On Integration of Textual and Graphical Modeling

Pragmatics in MENGES

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Outline

The Context of MENGES

Setting

- Design of safety-critical controlling systems in the rail-bounded transportation field

Current state in the business

- Requirements analysis
  $\longrightarrow$ huge amount of text documents, informal
- Design specifications with a proprietary modeling language
  $\longrightarrow$ formalized description of the system logic

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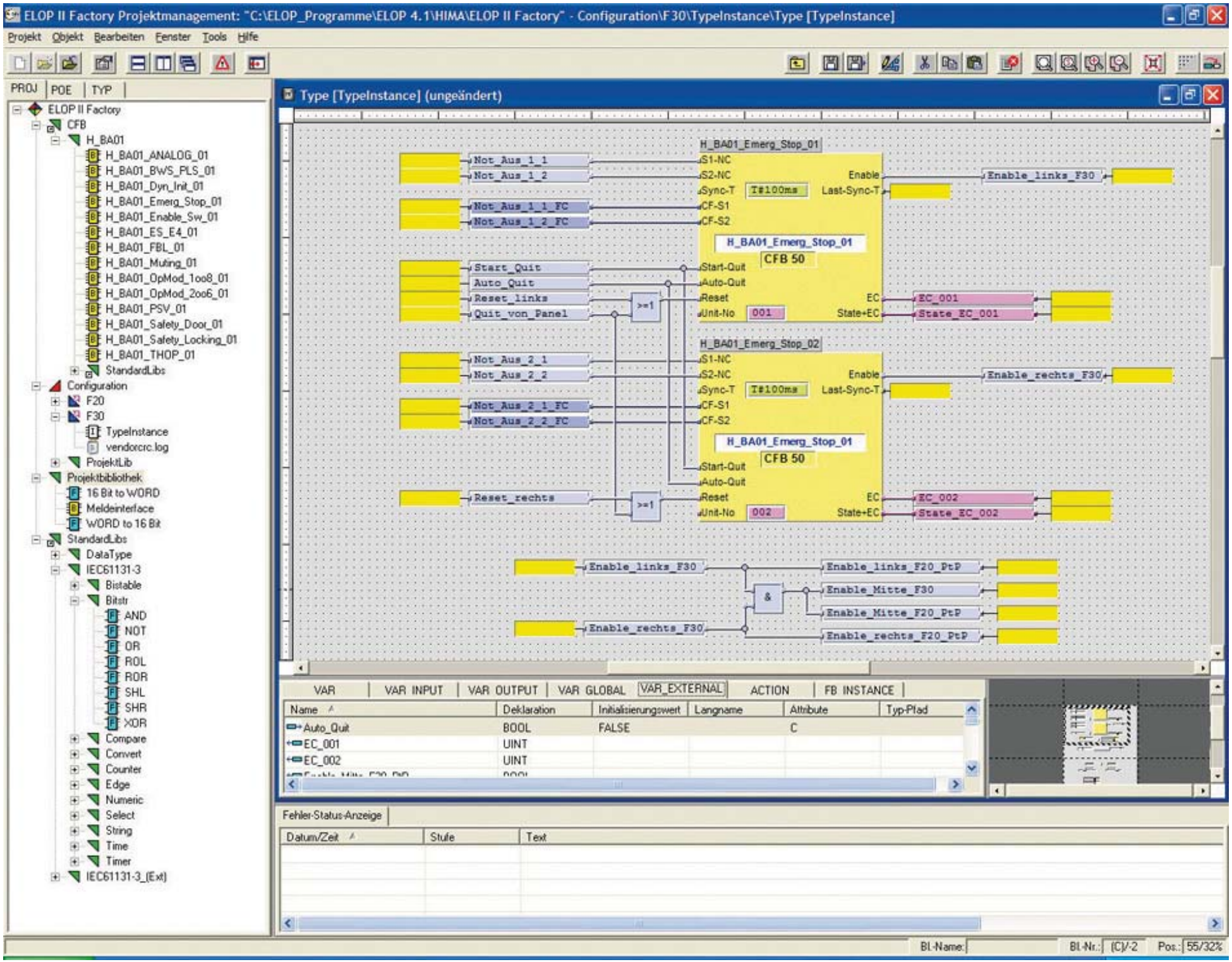

http://www.hima.de/Produkte/ELOP_II_Factory_default.php

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Most important issue

- No integration of those specifications (derivation, tracing, . . .)

The Aim of MENGES

- Engineers shall be assisted in these tasks, i.e. while
  - analysing,
  - designing,
  - maintaining,
  - testing,
  - verifying,
  - documenting and
  - translating systems and their parts

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- Engineers shall be assisted in these tasks, i.e. while
  - analysing,
  - designing,
  - maintaining,
  - testing,
  - verifying,
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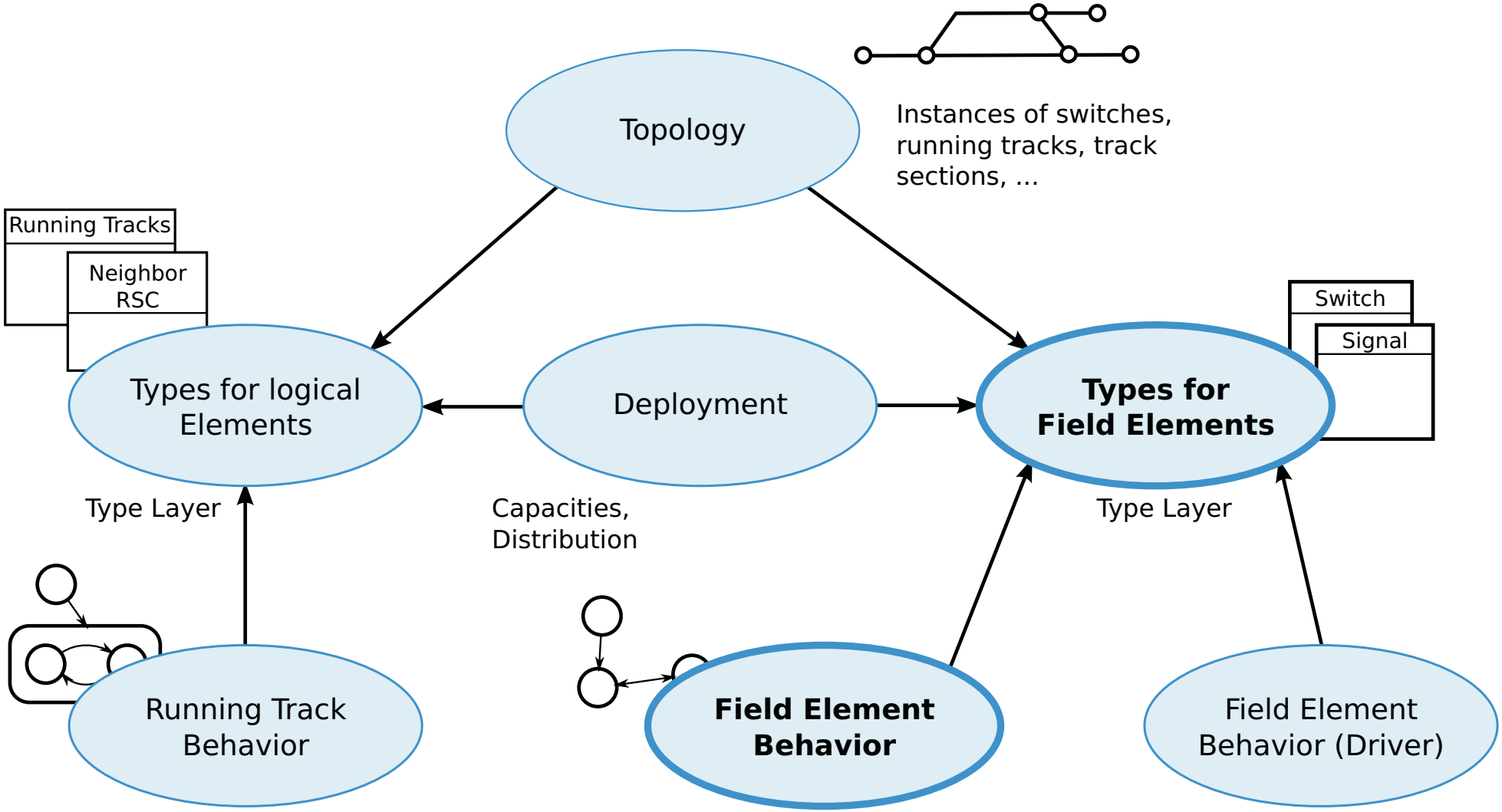
  - translating systems and their parts
- Domain Specific Languages(DSLs)+tooling are to be created
  - intended to cover the necessary specification parts and
  - form a homogeneous development environment

Kinds of specifications



Field Element description

```
1  field element Gleisabschnitt extends Beanspruchbar {
2    statevars
3      reserviert:
4        ( ja,
5          nein );
6      beansprucht:
7        ( nicht,
8          DWeg,     // als Durchrutschweg-Element
9          FLR,      // im Flankenschutzraumn
10         FWR,      // im Fahrweg einer Rangierstrasse
11         FWZ,      // im Fahrweg einer Zugstrasse
12         DWeg_FLR, FLR_FLR, FWR_FLR, FWZ_FLR, FWZ_DWeg,
13         DWeg_FLR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR    );
14   procedures
15     reservieren() = {
16         reserviert -> ja
17     };
18 }
```

Behavior specification - State Machines

```
1  state machine Gleisabschnitt_beansprucht_SM {
2      references beansprucht in Gleisabschnitt;
3      transitions
4      start nicht   --> DWeg, FLR, FWR, FWZ;
5      DWeg          --> nicht, DWeg_FLR, FWZ_DWeg;
6      FLR           --> nicht, DWeg_FLR, FLR_FLR, FWR_FLR, FWZ_FLR;
7      FWR           --> nicht, FWR_FLR;
8      FWZ           --> nicht, FWZ_FLR, FWZ_DWeg;
9      DWeg_FLR      --> DWeg, FLR, DWeg_FLR_FLR;
10     FLR_FLR       --> FLR, DWeg_FLR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR;
11     FWR_FLR       --> FLR, FWR, FWR_FLR_FLR;
12     FWZ_DWeg      --> DWeg, FWZ;
13     FWZ_FLR       --> FLR, FWZ, FWZ_FLR_FLR;
14     DWeg_FLR_FLR  --> DWeg_FLR, FLR_FLR;
15     FWR_FLR_FLR   --> FWR_FLR, FLR_FLR;
16     FWZ_FLR_FLR   --> FWZ_FLR, FLR_FLR;
17 }
```

