On Integration of Textual and Graphical Modeling

Pragmatics in MENGES

Christian Schneider

Real-Time Systems and Embedded Systems Group
Department of Computer Science
Christian-Albrechts-Universität zu Kiel
www.informatik.uni-kiel.de/rtsys

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Outline

The MENGES project
  The Setting
  Current State
  Textual vs. Graphical Modeling

Pragmatics
  A Definition
  Our Approach
  Dynamic Views
  View Management

Conclusion
The Context of MENGES

Setting

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

Current state in the business

- Requirements analysis
  \[\rightarrow\] huge amount of text documents, informal
- Design specifications with a proprietary modeling language
  \[\rightarrow\] formalized description of the system logic
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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
The Aim of MENGES

- Engineers shall be assisted in these tasks, i.e. while
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- 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

- Topology: Instances of switches, running tracks, track sections, ...
- Types for logical Elements
- Deployment
- Types for Field Elements
- Running Track Behavior
- Field Element Behavior
- Field Element Behavior (Driver)
- Type Layer
Field Element description

```java
field element Gleisabschnitt extends Beanspruchbar {
    statevars
    reserviert:
        ( ja,
        nein );
    beansprucht:
        ( nicht,
        DWeg,   // als Durchrutschweg-Element
        FLR,    // im Flankenschutzraum
        FWR,    // im Fahrweg einer Rangierstrasse
        FWZ,    // im Fahrweg einer Zugstrasse
        DWeg_FLR, FLR_FLR, FWR_FLR, FWZ_FLR, FWZ_DWeg,
        DWeg_FLR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR );
    procedures
    reservieren() = {
        reserviert -> ja
    };
}
```
Behavior specification - State Machines

```plaintext
state machine Gleisabschnitt_beansprucht_SM {
    references beansprucht in Gleisabschnitt;
    transitions
    start 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;
}
```
Behavior specification - Rule Blocks

```
rule block reserviere references Gleisabschnitt {
  rule graph
    --> [istReservierungsVorbedingung()] {
      -> [beansprucht == nicht] / {
        reservieren()
      }
    }
    --> [beansprucht == DWeg] / {
        reservieren()
    }
    --> [beansprucht == FLR] / {
        reservieren()
    }
    --> [beansprucht == FLR_FLR] / {
        reservieren()
    }
}
```
Assessment

The textual languages are . . .

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

The textual languages are . . .

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

but . . .

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

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Question: What about graphical languages?
A graphical notation of state machines
SOS!
Assessment - cont’d

Graphical languages/representations may be . . .

- formal and compact
- precise in terms of separation of concerns
- easier to conceive
- more flexible
Assessment - cont’d

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Assessment - cont’d

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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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- 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 $=_{\text{def}}$ 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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The key enabler:

**Automatic, flexible synthesis of graphical & textual views organized by a powerful View Management**
Our Approach ...
Our Approach . . .
Our Approach...
Our Approach . . .
Dynamic Views . . .

. . . on state machines
Recall: rule blocks

```plaintext
rule block reserviere references Gleisabschnitt {
  rule graph
    --> [istReservierungsVorbedingung()] {
      -> [beansprucht == nicht] / {
        reservieren()
      };
      -> [beansprucht == DWeg] / {
        reservieren()
      };
      -> [beansprucht == FLR] / {
        reservieren()
      };
      -> [beansprucht == FLR_FLR] / {
        reservieren()
      };
    }
}
```
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
  - clicking 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 tasks
  - ...

