"

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- The semantics of ECNO could, probably, be expressed in ECNO itself!

I have a sketch (but not fully worked out yet).

Idea similar to PN semantics; needs most of the advanced concepts (except inheritance).

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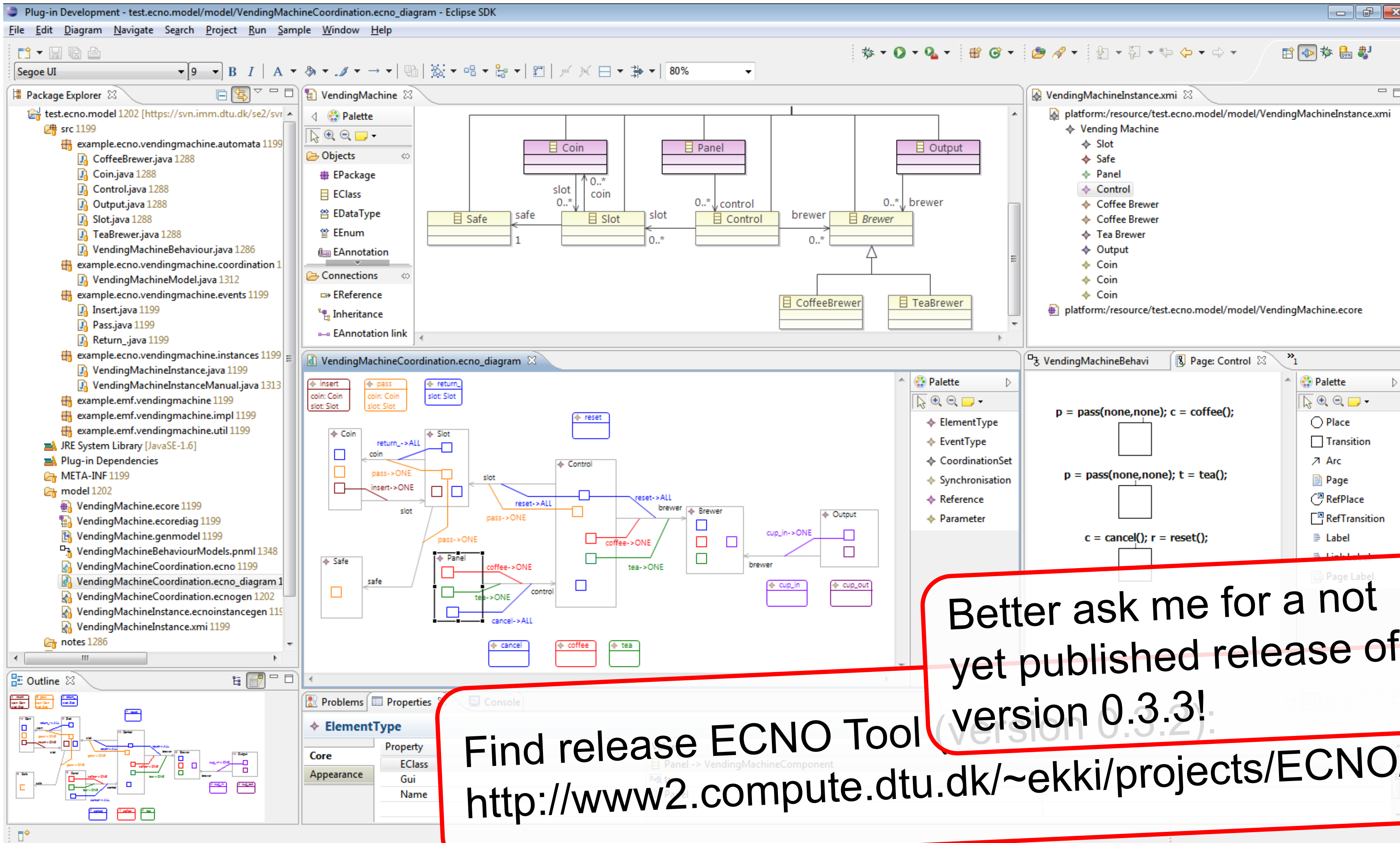

Find release ECNO Tool (version 0.3.2):
http://www2.compute.dtu.dk/~ekki/projects/ECNO/

Better ask me for a not yet published release of version 0.3.3!