Behavior specification - Rule Blocks

```
1  rule block reserviere references Gleisabschnitt {
2      rule graph
3      --> [istReservierungsVorbedingung()] {
4          -> [beansprucht == nicht] / {
5              reservieren()
6          };
7          -> [beansprucht == DWeg] / {
8              reservieren()
9          };
10         -> [beansprucht == FLR] / {
11             reservieren()
12         };
13         -> [beansprucht == FLR_FLR] / {
14             reservieren()
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```

Assessment

The textual languages are ...

- ☺ formal and compact
- ☺ precise in terms of separation of concerns
- ☺ easily and fast editable

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but ...

- ☹ content may be hard to conceive
- ☹ they are inflexible:
  mostly text = document
- ☹ exploring is laborious
- ☹ the context is missing / get lost quickly

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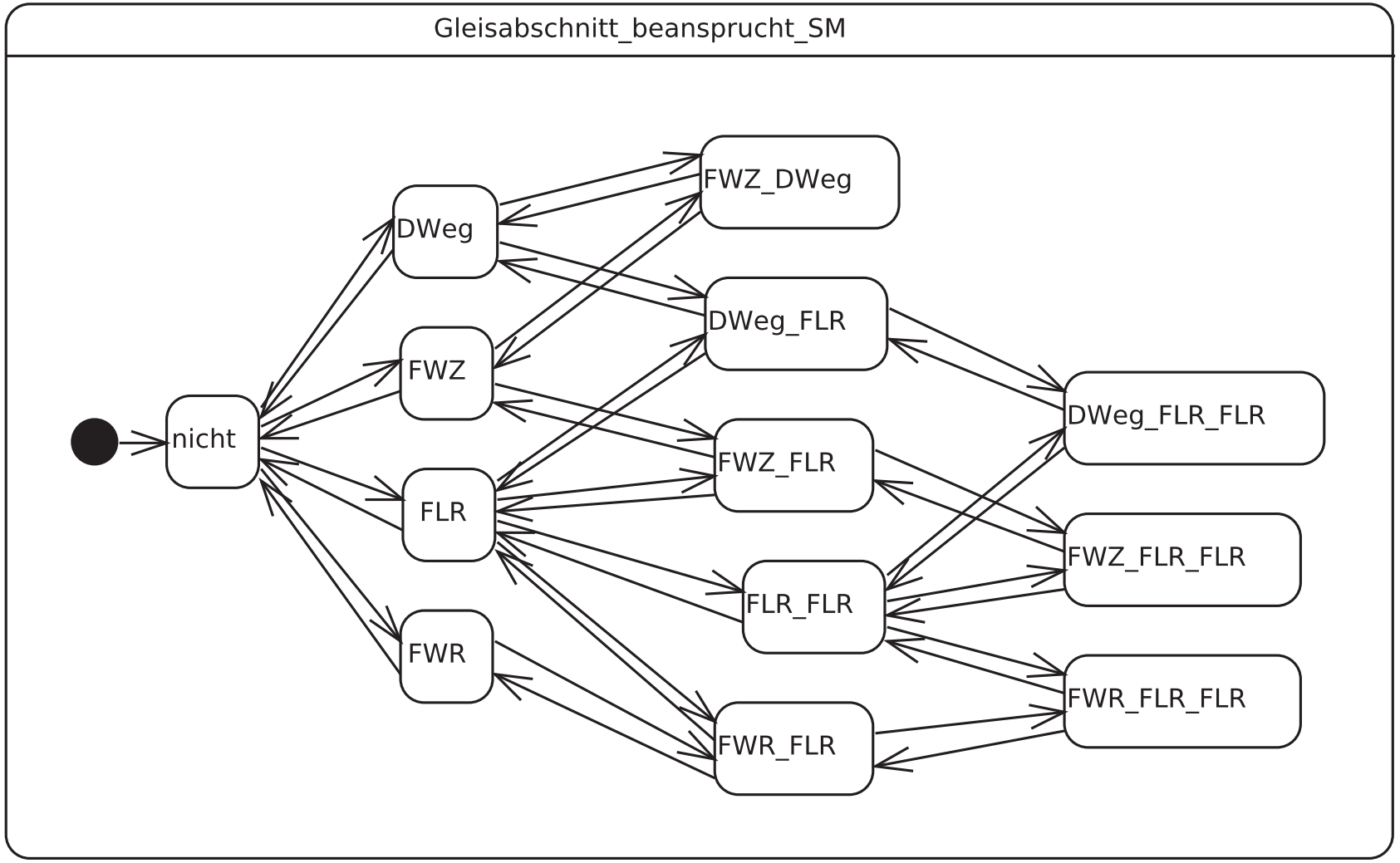
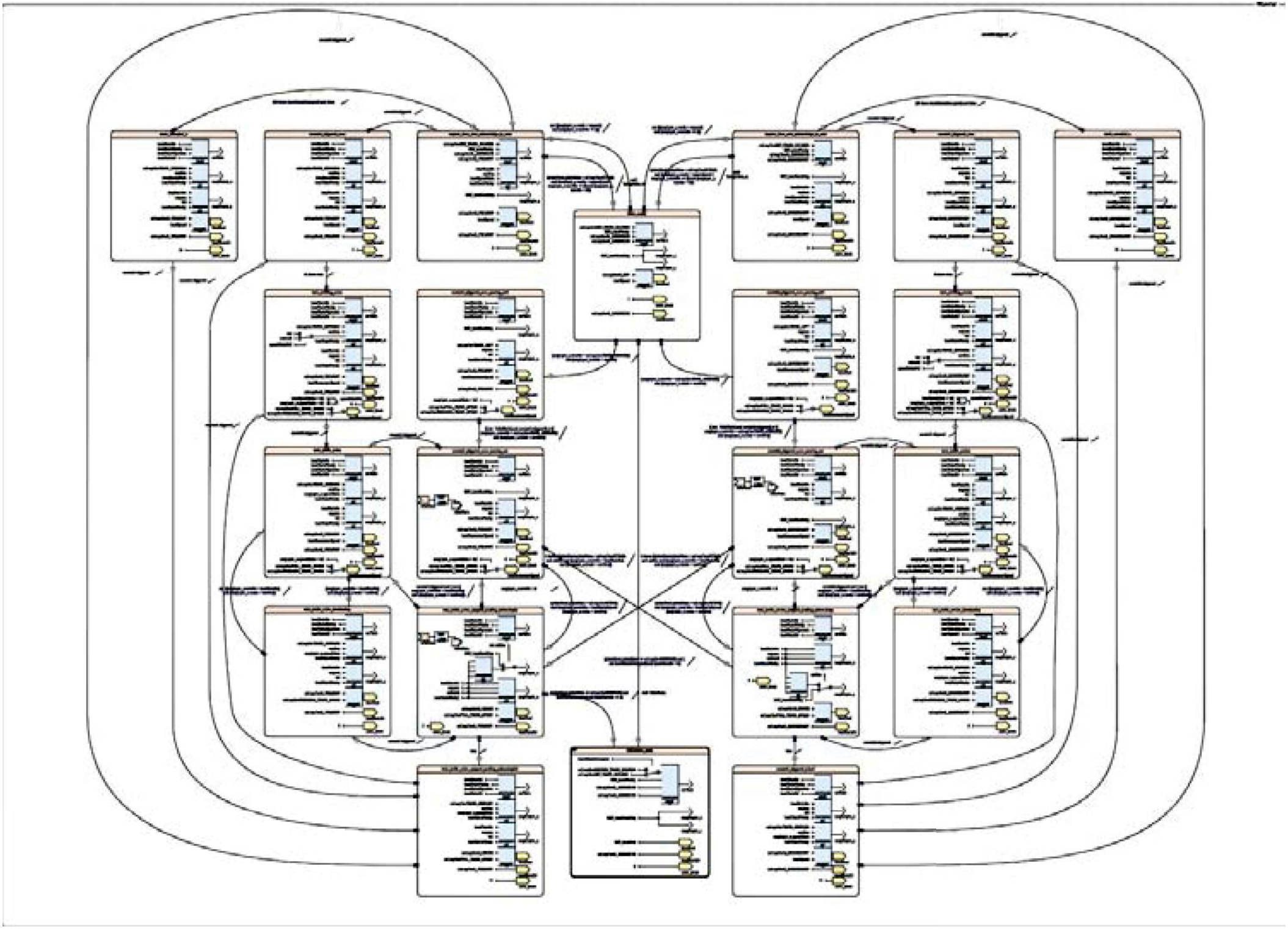
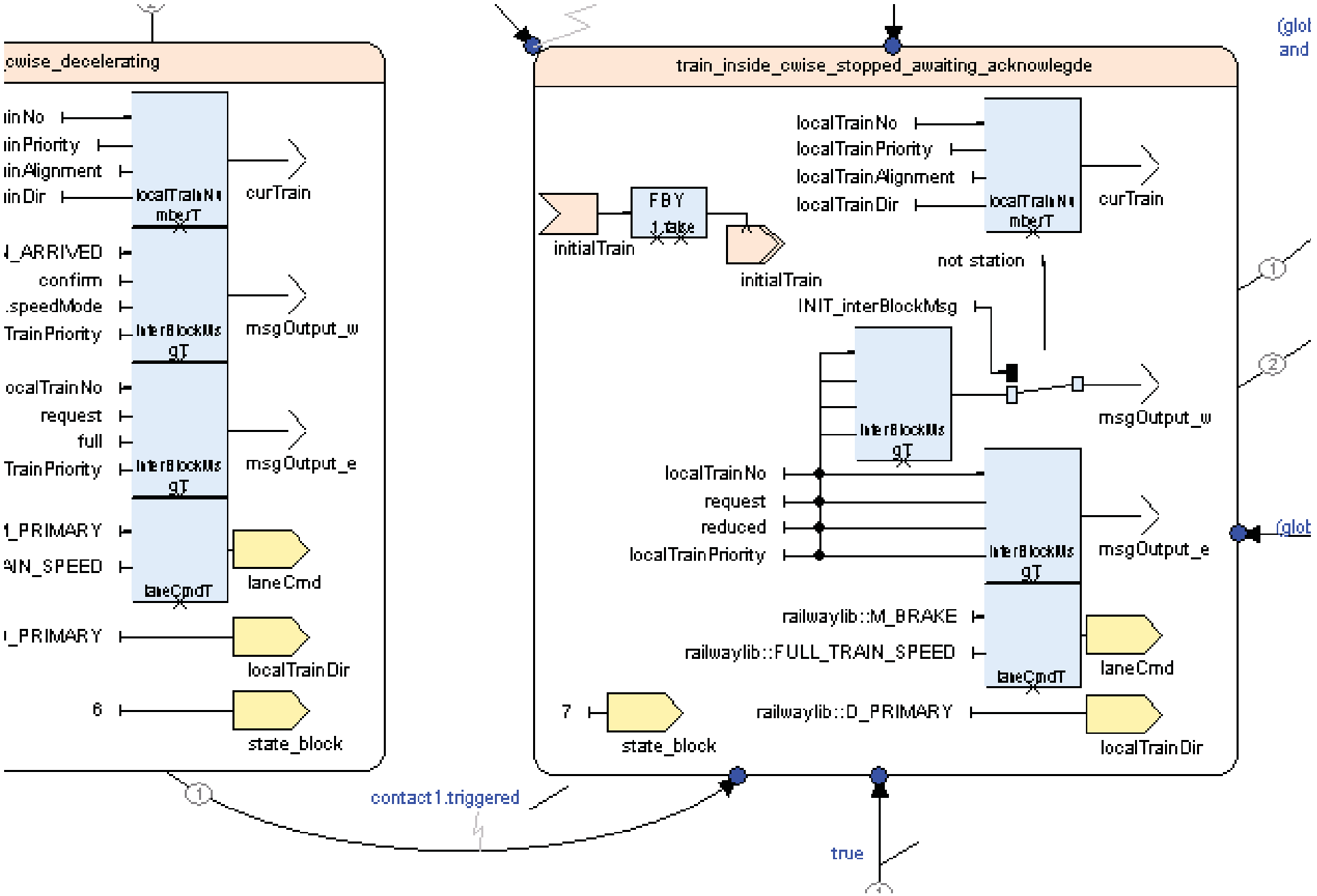
Question: What about graphical languages?

A graphical notation of state machines






cwise_decelerating
