Model Transformation Lab

From UML Activities to Petri nets by VIATRA2

Recap – VIATRA2

- **VIATRA2**
  - an **Eclipse** Modelling Subproject
  - http://wiki.eclipse.org/VIATRA2
  - http://www.eclipse.org/gmt/VIATRA2/
- Developed at BME FTSRG
  - Used in several EU research projects
    - DECOS
    - SENSORIA
    - DIANA
    - MOGENTES
    - SECURECHANGE

What is VIATRA2?

- A platform for MT
  - Transformation execution
  - Model representation
- A programming language
  - Tailored for the specification of transformations
- A development environment
  - using Eclipse technology
- An extensible framework
  - Access various model representations (UML, EMF, etc.)
  - Augment transformation functionality

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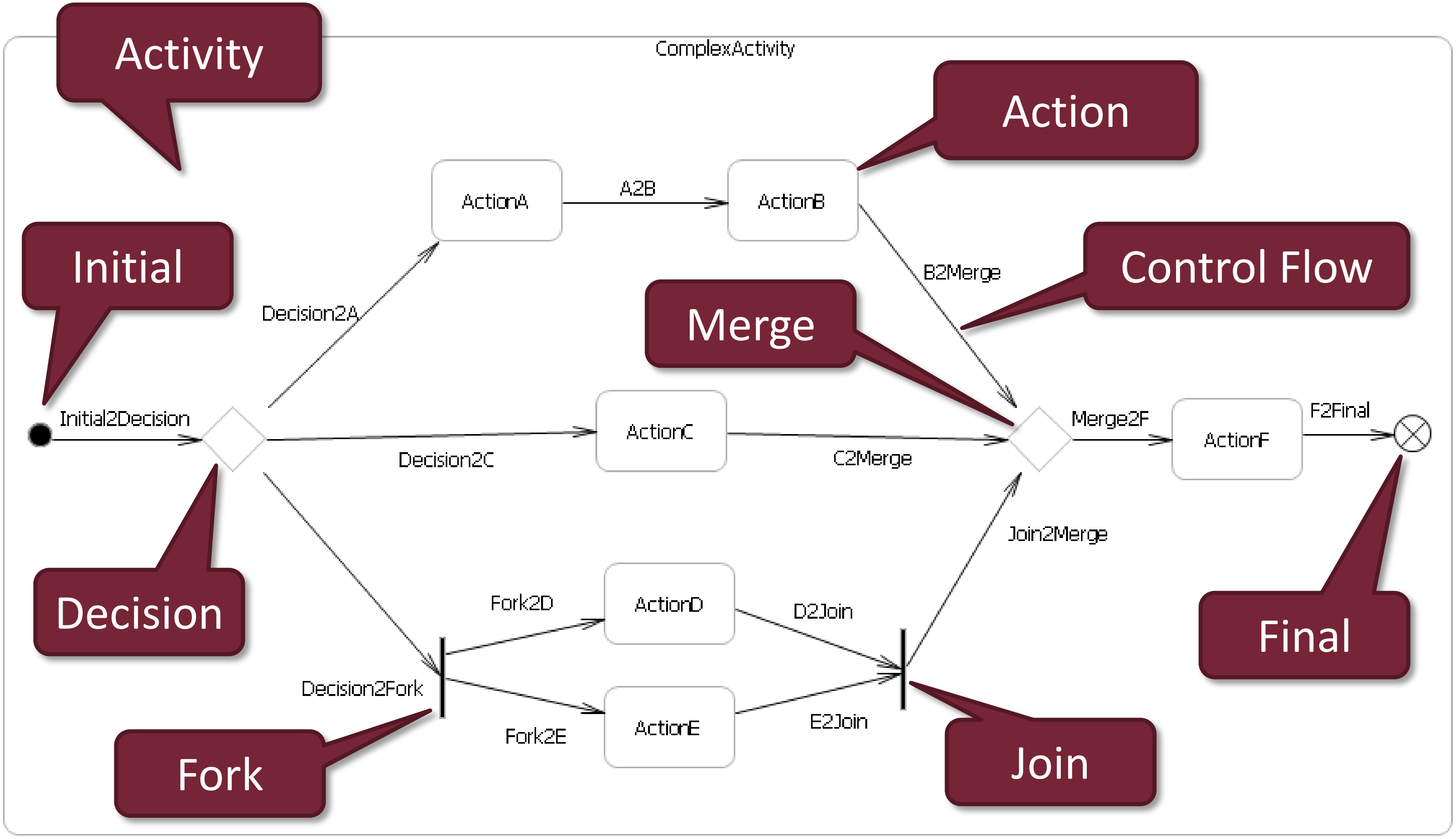
Declarative processing of models with optimized execution

Common ground for heterogeneous models

Example Transformation

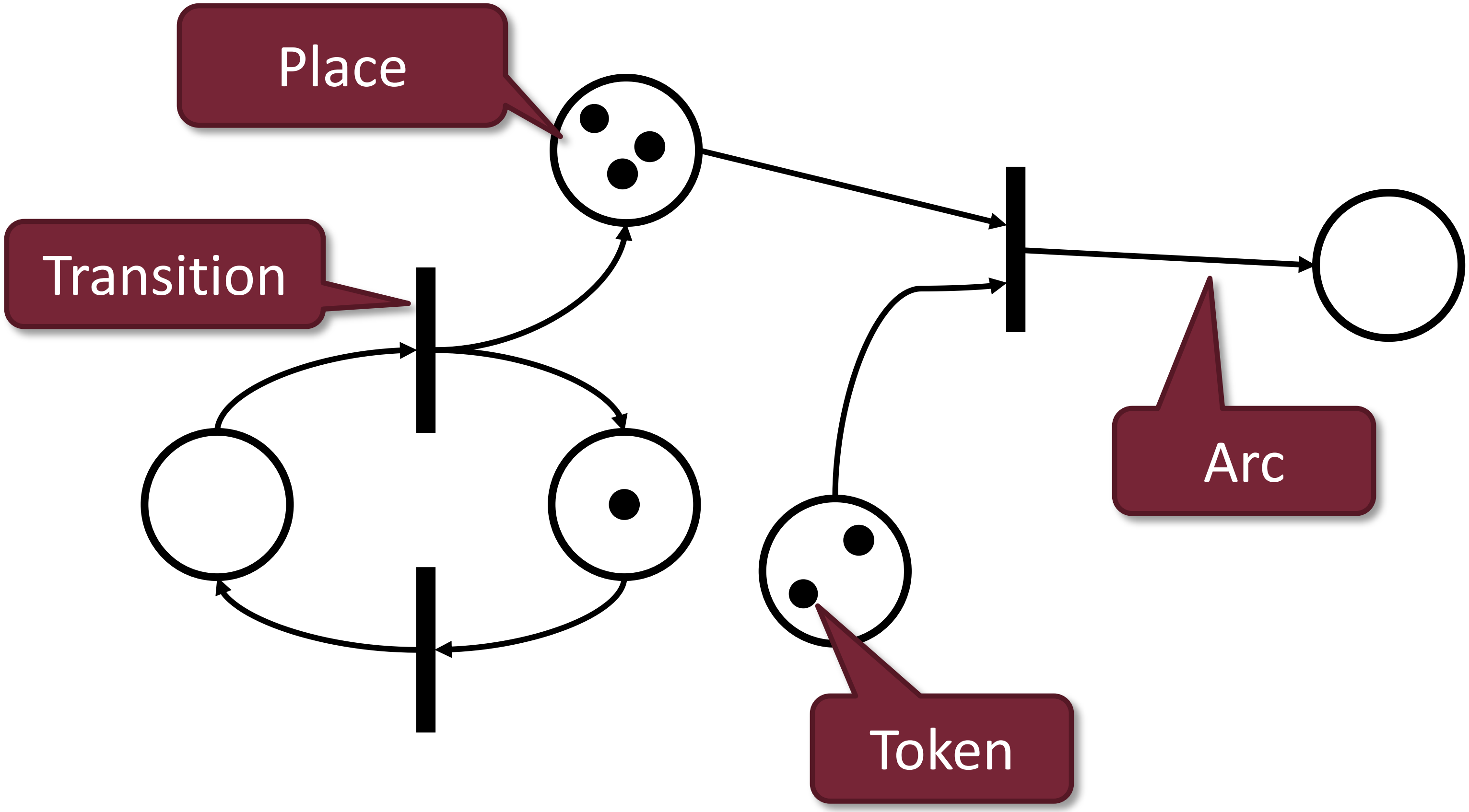
- Source domain: **UML Activities** (core elements)
  - standard process description language
  - countless editors available
- Target domain: **Petri nets** (basic elements)
  - mathematical formalism
  - concurrent behavioural model
  - efficient analysis tools available

UML Activities (core)