Next Steps

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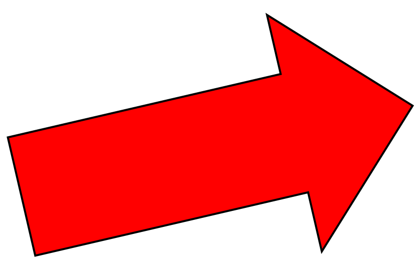

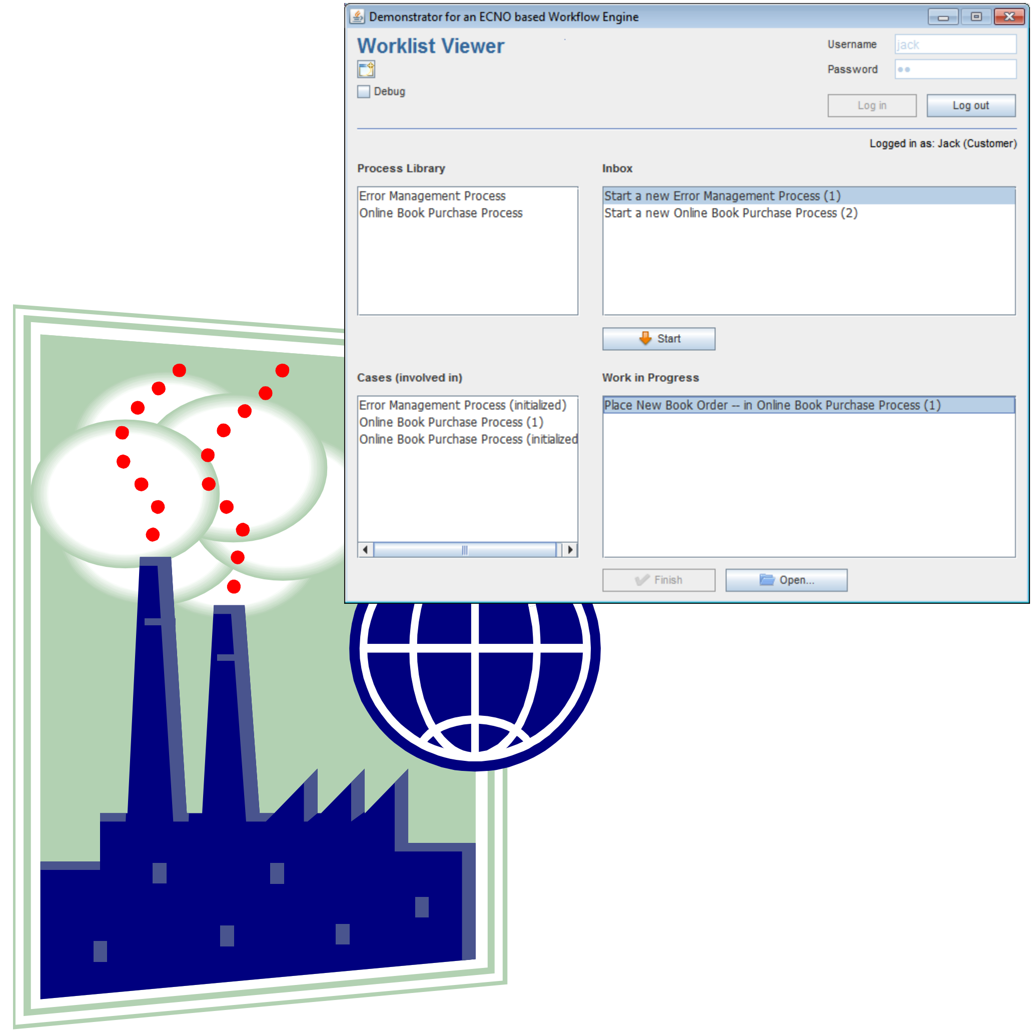

Next Steps (cntd.)

- Documentation
- Database integration (e.g. Hibernate/Teneo)

- GUI modelling (DSL for GUI for ECNO applications)
- Better IDE support & debugger

- Case studies
- Efficiency / distributed execution
- Standard adapters for other technologies

- **Methodology & education**