curTrain
msgOutput_w
msgOutput_e
laneCmd
localTrainDir
state_block
train_inside_cwise_stopped_awaiting_acknowlegde
localTrainNo
localTrainPriority
localTrainAlignment
localTrainDir
FBY
1.take
initialTrain
not station
INIT_interBlockMsg
request
reduced
railwaylib::M_BRAKE
railwaylib::FULL_TRAIN_SPEED
railwaylib::D_PRIMARY
contact1.triggered
true

SOS!

Assessment - cont'd

Graphical languages/representations may be ...

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- ☺ more flexible

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Consequence?

Pragmatics of modeling languages

Pragmatics of modeling languages deserves more attention than it has received so far

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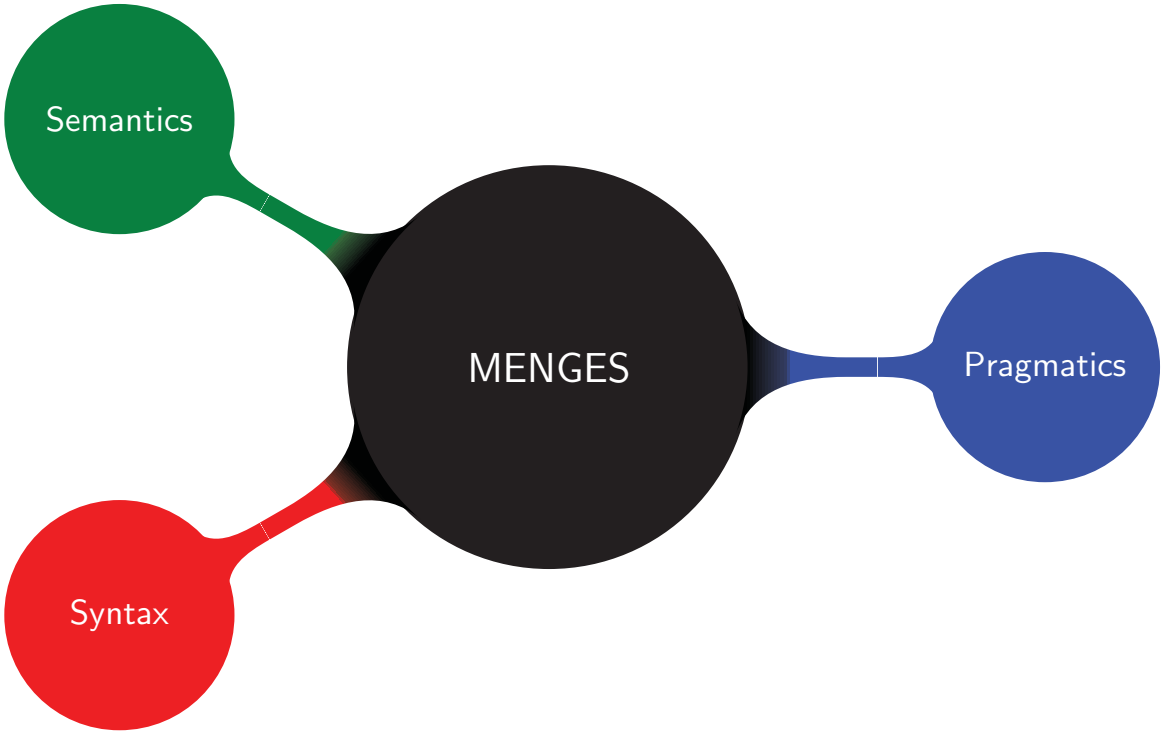

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- Pragmatics usually concentrates on practical aspects of how constructs and features of a language may be used to achieve various objectives (*e. g.*, when to use an assignment).
- Here, focus is on the mechanics of handling a language (editing, maintaining, inspecting).

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- Here, focus is on the mechanics of handling a language (editing, maintaining, inspecting).