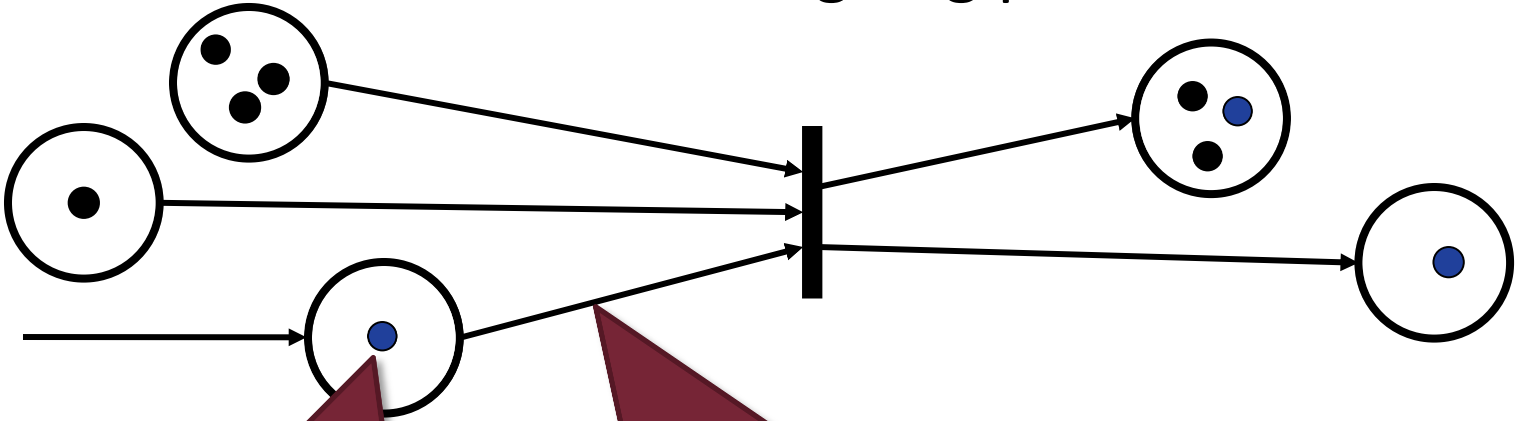
Petri nets

- AKA Place/Transition Nets



Petri nets

- State = marking of places
- State change: firing of a transition
  - *enabled* if all incoming places are *marked*
  - 1 token removed from each incoming place
  - 1 token added to each outgoing place

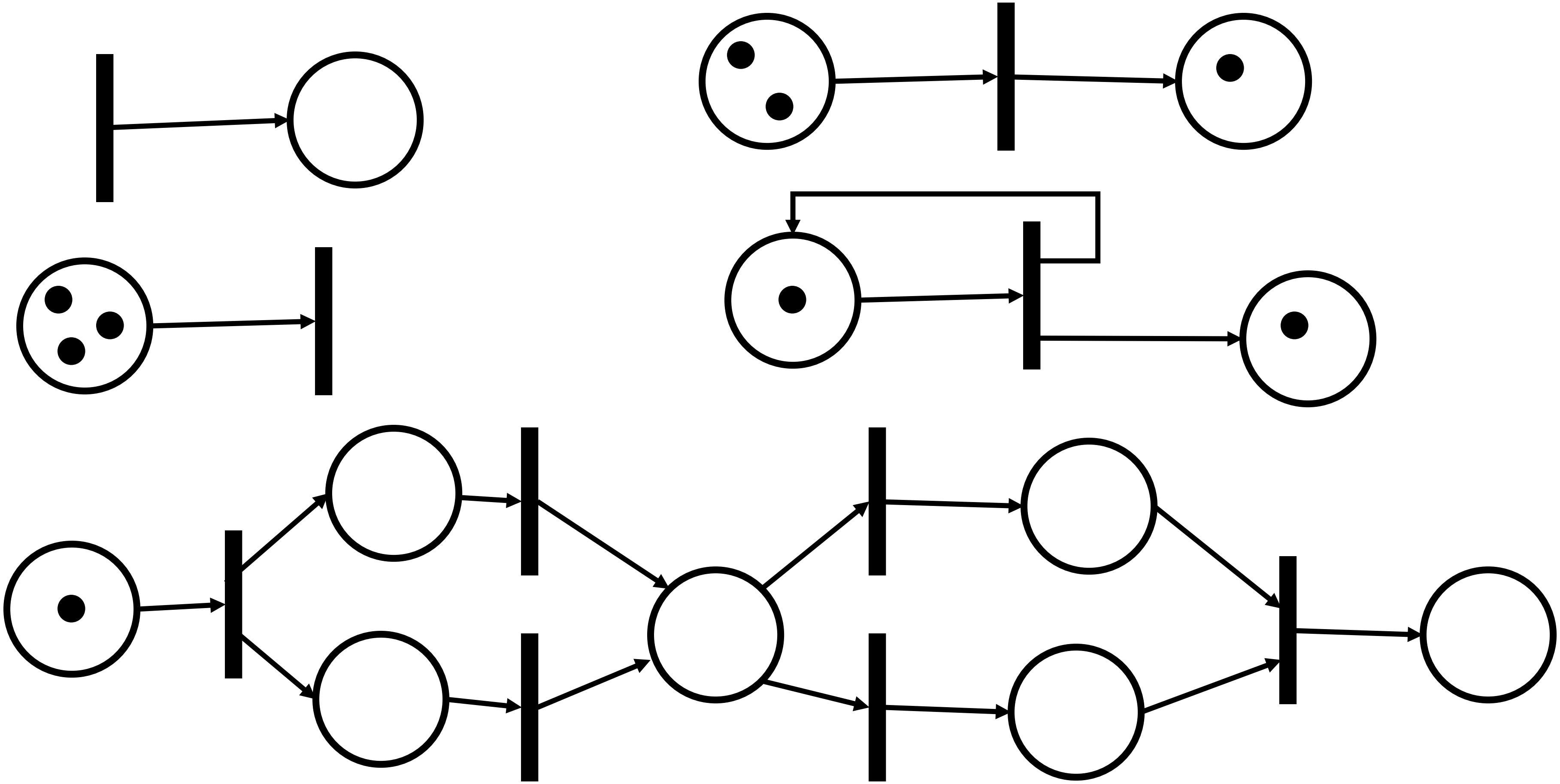


Now enabled

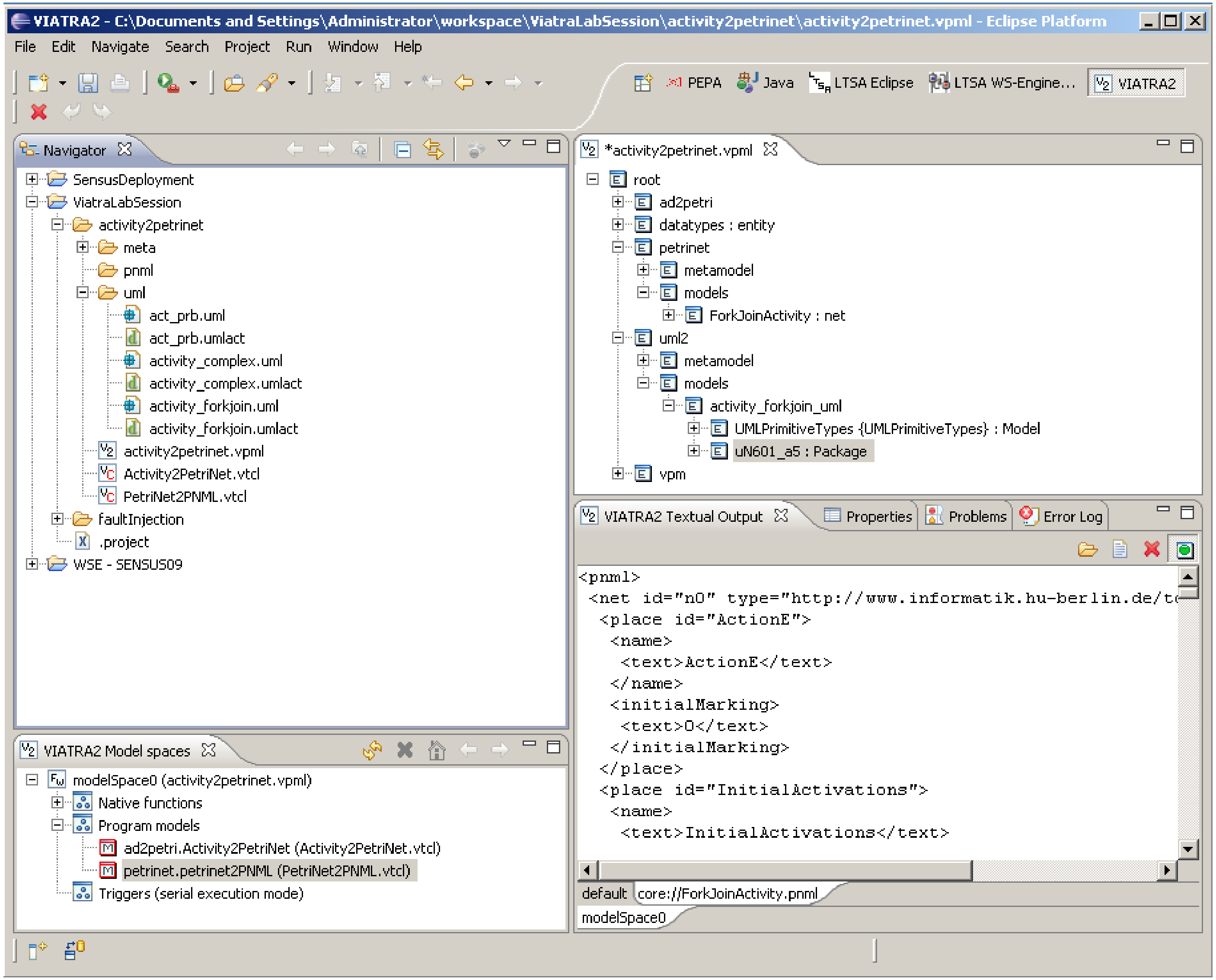
Transition not enabled

Petri nets

- What do these Petri nets do?