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state machine Gleisabschnitt_beansprucht_SM {
transitions
nicht --> DWeg, FLR, FRW, FWZ;
DWeg --> nicht, DWeg, FLR, FWZ, FRW, FWZ_Dweg;
FLR --> nicht, FLR, DWeg, FLR, FRW, FWZ_FLR, FRW_FLR, FWZ_FLR;
FRW --> nicht, FRW, FLR, FWZ_FLR, FRW_FLR, FWZ_FLR;
FWZ --> nicht, FWZ_FLR, FRW_FLR, FWZ_FLR;
D Weg, FLR_Dweg, FRW, FWZ_Dweg, FLR_FLR_Dweg, FRW_FLR_Dweg, FWZ_FLR_Dweg;
FLR_FLR --> FRW, FRW_FLR, FRW_FLR, FWZ_FLR_FLR, FRW_FLR_FLR;
FRW_FLR --> FRW, FRW_FLR, FRW_FLR, FWZ_FLR_FLR, FRW_FLR_FLR;
FWZ_FLR --> FRW, FRW_FLR, FRW_FLR, FWZ_FLR_FLR, FRW_FLR_FLR;
FWZ_FLR_FLR --> FRW, FRW_FLR, FRW_FLR, FWZ_FLR_FLR, FRW_FLR_FLR;
}

rule block beanspruche_FWZ references Gleisabschnitt (Fahrstrasse reservieren)
rule graph

-->{ IstBeanspruchungsVorbedingung() } {
  [beansprucht -> nicht] / {
    beanspruchen(FWZ);
  };
}

gleisabschnitt.feldelemente {
nein);
beansprucht: Beanspruchbar.beansprucht +
  ( DWeg, // beansprucht als Durchgangsstrasse
    FLR, // beansprucht in Flankenschutzraum
    FRW,
    FWZ, // beansprucht in Fahrstrasse
    DWeg_FLR, FLR_FLR, FRW_FLR, FWZ_FLR, DWeg_FLR_FLR, FLR_FLR_FLR, FRW_FLR_FLR, FWZ_FLR_FLR);
}

procedures
reservieren() = {
  reserviert = ja;
  beanspruchen(Beanspruchbar state) = {
    beansprucht = state,
    reserviert = nein;
  };
};
Resolve procedure calls
state machine Gleisabschnitt_beansprucht_SM {

transitions beansprucht in Gleisabschnitt;

nicht --> DWeg, FLR, FWR, FWZ;
DWeg --> nicht, DWeg_FLR, FWR_FLR, FWR, FWZ_FLR, FWZ_FLR_FLR;
FLR --> nicht, FWR_FLR, FWR_FLR, FWR, FWZ_FLR_FLR;
FR --> nicht, FWR_FLR, FWR_FLR, FWR, FWZ_FLR_FLR;
FW --> nicht, FWR_FLR, FWR_FLR, FWR, FWZ_FLR_FLR;
FWZ --> nicht, FWR_FLR, FWR_FLR, FWR, FWZ_FLR_FLR;
DWeg_FLR --> DWeg, FLR, DWeg_FLR_FLR, FWR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR;
FWR_FLR --> FLR, DWeg_FLR_FLR, FWR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR;
FLR_FLR --> FLR, DWeg_FLR_FLR, FWR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR;
FWZ_FLR --> FLR, DWeg_FLR_FLR, FWR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR;
FWZ_FLR_FLR --> FLR, DWeg_FLR_FLR, FWR_FLR, FWR_FLR_FLR, FWZ_FLR_FLR;
}

rule block beanspruche_FWZ references Gleisabschnitt (Fahrstrasse reservieren)

rule graph

--> [istBeanspruchungsVorbedingung()] {
  beanspruch == nicht } / {
  beanspruchen(FWZ);
}

procedures

reservieren() = {
  reserviert -> ja
};

beanspruchen(Beanspruchbar state) = {
  beanspruch -> state,
  reserviert -> nein
};
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
DVDPlayer

Signal: POWER, EJECT, PLAY, STOP, AUDIO.

On

- OpenTray
  - EJECT
  - EJECT

ClosedTray

- PAUSE
- PLAY
- STOP
- Stop

French
  - AUDIO
  - German
  - Spanish
  - English

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
      - state Spanish