Pragmatics of modeling languages $=_{def}$
practical aspects of handling a model in a model-based design flows

Our Approach ...

- Get inspiration from successful textual paradigms and tools
- Combine best of graphical and textual worlds
- Provide flexible, alternative views of system under development (SUD) allowing to focus on a certain context

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- Combine best of graphical and textual worlds
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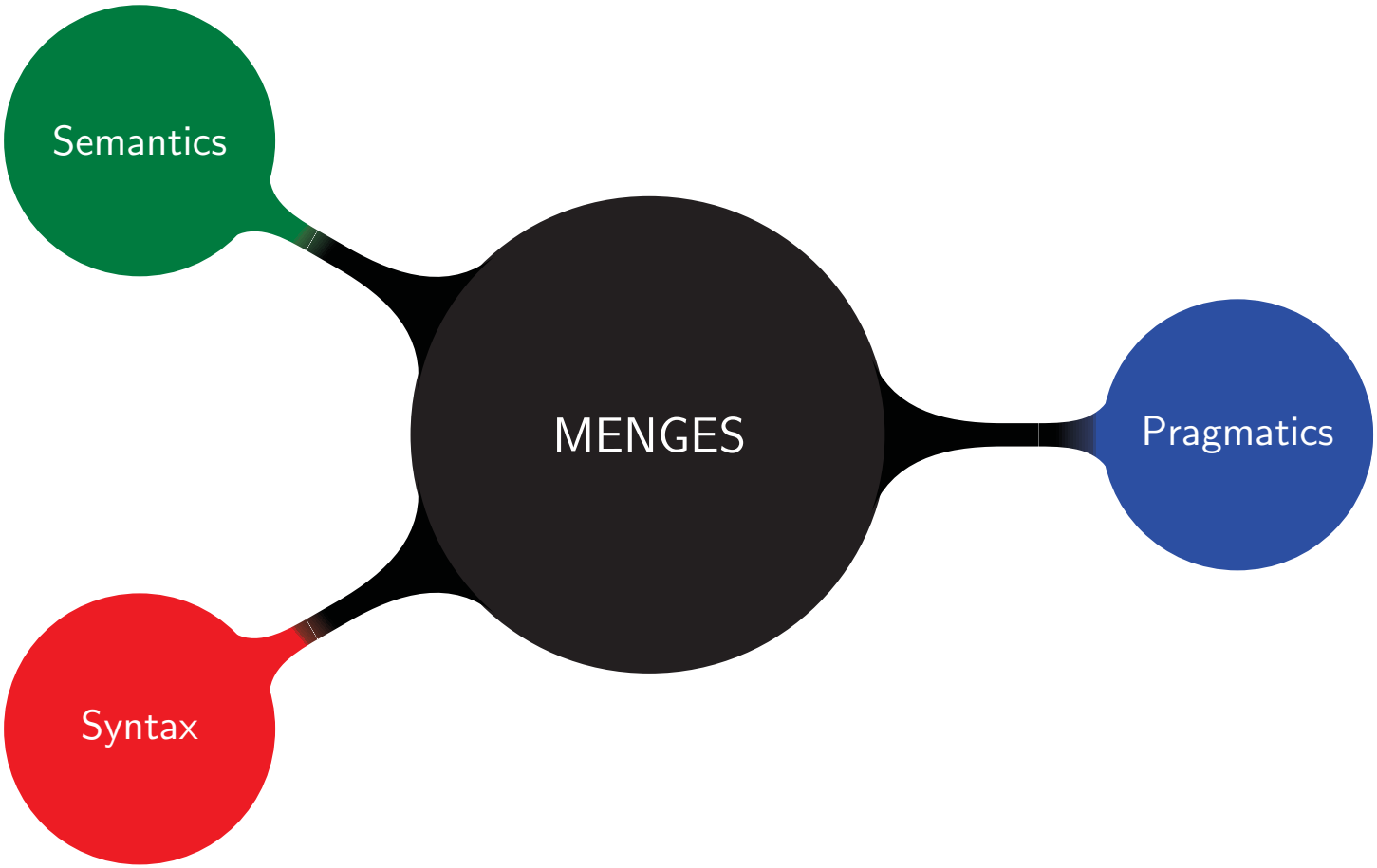
The key enabler:

Automatic, flexible synthesis of graphical & textual views organized by a powerful View Management

Our Approach ...



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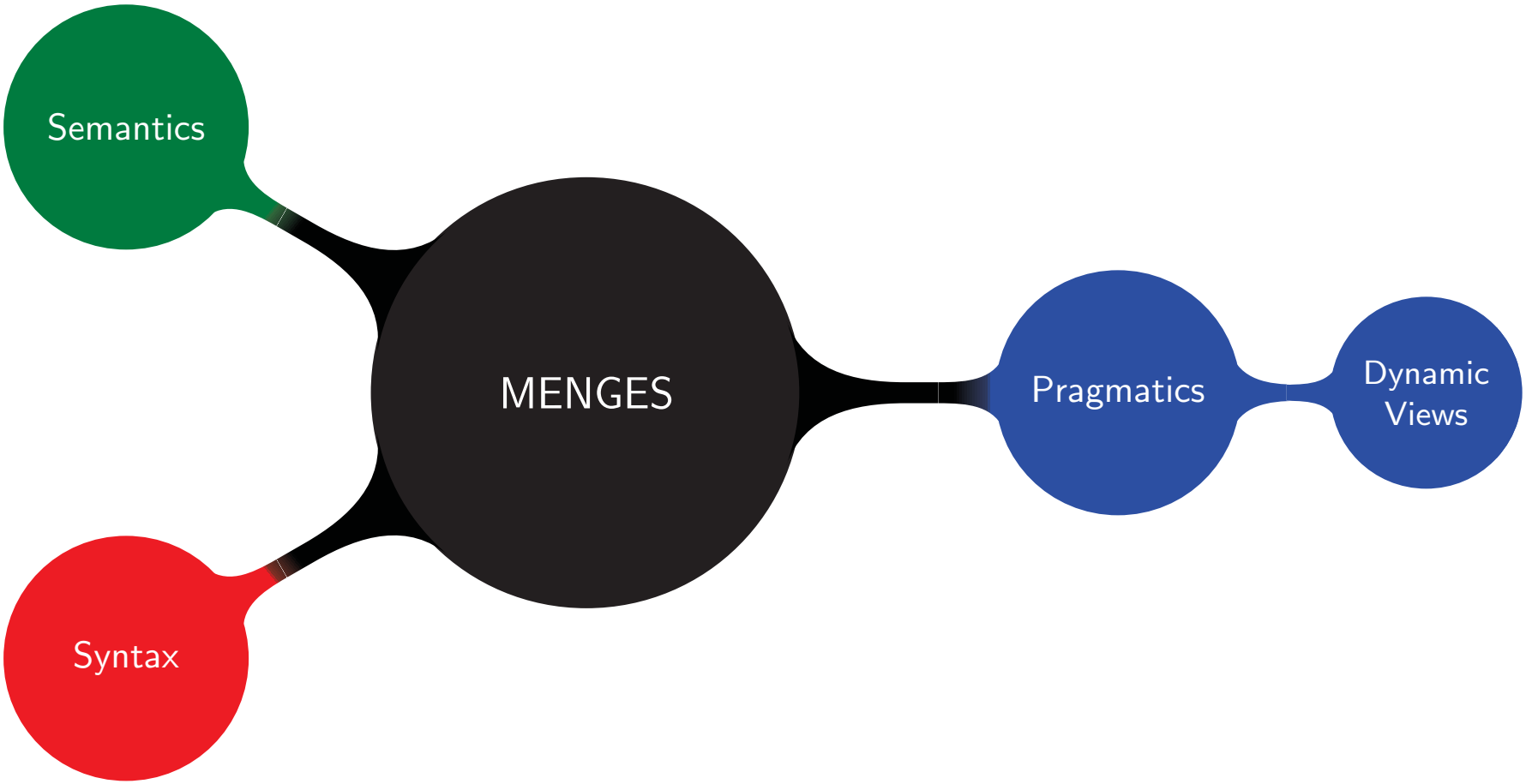

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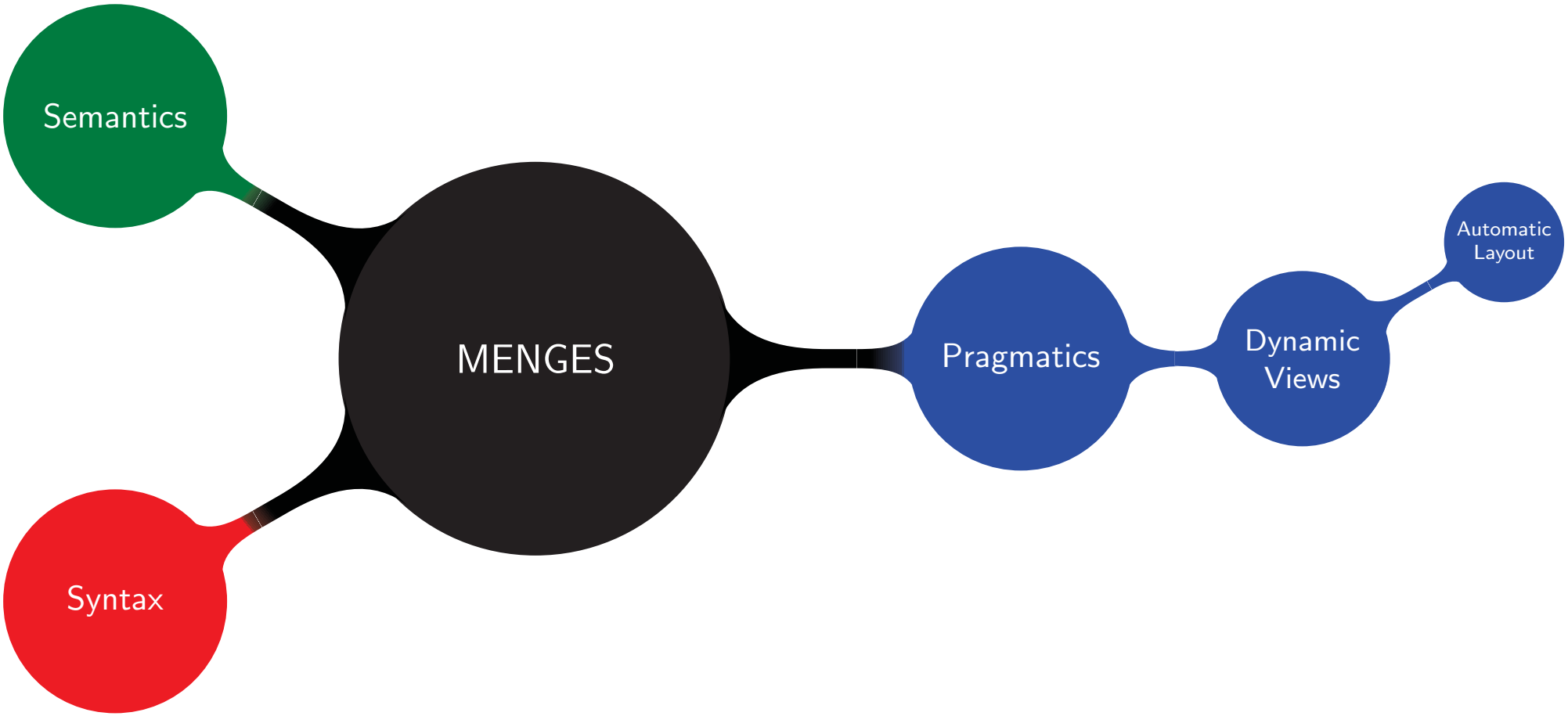

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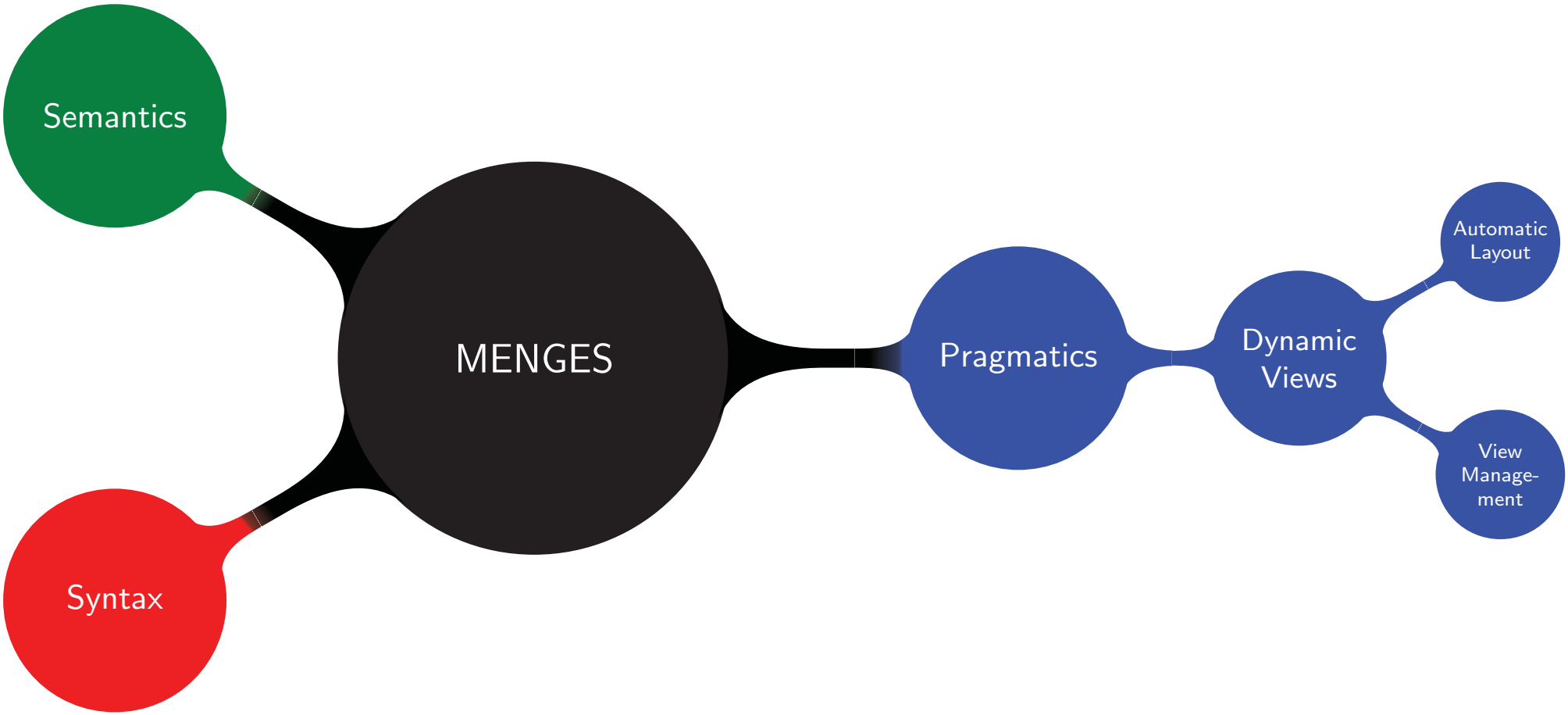
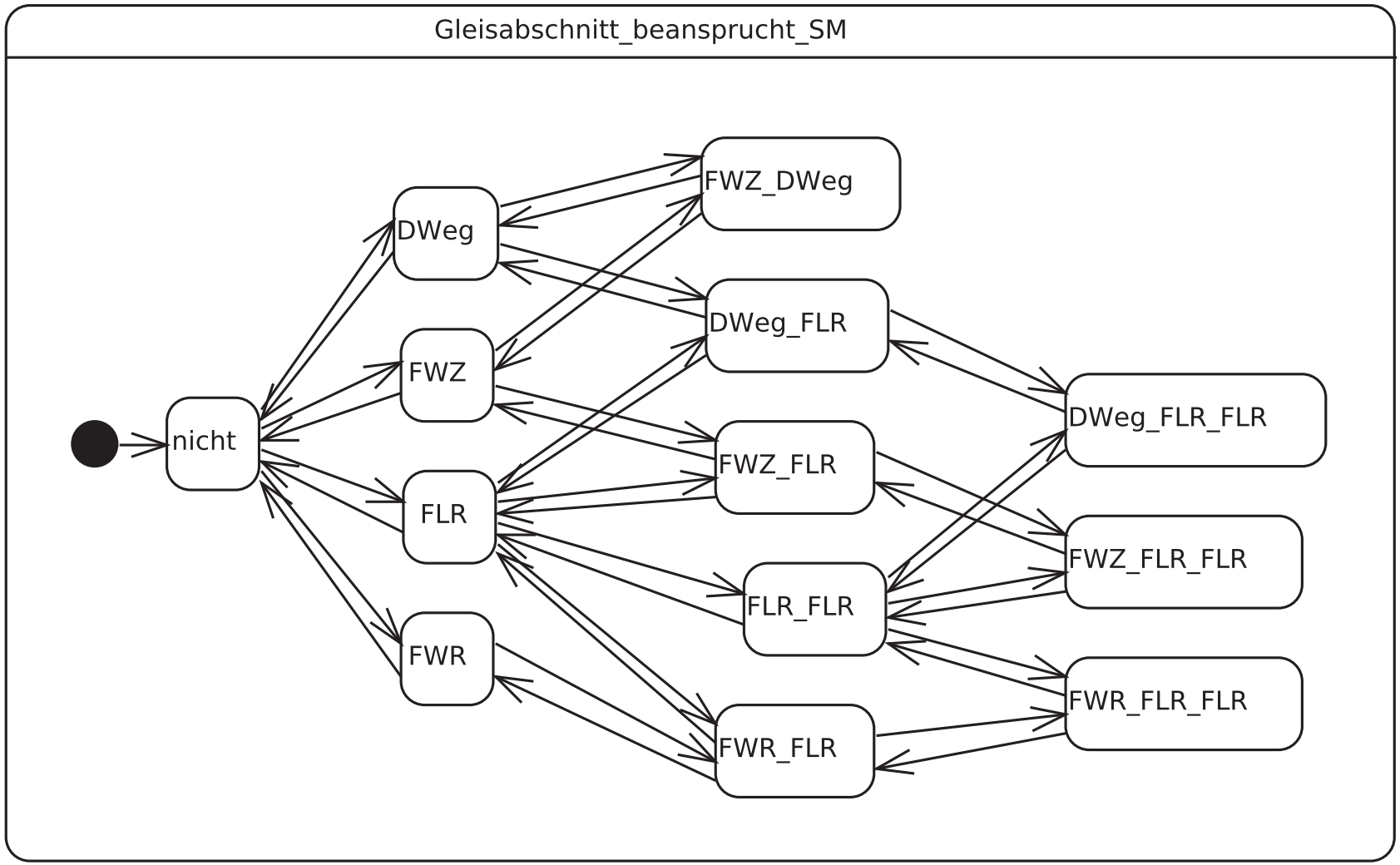


Dynamic Views . . .

. . . on state machines

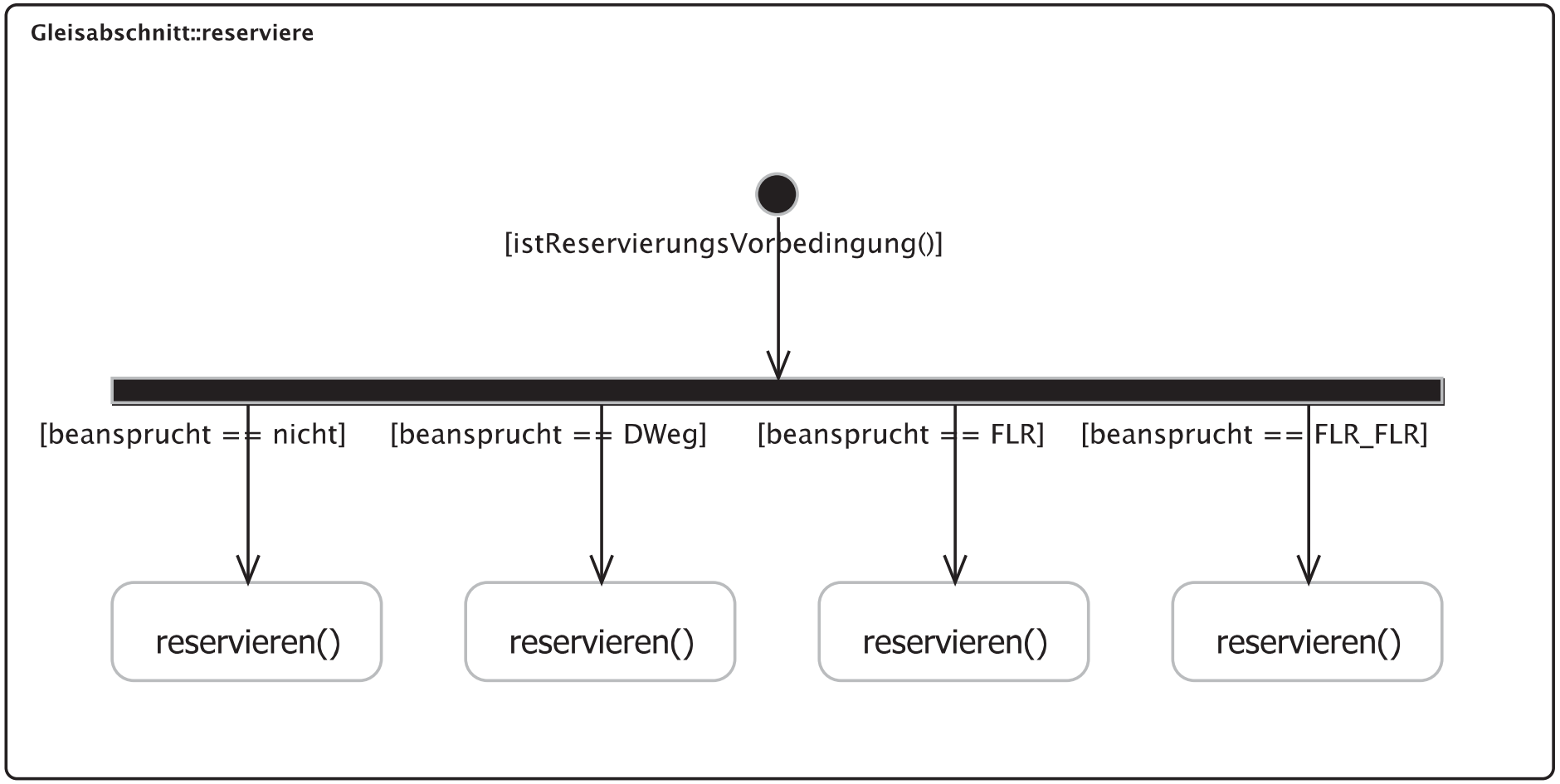


Recall: rule blocks