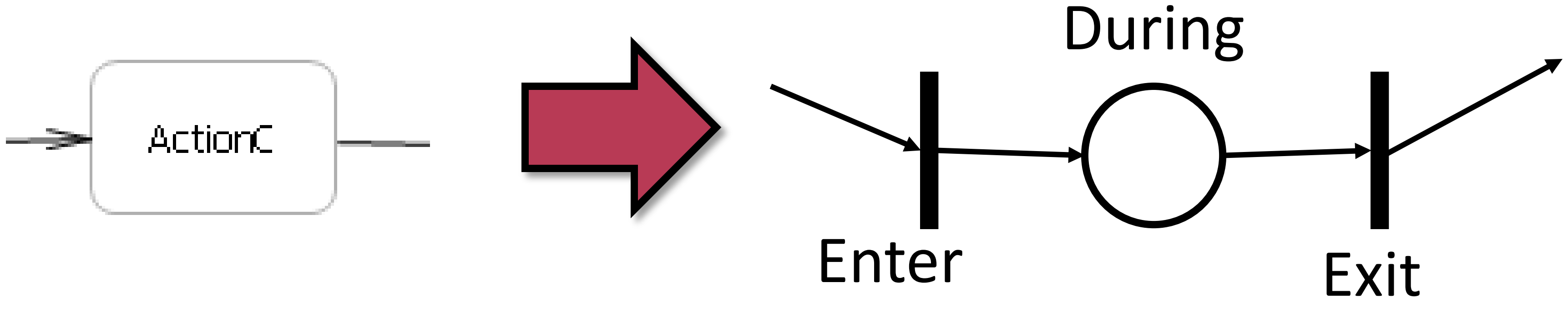
LAB Executing the transformation



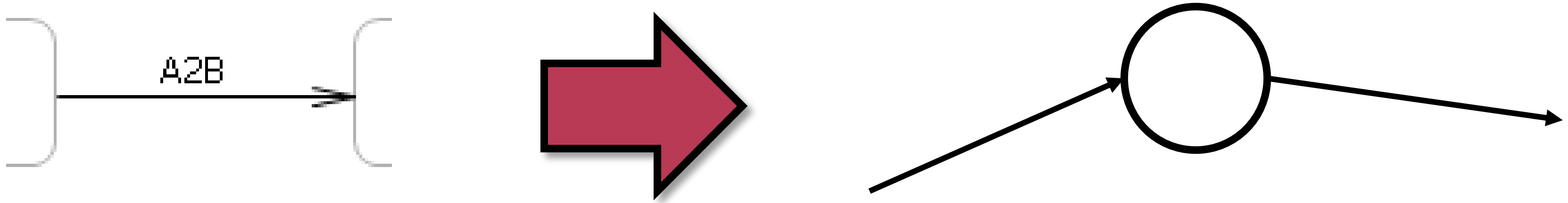
```
<pnml>
 <net id="n0" type="http://www.informatik.hu-berlin.de/t
  <place id="ActionE">
   <name>
    <text>ActionE</text>
   </name>
   <initialMarking>
    <text>0</text>
   </initialMarking>
  </place>
  <place id="InitialActivations">
   <name>
    <text>InitialActivations</text>
```