```
1  rule block reserviere references Gleisabschnitt {
2      rule graph
3      --> [istReservierungsVorbedingung()] {
4          -> [beansprucht == nicht] / {
5              reservieren()
6          };
7          -> [beansprucht == DWeg] / {
8              reservieren()
9          };
10         -> [beansprucht == FLR] / {
11             reservieren()
12         };
13         -> [beansprucht == FLR_FLR] / {
14             reservieren()
15         };
16     }
17 }
```

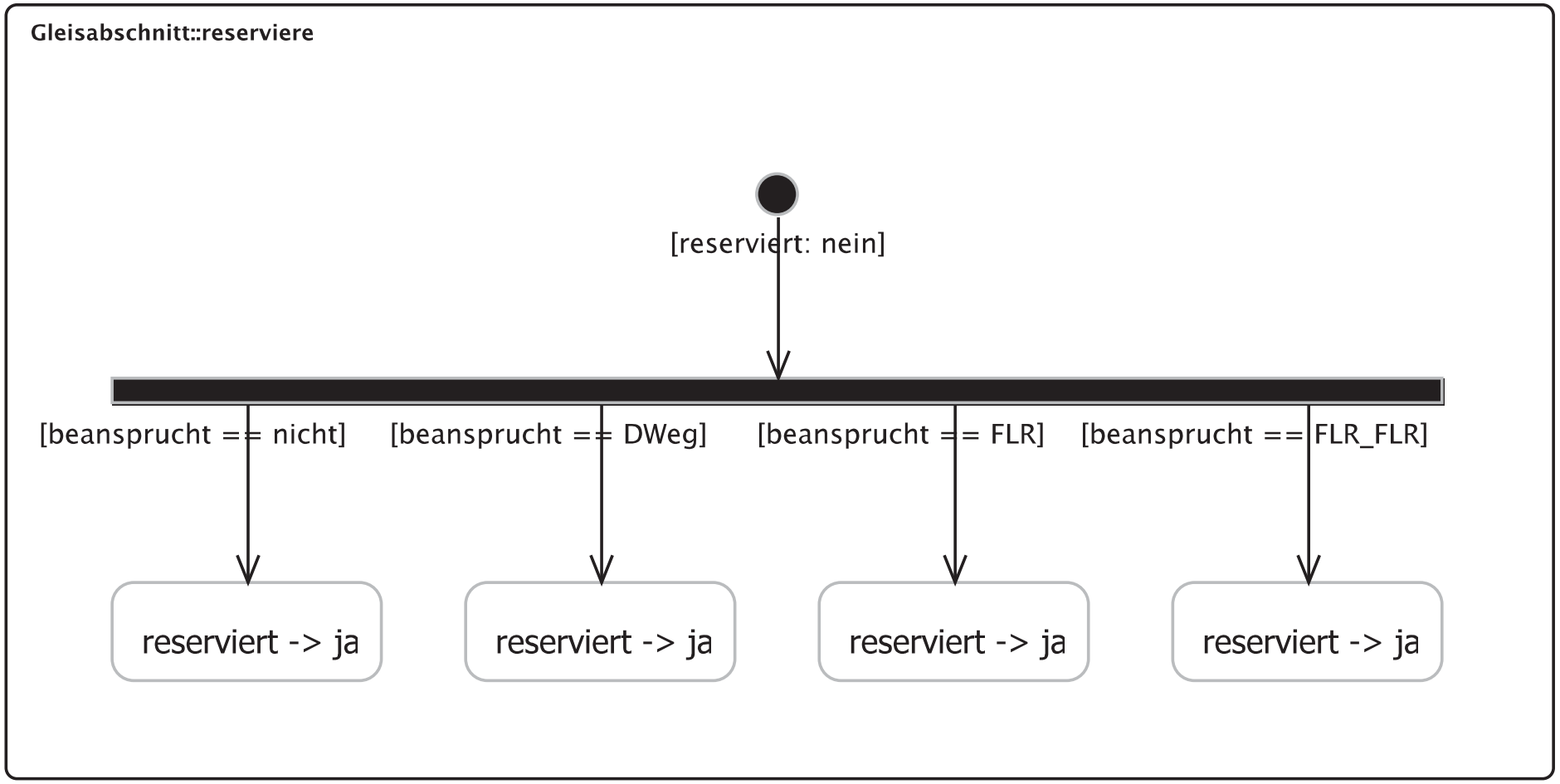
Dynamic Views . . .

. . . on rule blocks



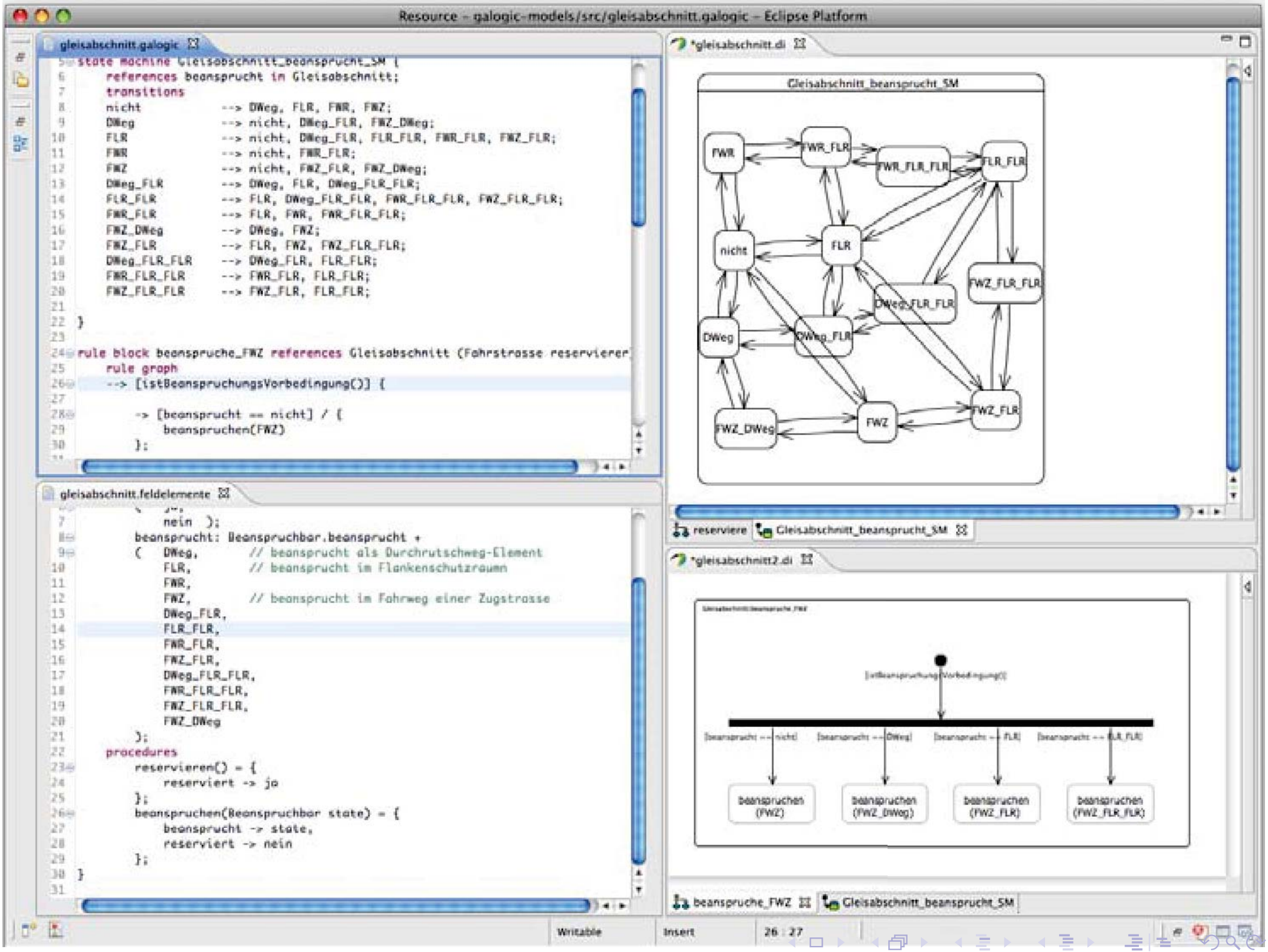
Dynamic Views . . .

. . . on rule blocks - resolved



View Management

- Provide a (graphical) view of the part under development
  - allow to resolve called procedures, ...
- Support interactive browsing
  - licking on an element reveals its declaration / origin
- Find mutual references of state transitions and rule blocks
  - compute and highlight (un-) covered transitions
- Synchronize open views if model has been changed
  - without any user request
- Focus on context in simulation and testing taks
- ...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gleisabschnitt.galogic
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transitions
nicht --> DWeg, FLR, FWR, FWZ;
DWeg --> nicht, DWeg_FLR, FWZ_DWeg;
FLR --> nicht, DWeg_FLR, FLR_FLR, FWR_FLR, FWZ_FLR;
FWR --> nicht, FWR_FLR;
FWZ --> nicht, FWZ_FLR, FWZ_DWeg;
DWeg_FLR --> DWeg, FLR, DWeg_FLR_FLR;
FLR_FLR --> FLR, DWeg_FLR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR;
FWR_FLR --> FLR, FWR, FWR_FLR_FLR;
FWZ_DWeg --> DWeg, FWZ;
FWZ_FLR --> FLR, FWZ, FWZ_FLR_FLR;
DWeg_FLR_FLR --> DWeg_FLR, FLR_FLR;
FWR_FLR_FLR --> FWR_FLR, FLR_FLR;