UML Activity → Petri net

- Action

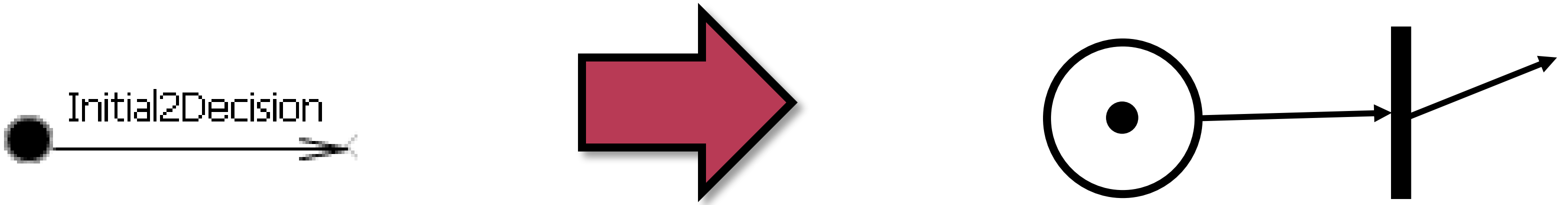


- Control flow

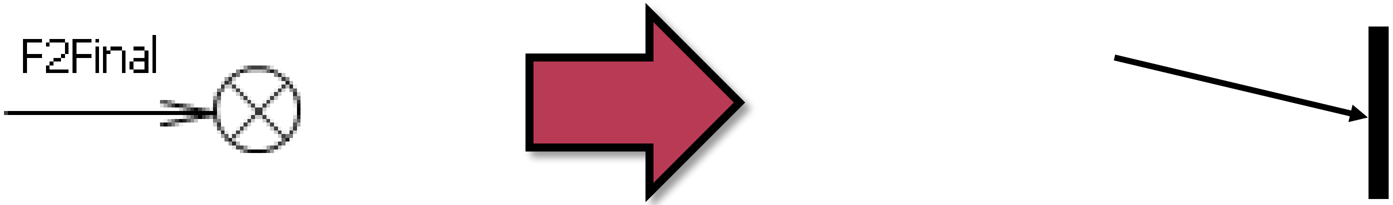


UML Activity → Petri net

- Initial node

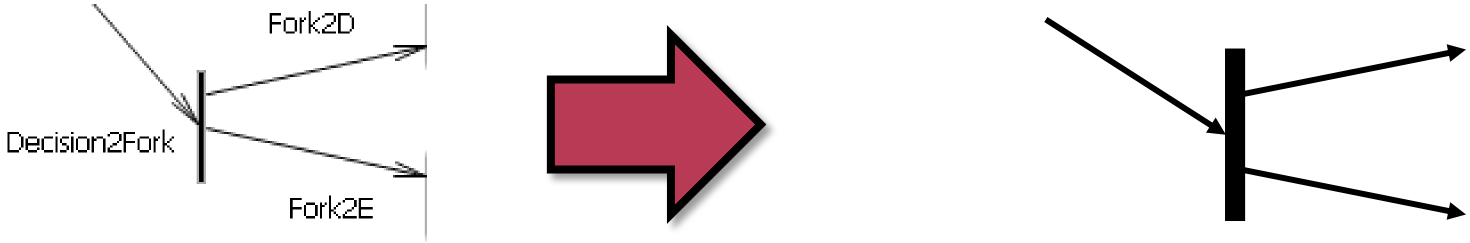


- (Flow) final node

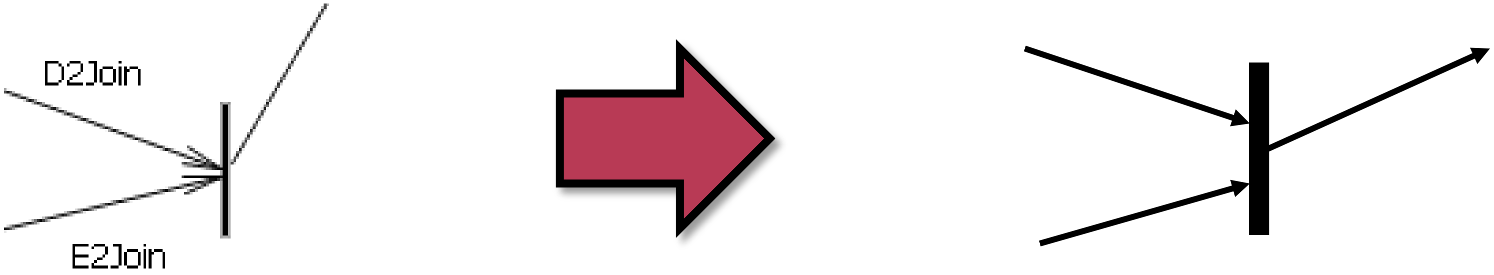


UML Activity → Petri net

- Fork node

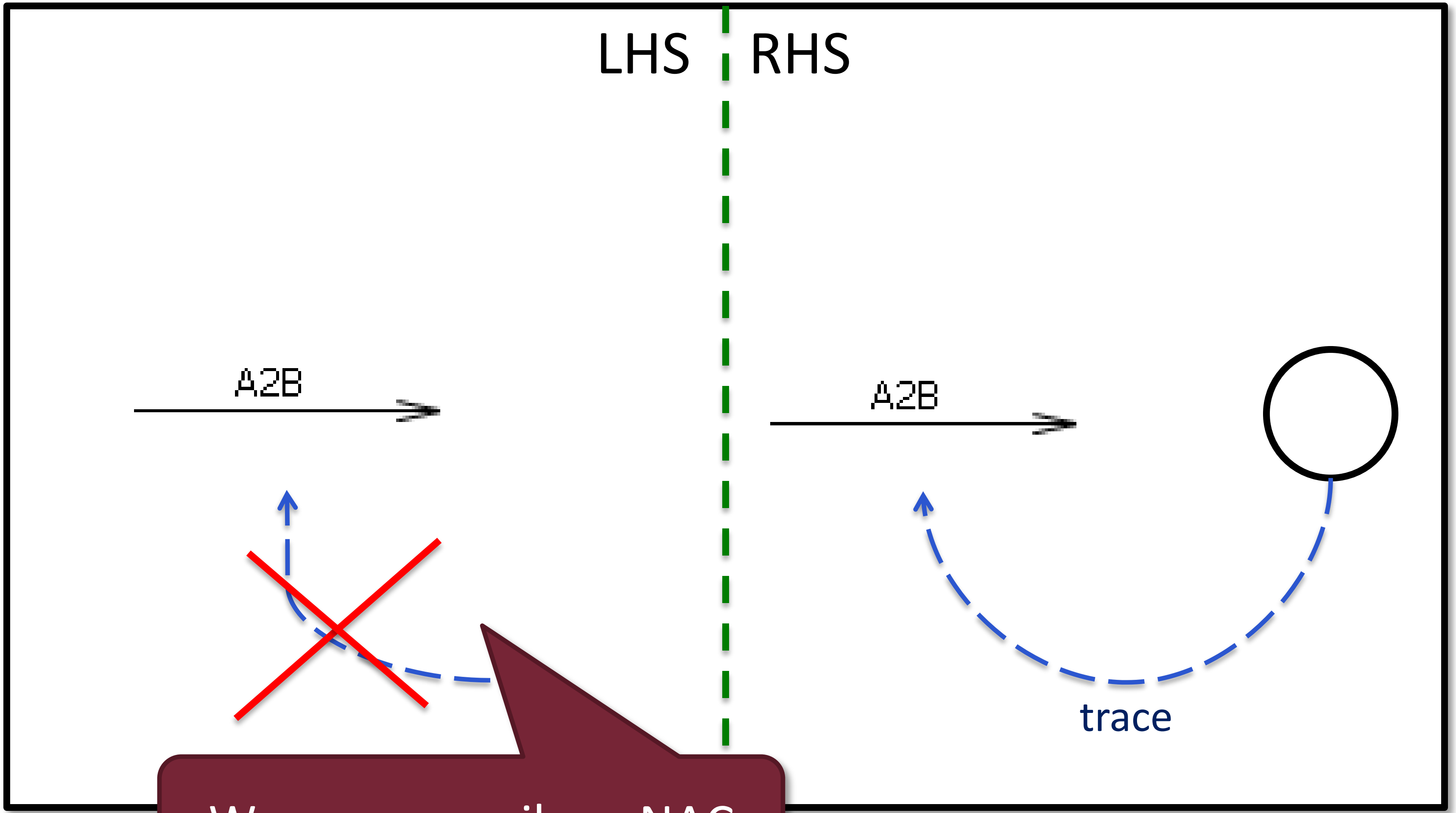


- Join node



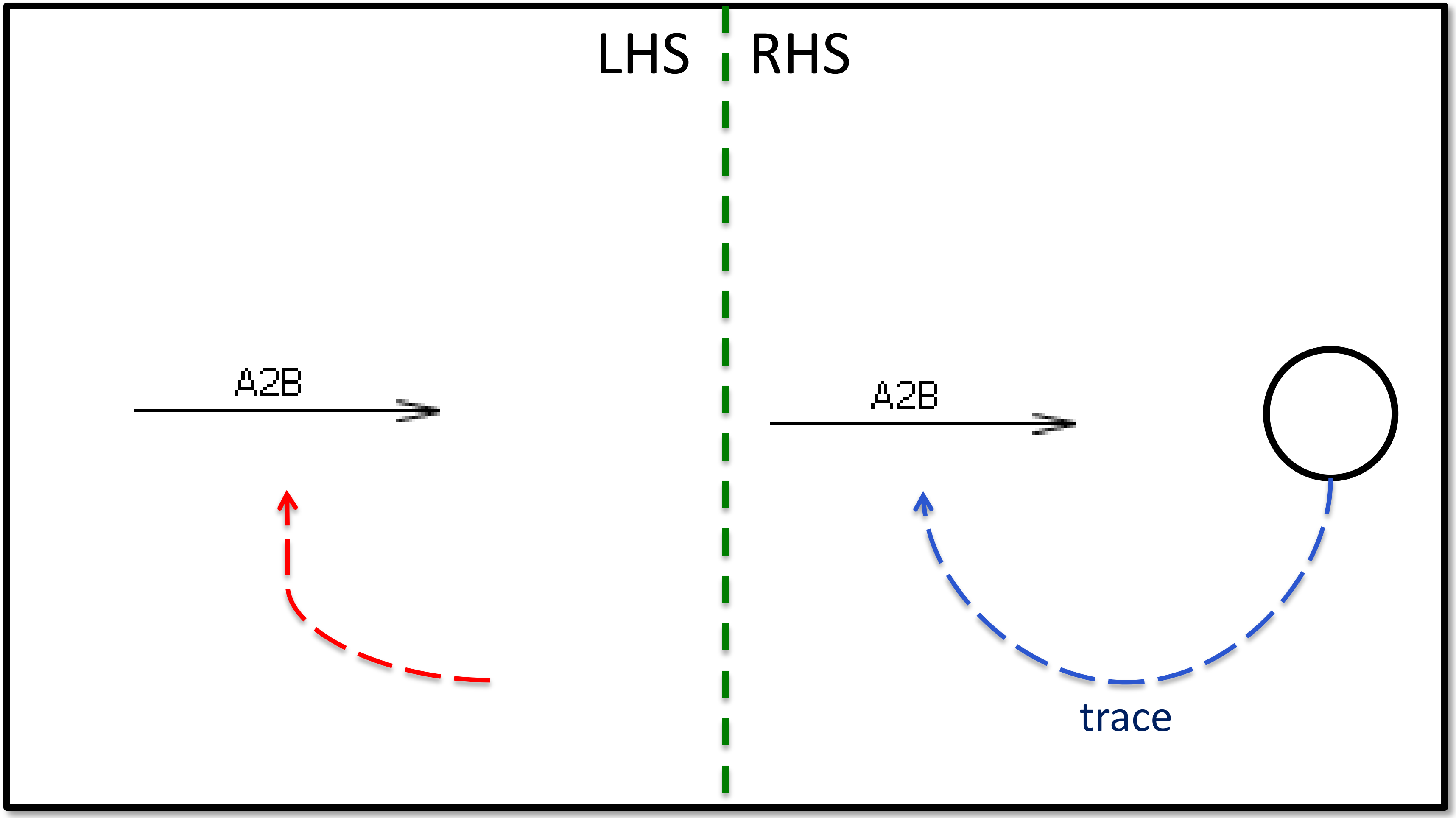
GT rules – Control Flow

- Mostly straightforward



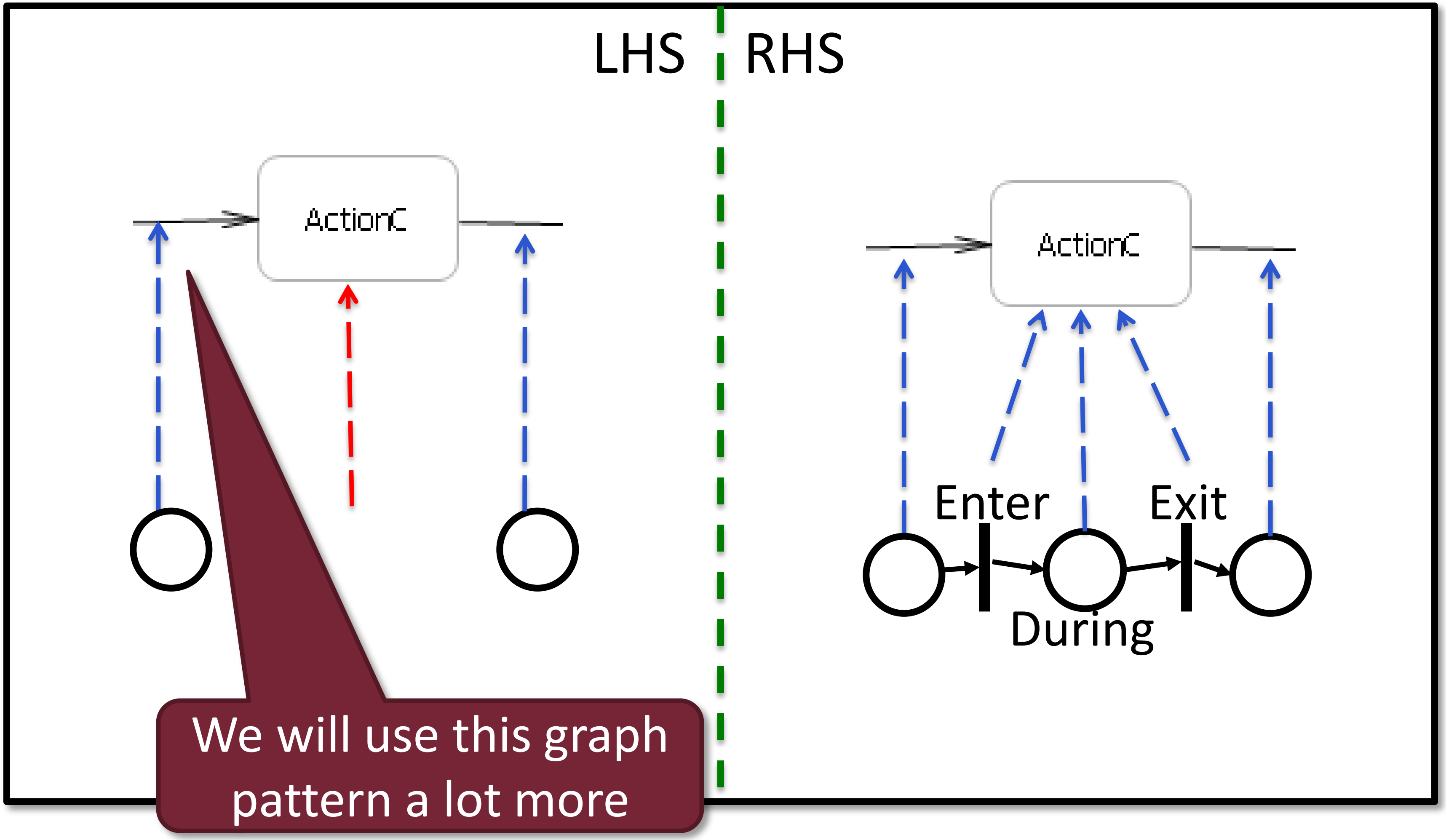
We can prescribe a NAC

DEMO Simple GT rules in VIATRA2



GT rules – Action

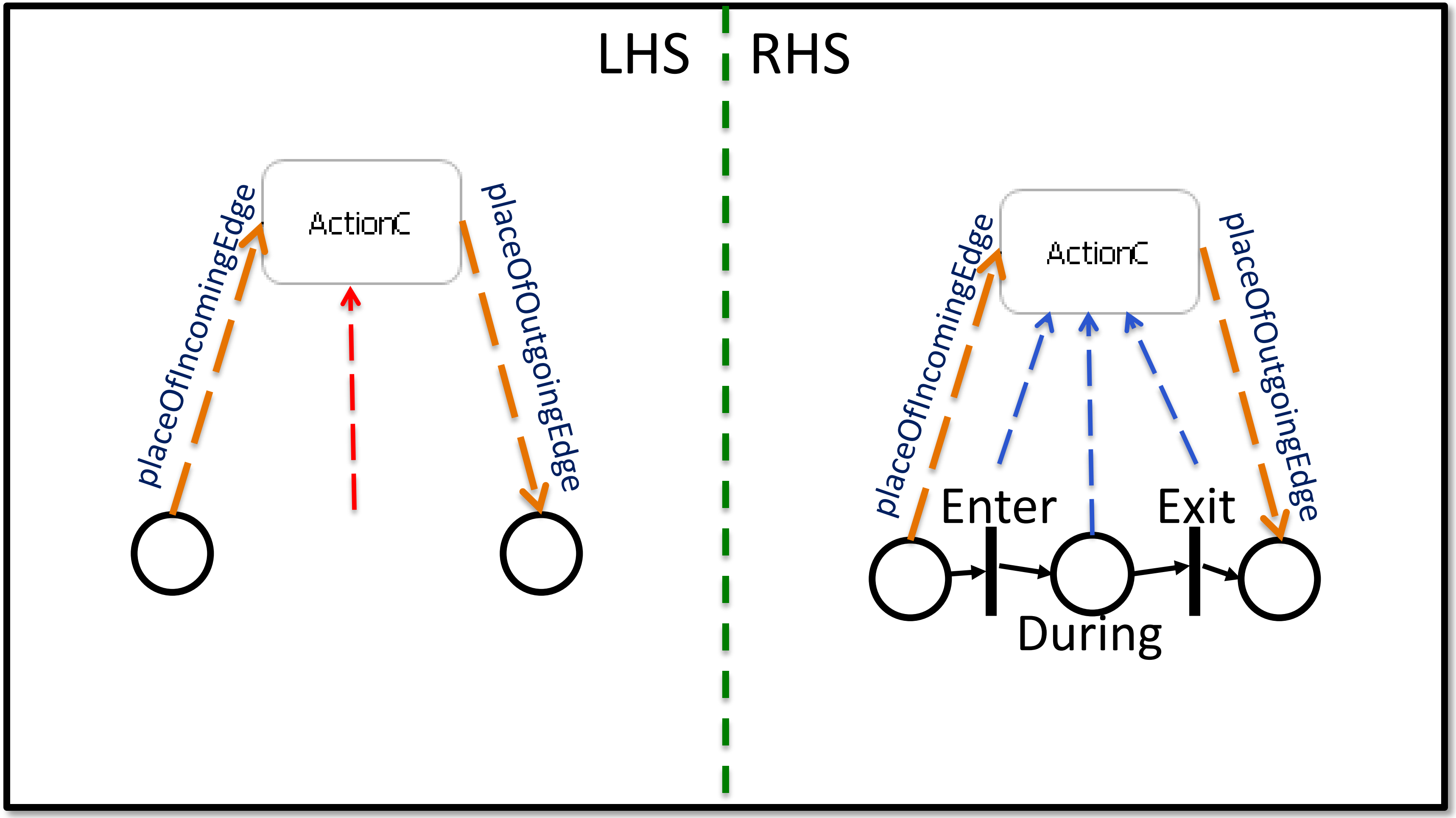
- Straightforward, but big



We will use this graph pattern a lot more

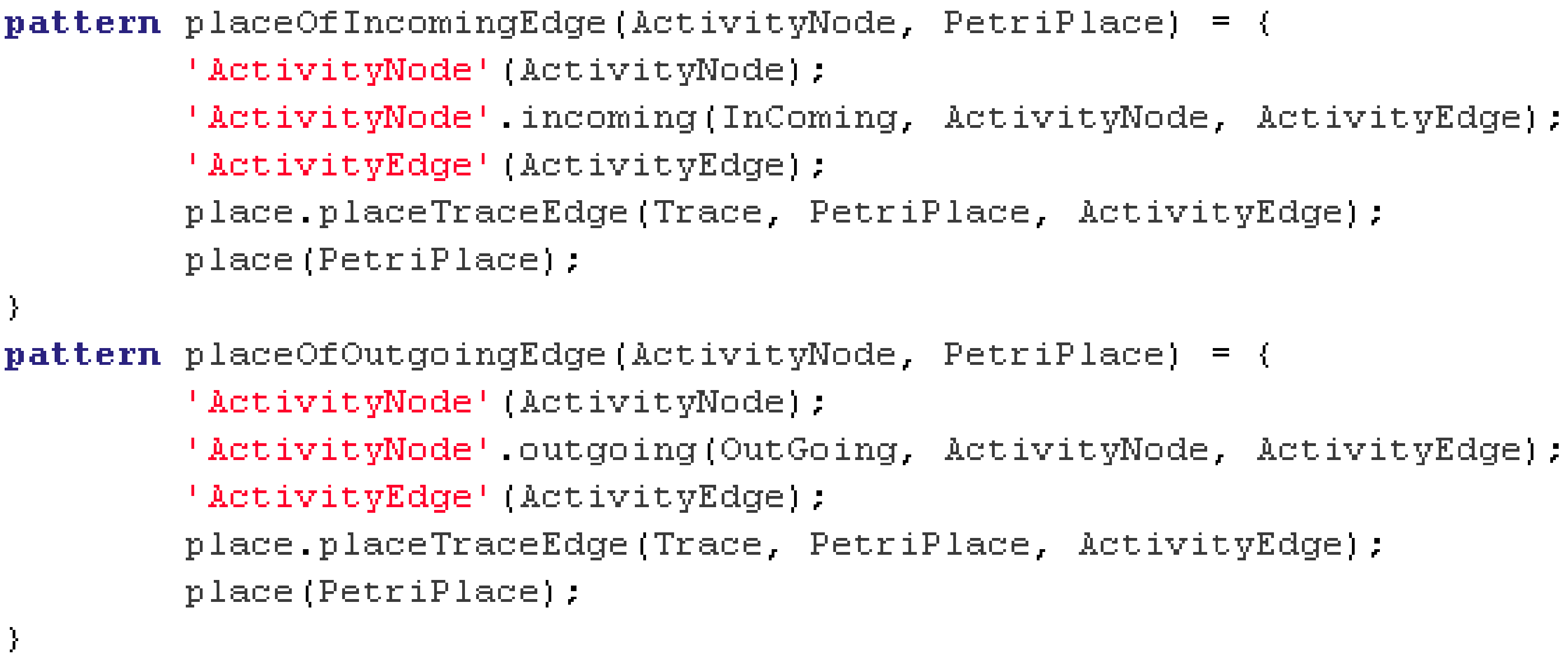
GT rules – reusing patterns

- Let’s reuse!