FWZ_FLR_FLR --> FWZ_FLR, FLR_FLR;
}
rule block beanspruche_FWZ references Gleisabschnitt (Fahrstrasse reservierer
rule graph
--> [istBeanspruchungsVorbedingung()] {
-> [beansprucht == nicht] / {
beanspruchen(FWZ)
};
*gleisabschnitt.di
Gleisabschnitt_beansprucht_SM
FWR
FWR_FLR
FWR_FLR_FLR
FLR_FLR
nicht
FLR
FWZ_FLR_FLR
DWeg_FLR_FLR
DWeg
DWeg_FLR
FWZ_FLR
FWZ_DWeg
FWZ
reserviere
Gleisabschnitt_beansprucht_SM
gleisabschnitt.feldelemente
nein);
beansprucht: Beanspruchbar.beansprucht +
(DWeg, // beansprucht als Durchrutschweg-Element
FLR, // beansprucht im Flankenschutzraum
FWR,
FWZ, // beansprucht im Fahrweg einer Zugstrasse
DWeg_FLR,
FLR_FLR,
FWR_FLR,
FWZ_FLR,
DWeg_FLR_FLR,
FWR_FLR_FLR,
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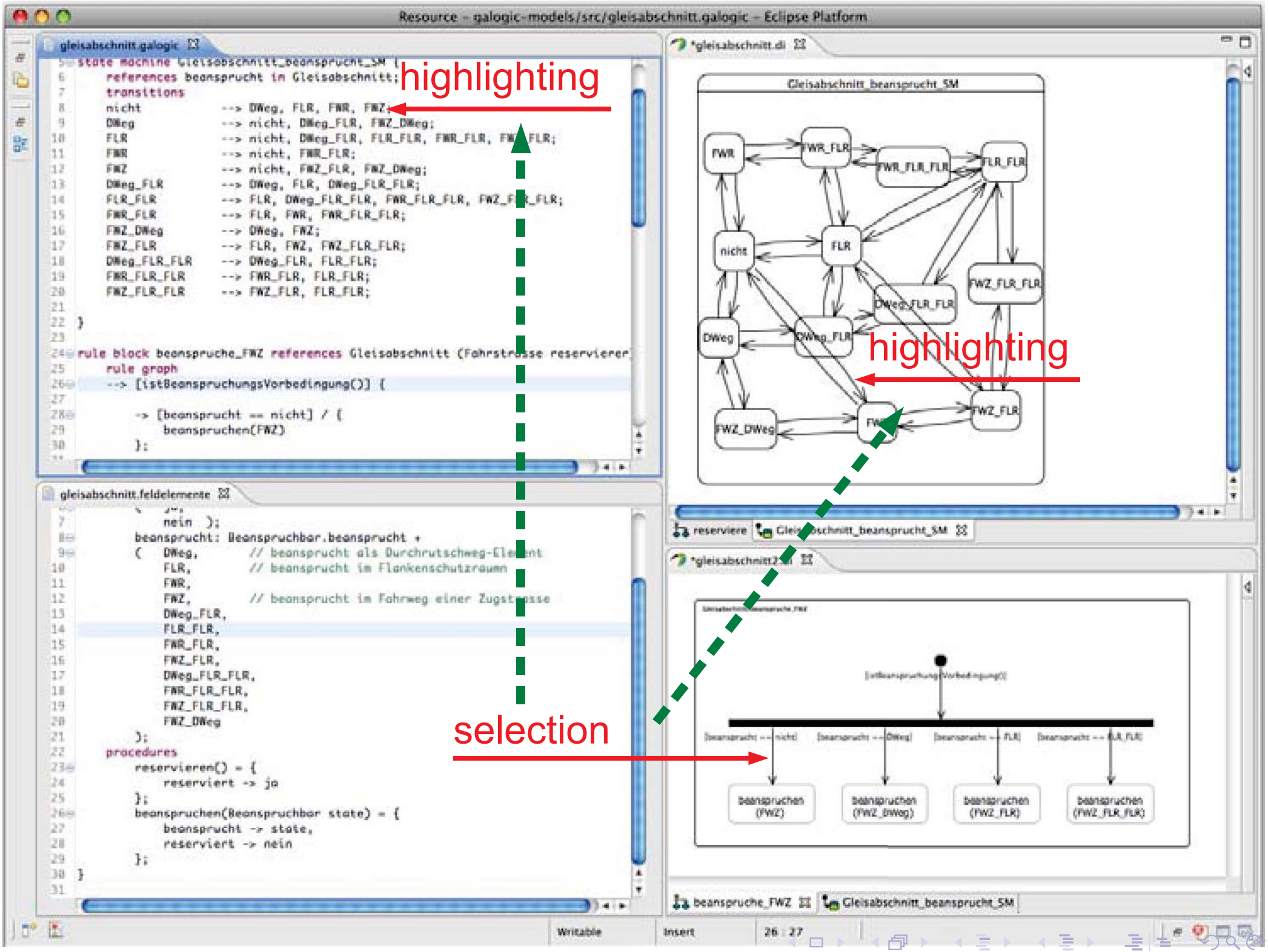
FWZ_DWeg
);
procedures
reservieren() = {
reserviert -> ja
};
beanspruchen(Beanspruchbar state) = {
beansprucht -> state,
reserviert -> nein
};
}
*gleisabschnitt2.di
[istBeanspruchungsVorbedingung()]
[beansprucht == nicht]
[beansprucht == DWeg]
[beansprucht == FLR]
[beansprucht == FLR_FLR]
beanspruchen (FWZ)
beanspruchen (FWZ_DWeg)
beanspruchen (FWZ_FLR)
beanspruchen (FWZ_FLR_FLR)
beanspruche_FWZ
Gleisabschnitt_beansprucht_SM
Writable
Insert
26 : 27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FWZ --> nicht, FWZ_FLR, FWZ_DWeg;
DWeg_FLR --> DWeg, FLR, DWeg_FLR_FLR;
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};
highlighting
gleisabschnitt.feldelemente
nein);
beansprucht: Beanspruchbar.beansprucht +
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procedures
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};
beanspruchen(Beanspruchbar state) = {
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};
}
selection