CODE

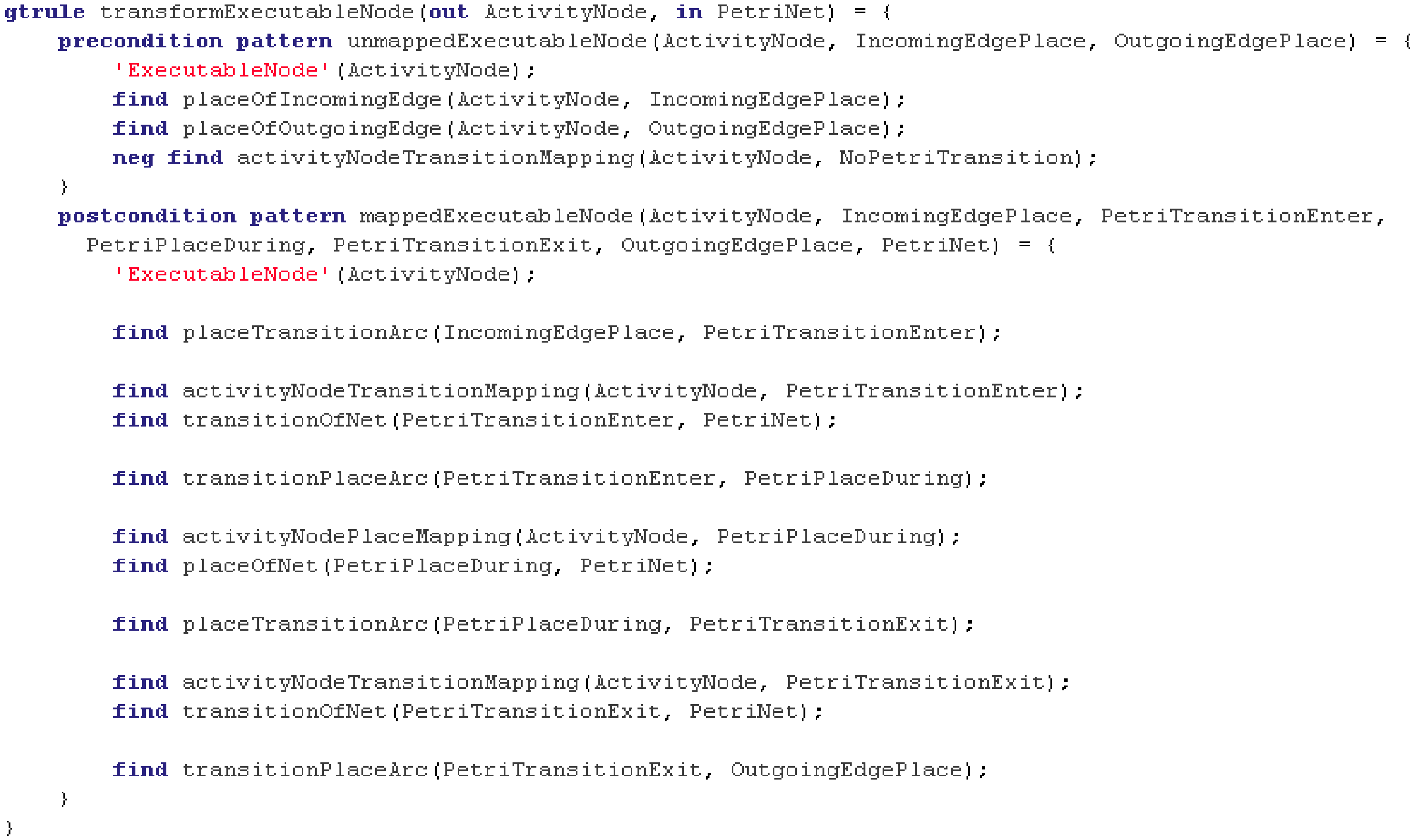
Pattern composition in VIATRA2



```
pattern placeOfIncomingEdge(ActivityNode, PetriPlace) = {
        'ActivityNode'(ActivityNode);
        'ActivityNode'.incoming(InComing, ActivityNode, ActivityEdge);
        'ActivityEdge'(ActivityEdge);
        place.placeTraceEdge(Trace, PetriPlace, ActivityEdge);
        place(PetriPlace);
}
pattern placeOfOutgoingEdge(ActivityNode, PetriPlace) = {
        'ActivityNode'(ActivityNode);
        'ActivityNode'.outgoing(OutGoing, ActivityNode, ActivityEdge);
        'ActivityEdge'(ActivityEdge);
        place.placeTraceEdge(Trace, PetriPlace, ActivityEdge);
        place(PetriPlace);
}
```