*gleisabschnitt.di
Gleisabschnitt_beansprucht_SM
FWR
FWR_FLR
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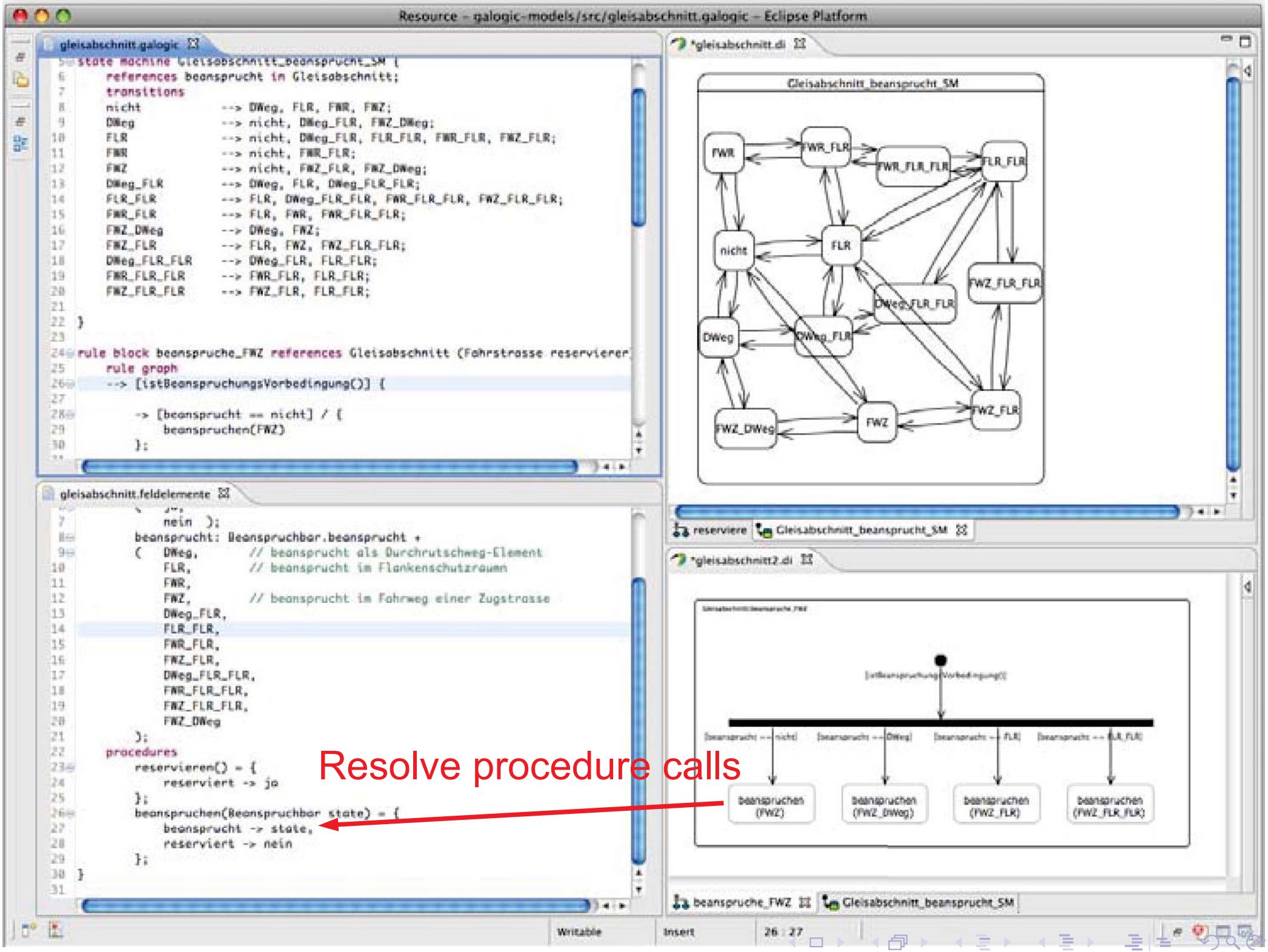
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}
Resolve procedure calls
*gleisabschnitt2.di
beanspruchen (FWZ)
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beanspruchen (FWZ_FLR_FLR)
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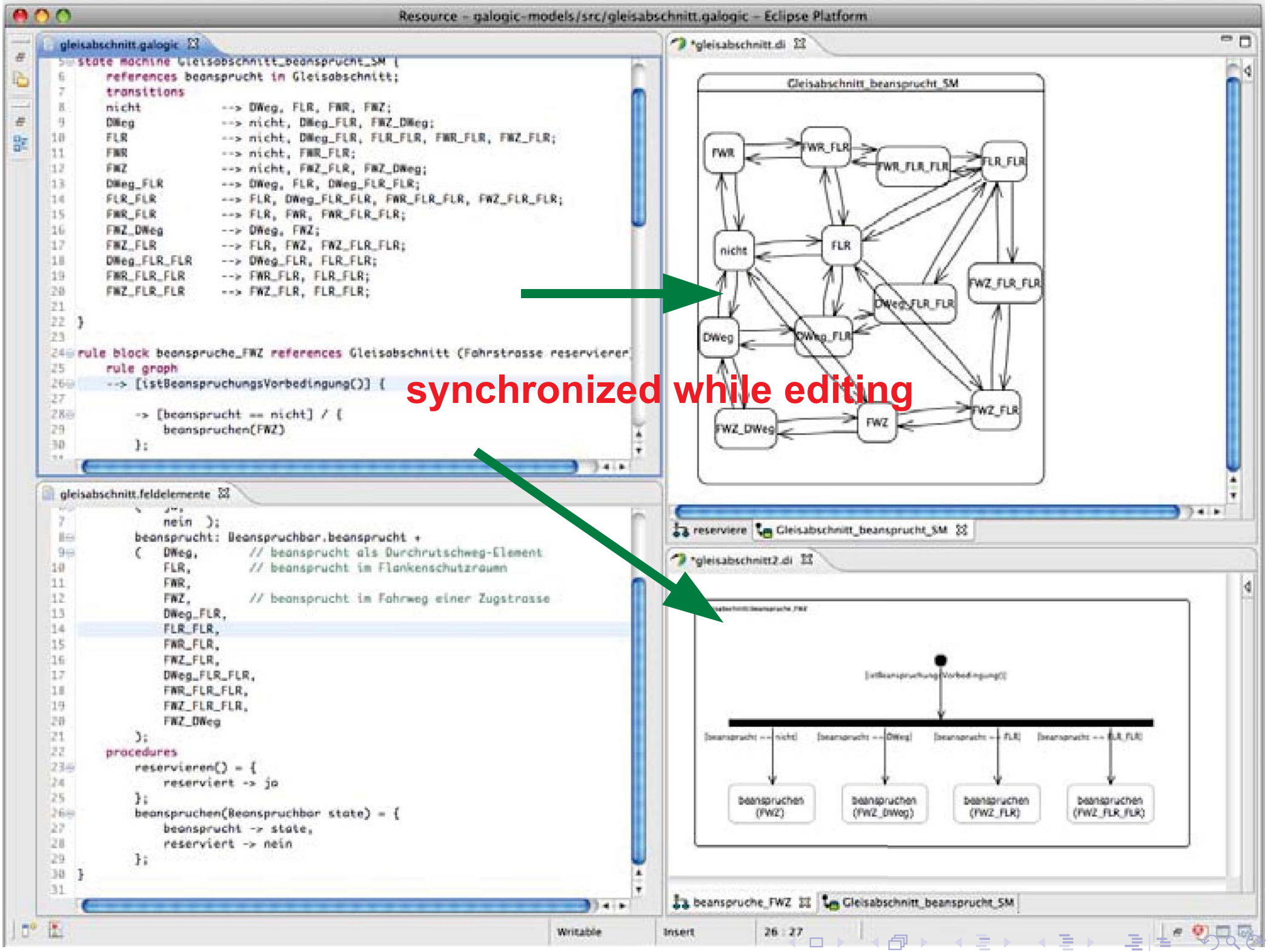
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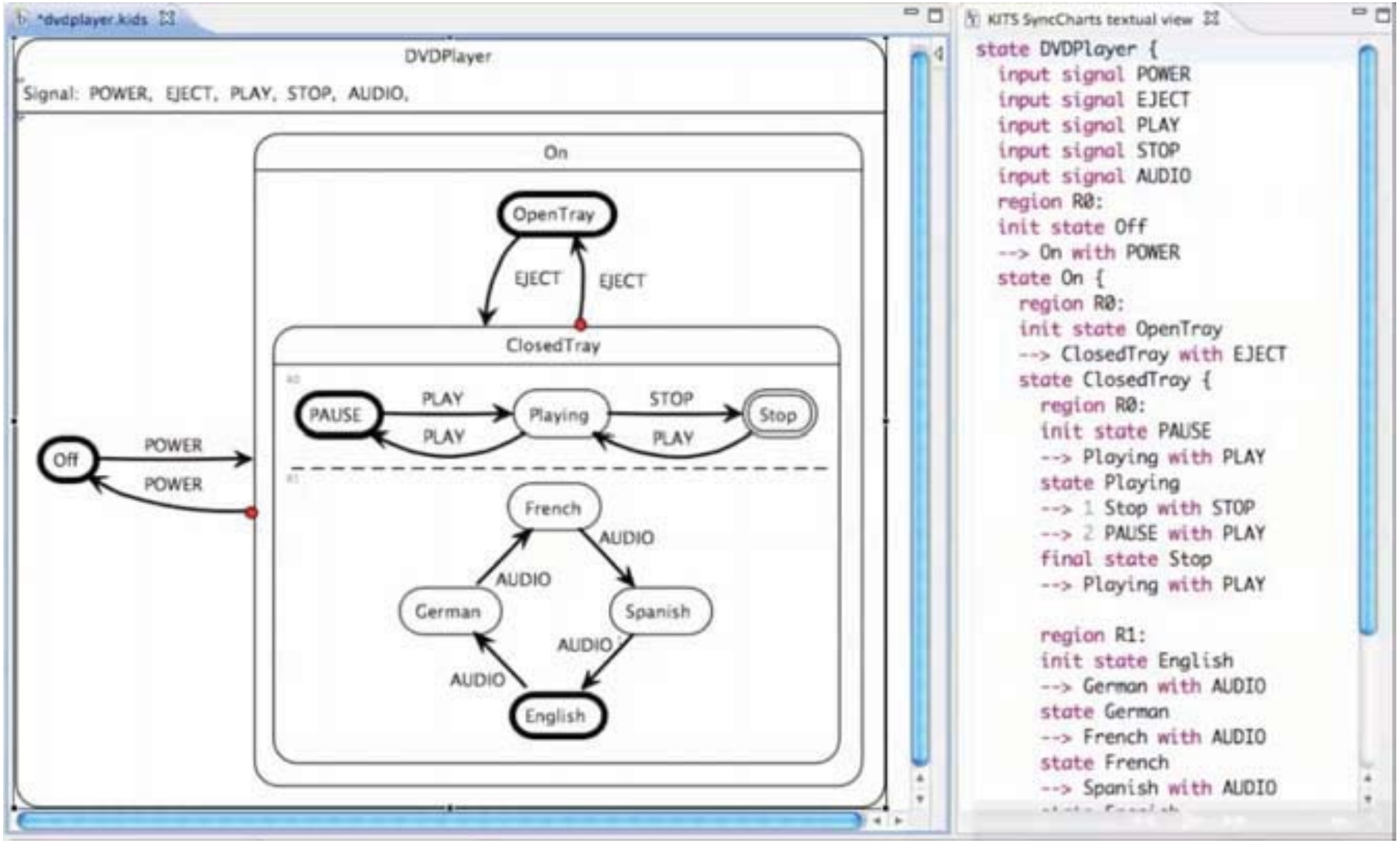
FWZ --> nicht, FWZ_FLR, FWZ_DWeg;
DWeg_FLR --> DWeg, FLR, DWeg_FLR_FLR;
FLR_FLR --> FLR, DWeg_FLR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR;
FWR_FLR --> FLR, FWR, FWR_FLR_FLR;
FWZ_DWeg --> DWeg, FWZ;
FWZ_FLR --> FLR, FWZ, FWZ_FLR_FLR;
DWeg_FLR_FLR --> DWeg_FLR, FLR_FLR;
FWR_FLR_FLR --> FWR_FLR, FLR_FLR;
FWZ_FLR_FLR --> FWZ_FLR, FLR_FLR;
}
rule block beanspruche_FWZ references Gleisabschnitt (Fahrstrasse reservierer
rule graph
--> [istBeanspruchungsVorbedingung()] {
-> [beansprucht == nicht] / {
beanspruchen(FWZ)
};
*gleisabschnitt.di
Gleisabschnitt_beansprucht_SM
FWR
FWR_FLR
FWR_FLR_FLR
FLR_FLR
nicht
FLR
FWZ_FLR_FLR
DWeg_FLR_FLR
DWeg
DWeg_FLR
FWZ_FLR
FWZ_DWeg
FWZ
reserviere
Gleisabschnitt_beansprucht_SM
synchronized while editing
gleisabschnitt.feldelemente
nein);
beansprucht: Beanspruchbar.beansprucht +
(DWeg, // beansprucht als Durchrutschweg-Element
FLR, // beansprucht im Flankenschutzraum
FWR,
FWZ, // beansprucht im Fahrweg einer Zugstrasse
DWeg_FLR,
FLR_FLR,
FWR_FLR,
FWZ_FLR,
DWeg_FLR_FLR,
FWR_FLR_FLR,
FWZ_FLR_FLR,
FWZ_DWeg
);
procedures
reservieren() = {
reserviert -> ja
};
beanspruchen(Beanspruchbar state) = {
beansprucht -> state,
reserviert -> nein
};
}