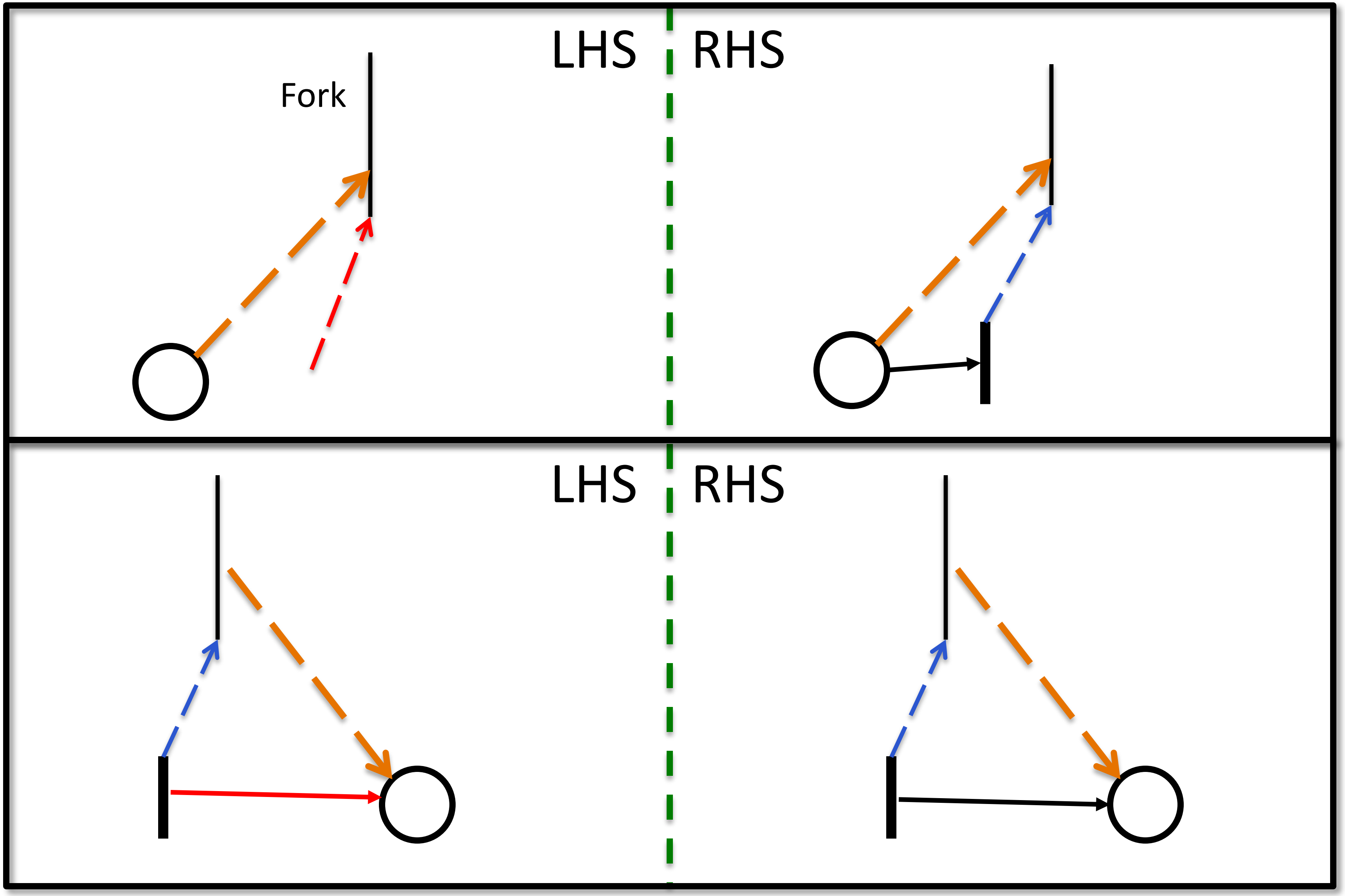
CODE

Pattern composition in VIATRA2

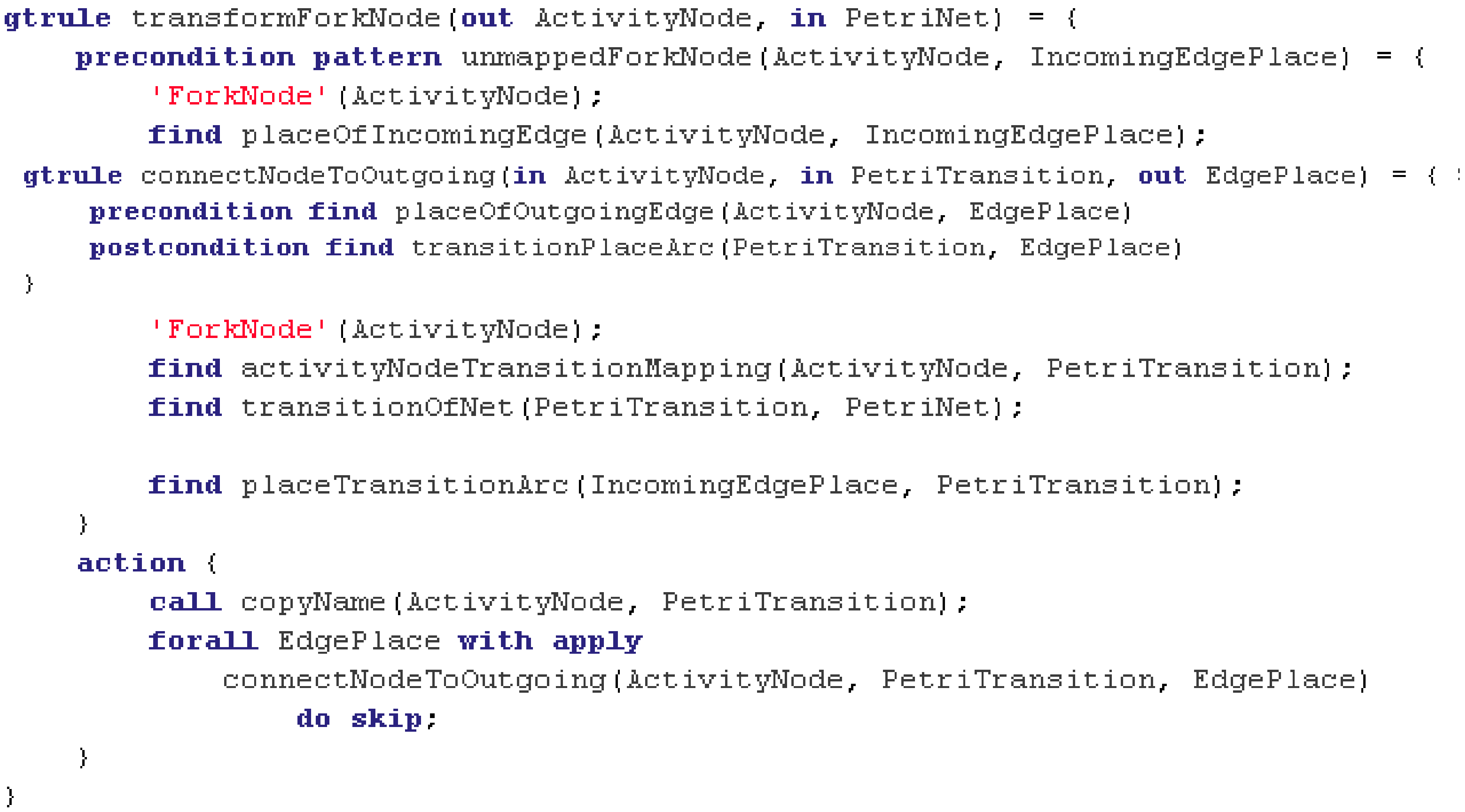


```
gtrule transformExecutableNode(out ActivityNode, in PetriNet) = {
    precondition pattern unmappedExecutableNode(ActivityNode, IncomingEdgePlace, OutgoingEdgePlace) = {
        'ExecutableNode'(ActivityNode);
        find placeOfIncomingEdge(ActivityNode, IncomingEdgePlace);
        find placeOfOutgoingEdge(ActivityNode, OutgoingEdgePlace);
        neg find activityNodeTransitionMapping(ActivityNode, NoPetriTransition);
    }
    postcondition pattern mappedExecutableNode(ActivityNode, IncomingEdgePlace, PetriTransitionEnter,
      PetriPlaceDuring, PetriTransitionExit, OutgoingEdgePlace, PetriNet) = {
        'ExecutableNode'(ActivityNode);

        find placeTransitionArc(IncomingEdgePlace, PetriTransitionEnter);

        find activityNodeTransitionMapping(ActivityNode, PetriTransitionEnter);
        find transitionOfNet(PetriTransitionEnter, PetriNet);

        find transitionPlaceArc(PetriTransitionEnter, PetriPlaceDuring);

        find activityNodePlaceMapping(ActivityNode, PetriPlaceDuring);
        find placeOfNet(PetriPlaceDuring, PetriNet);

        find placeTransitionArc(PetriPlaceDuring, PetriTransitionExit);

        find activityNodeTransitionMapping(ActivityNode, PetriTransitionExit);
        find transitionOfNet(PetriTransitionExit, PetriNet);

        find transitionPlaceArc(PetriTransitionExit, OutgoingEdgePlace);
    }
}
```

GT rules - Fork



CODE Cooperating rules in Viatra2



```
gtrule transformForkNode(out ActivityNode, in PetriNet) = {
    precondition pattern unmappedForkNode(ActivityNode, IncomingEdgePlace) = {
        'ForkNode'(ActivityNode);
        find placeOfIncomingEdge(ActivityNode, IncomingEdgePlace);
 gtrule connectNodeToOutgoing(in ActivityNode, in PetriTransition, out EdgePlace) = {
     precondition find placeOfOutgoingEdge(ActivityNode, EdgePlace)
     postcondition find transitionPlaceArc(PetriTransition, EdgePlace)
 }
        'ForkNode'(ActivityNode);
        find activityNodeTransitionMapping(ActivityNode, PetriTransition);
        find transitionOfNet(PetriTransition, PetriNet);

        find placeTransitionArc(IncomingEdgePlace, PetriTransition);
    }
    action {
        call copyName(ActivityNode, PetriTransition);
        forall EdgePlace with apply
            connectNodeToOutgoing(ActivityNode, PetriTransition, EdgePlace)
                do skip;
    }
}
```

CODE Cooperating rules in Viatra2

```
gtrule transformForkNode(out ActivityNode, in PetriNet) = {
    precondition pattern unmappedForkNode(ActivityNode, IncomingEdgePlace) = {
        'ForkNode'(ActivityNode);
        find placeOfIncomingEdge(ActivityNode, IncomingEdgePlace);

        find ac                 nMapping(ActivityNode, PetriTransition);
        find trans                Transition, PetriNet);

        find placeTransi             omingEdgePlace, PetriTransition);
    }
    action {
        call copyName(ActivityNode,  etriTransition);
        forall EdgePlace with apply
            connectNodeToOutgoing(ActivityNode, PetriTransition, EdgePlace)
                do skip;
    }
}
```

```
gtrule connectNodeToOutgoing(in ActivityNode, in PetriTransition, out EdgePlace) = {
    precondition find placeOfOutgoingEdge(ActivityNode, EdgePlace)
    postcondition find transitionPlaceArc(PetriTransition, EdgePlace)
}
```

Similarities

- Fork Node
  - Create transition, trace back to fork node
  - Connect the *placeOfIncomingEdge* to transition
  - Connect transition to each *placeOfOutgoingEdge*
- Join Node
  - Create transition, trace back to join node
  - Connect each *placeOfIncomingEdge* to transition
  - Connect transition to the *placeOfOutgoingEdge*
- Flow Final Node
  - Create transition, trace back to final node
  - Connect the *placeOfIncomingEdge* to transition
  - Connect transition to each *placeOfOutgoingEdge* (there is none, this does nothing)