*gleisabschnitt2.di
beanspruchen (FWZ)
beanspruchen (FWZ_DWeg)
beanspruchen (FWZ_FLR)
beanspruchen (FWZ_FLR_FLR)
beanspruche_FWZ
Gleisabschnitt_beansprucht_SM
Writable
Insert
26 : 27

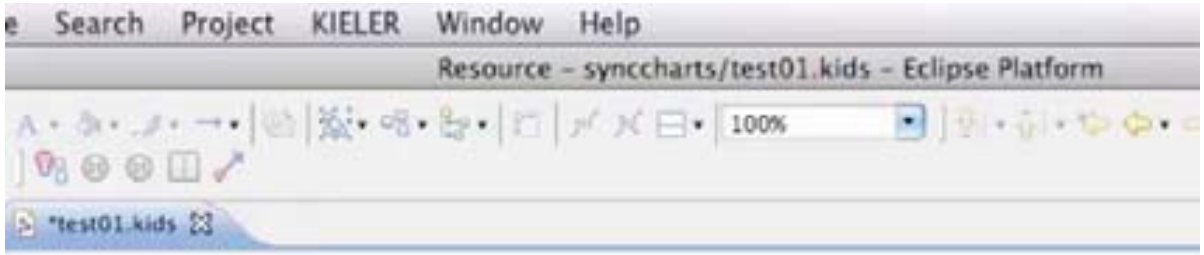
Conclusion

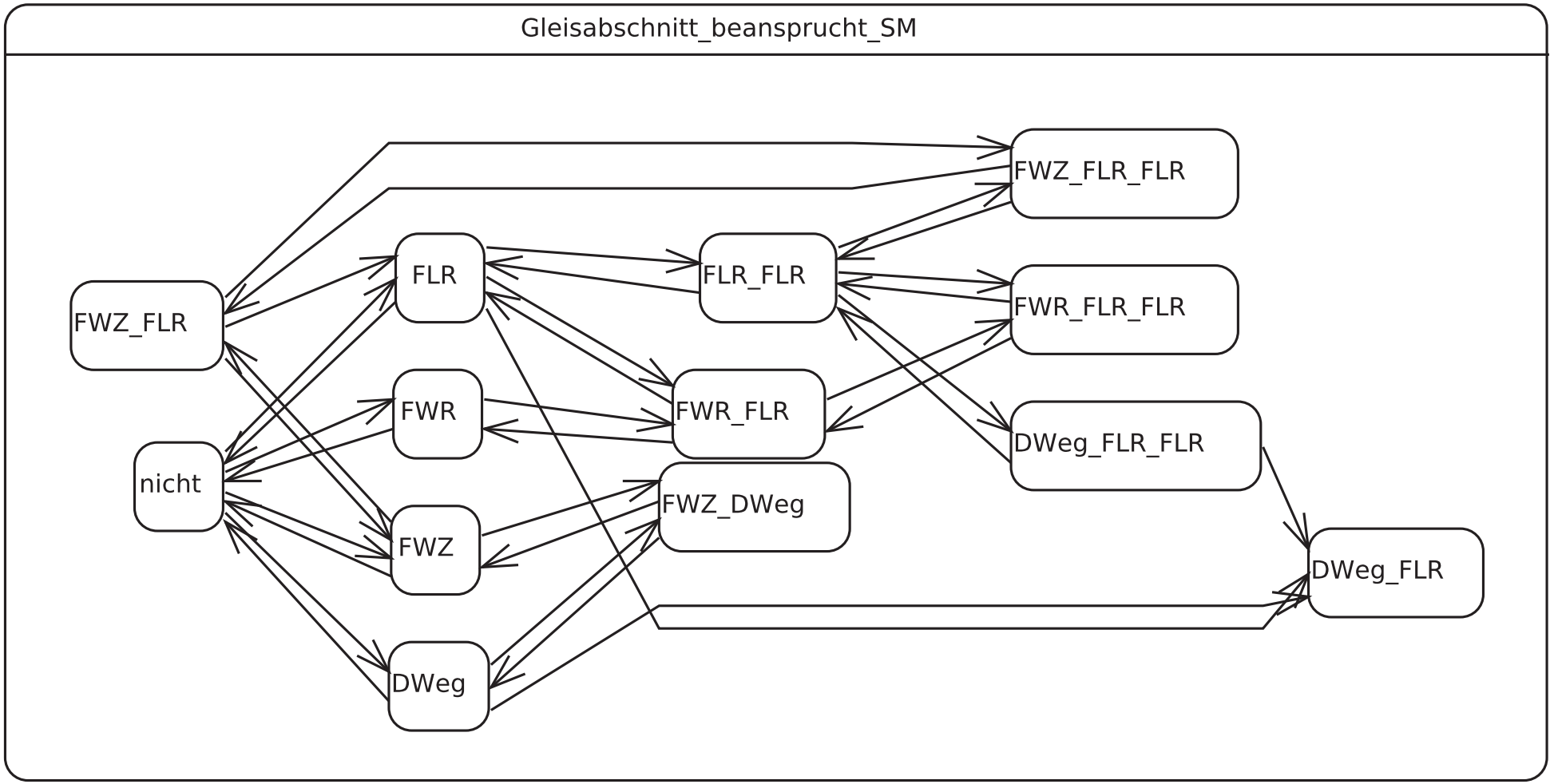
What did I talk about?

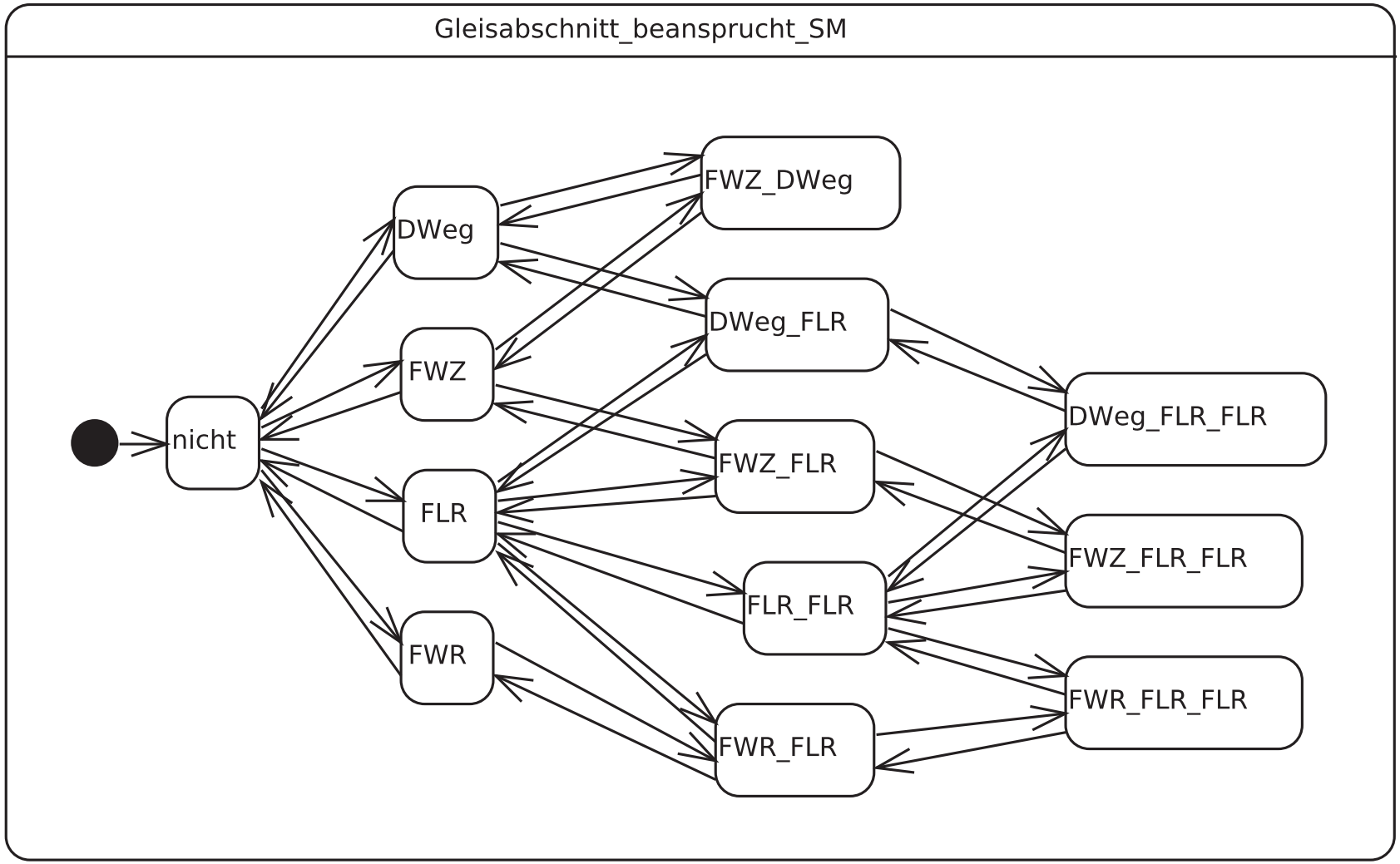
- shortly introduced the MENGES project
- outlined the deployment of textual languages
- motivated benefits/downsides of textual & graphical notations
- sketched an approach on how to integrate them
  resulting in much more abilities of handling models

APPENDIX


*dvdplayer.kids
DVDPlayer
Signal: POWER, EJECT, PLAY, STOP, AUDIO,
On
OpenTray
EJECT
EJECT
ClosedTray
PAUSE
PLAY
Playing
STOP
Stop
PLAY
PLAY
Off
POWER
POWER
French
AUDIO
AUDIO
German
Spanish
AUDIO
AUDIO
English
KITS SyncCharts textual view
state DVDPlayer {
input signal POWER
input signal EJECT
input signal PLAY
input signal STOP
input signal AUDIO
region R0:
init state Off
--> On with POWER
state On {
region R0:
init state OpenTray
--> ClosedTray with EJECT
state ClosedTray {
region R0:
init state PAUSE
--> Playing with PLAY
state Playing
--> 1 Stop with STOP
--> 2 PAUSE with PLAY
final state Stop
--> Playing with PLAY
region R1:
init state English
--> German with AUDIO
state German
--> French with AUDIO
state French
--> Spanish with AUDIO


Search
Project
KIELER
Window
Help
Resource – syncharts/test01.kids – Eclipse Platform
100%
*test01.kids


Gleisabschnitt_beansprucht_SM
FWZ_FLR
nicht
FLR
FWR
FWZ
DWeg
FLR_FLR
FWR_FLR
FWZ_DWeg
FWZ_FLR_FLR
FWR_FLR_FLR
DWeg_FLR_FLR
DWeg_FLR


Gleisabschnitt_beansprucht_SM
nicht
DWeg
FWZ
FLR
FWR
FWZ_DWeg
DWeg_FLR
FWZ_FLR
FLR_FLR
FWR_FLR
DWeg_FLR_FLR
FWZ_FLR_FLR
FWR_FLR_FLR