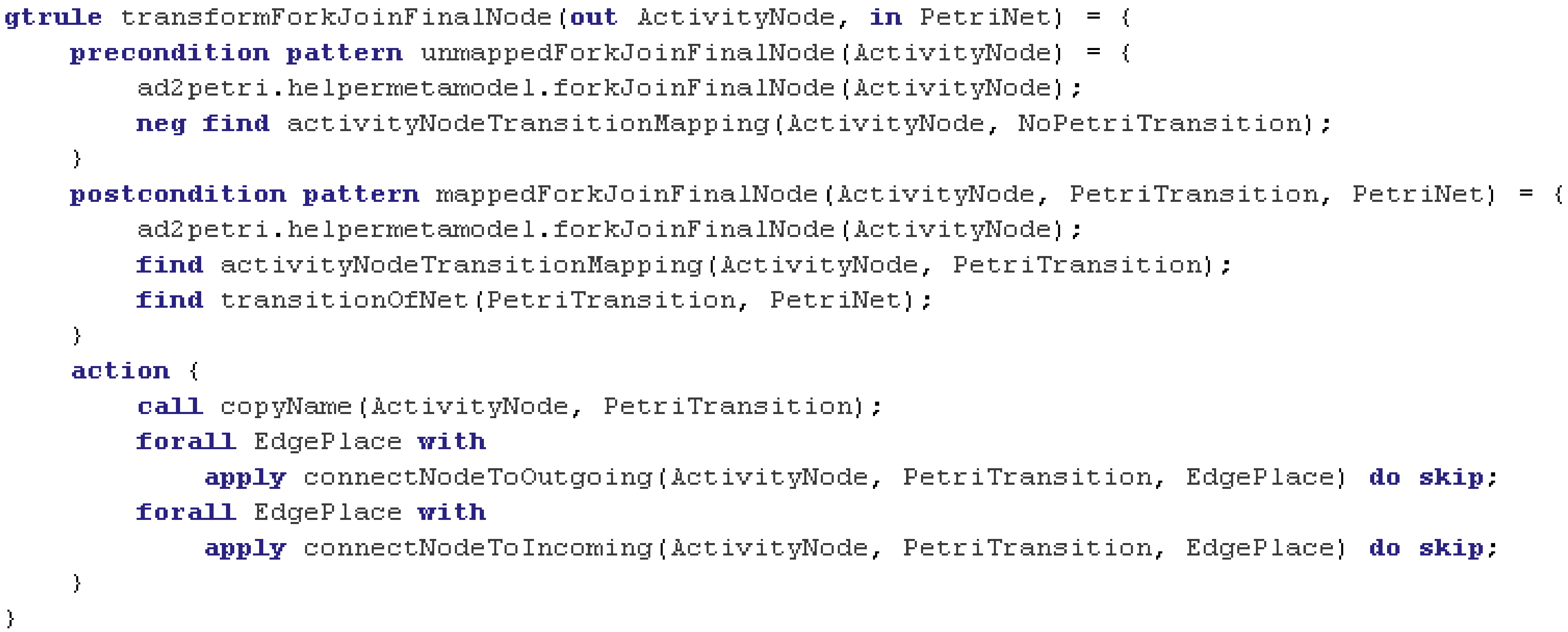
Similarities

- Fork Node
  - Create transition, trace back to fork node
  - Connect **the** *placeOfIncomingEdge* to transition
  - Connect transition to **each** *placeOfOutgoingEdge*
- Join Node
  - Create transition, trace back to join node
  - Connect **each** *placeOfIncomingEdge* to transition
  - Connect transition to **the** *placeOfOutgoingEdge*
- Flow Final Node
  - Create transition, trace back to final node
  - Connect **the** *placeOfIncomingEdge* to transition
  - Connect transition to **each** *placeOfOutgoingEdge* (there is none, this does nothing)

Trick

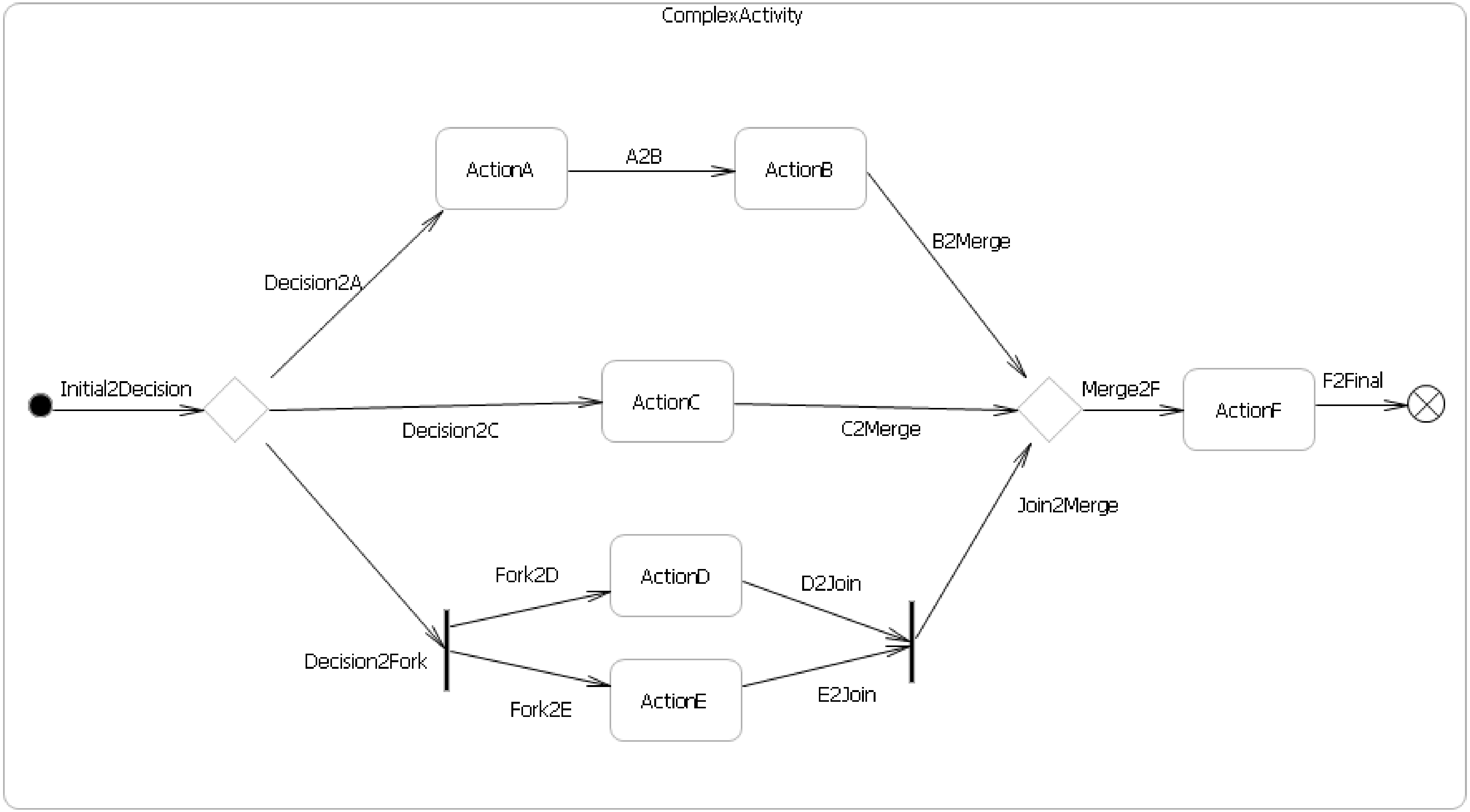
- Fork / Join / Final Node
  - Create transition, trace back to activity node
  - Connect **each** *placeOfIncomingEdge* to transition
  - Connect transtition to **each** *placeOfOutgoingEdge*
- Let’s reuse!

Transformation program



```
gtrule transformForkJoinFinalNode(out ActivityNode, in PetriNet) = {
    precondition pattern unmappedForkJoinFinalNode(ActivityNode) = {
        ad2petri.helpermetamodel.forkJoinFinalNode(ActivityNode);
        neg find activityNodeTransitionMapping(ActivityNode, NoPetriTransition);
    }
    postcondition pattern mappedForkJoinFinalNode(ActivityNode, PetriTransition, PetriNet) = {
        ad2petri.helpermetamodel.forkJoinFinalNode(ActivityNode);
        find activityNodeTransitionMapping(ActivityNode, PetriTransition);
        find transitionOfNet(PetriTransition, PetriNet);
    }
    action {
        call copyName(ActivityNode, PetriTransition);
        forall EdgePlace with
            apply connectNodeToOutgoing(ActivityNode, PetriTransition, EdgePlace) do skip;
        forall EdgePlace with
            apply connectNodeToIncoming(ActivityNode, PetriTransition, EdgePlace) do skip;
    }
}
```

Exercise: what’s missing?



Exercise: what’s missing?

- Decision and Merge Nodes
- What PN constructs should they be mapped into?
- Come up with GT rules
- Implement in VIATRA2
- Try activity_complex and activity_prb!

More things to learn

- Extending the transformation system
  - Domain metamodels, importers, exporters
  - Native functions (calls to Java)
- Advanced features
  - Language features: recursion, injectivity, etc.
  - Performance optimization
  - Triggers
  - Live synchronization

Additional material

- http://wiki.eclipse.org/VIATRA2
    - Installation
    - Syntax
    - How-tos and Examples
    - Learn about many other features of Viatra2
- Fresh release: R3.2 – April 2011
    - Bug reports are very welcome