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Decomposition Tool: Development and Usage

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www.deploy-project.eu
www.event-b.org

deploy

Outline

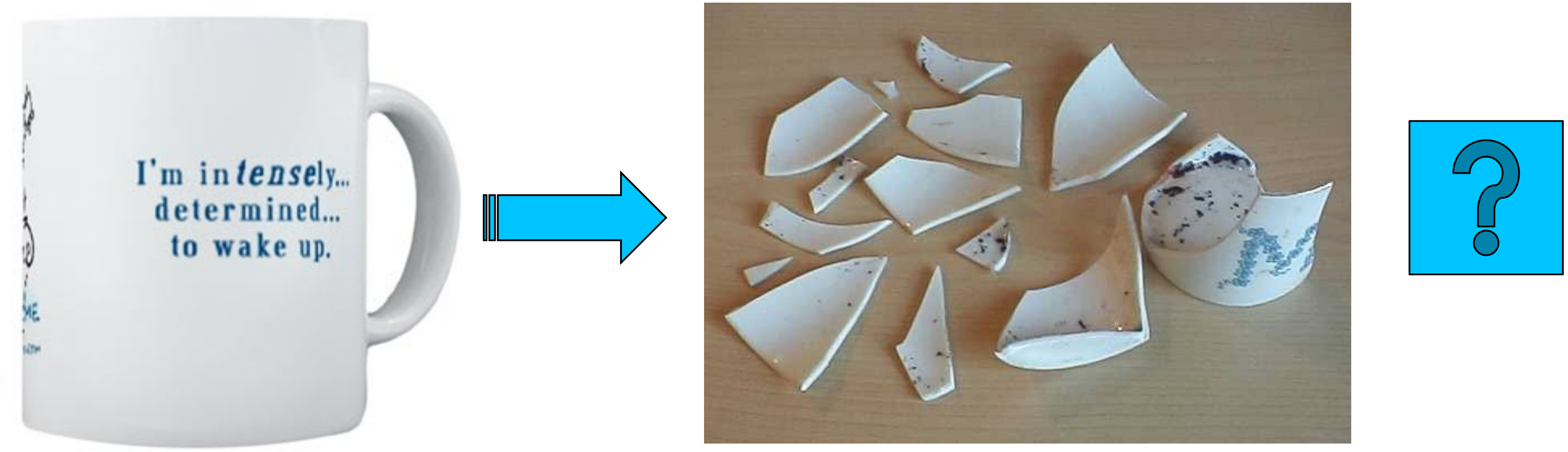
- Motivation
- Decomposition in Event-B: Shared Variable and Shared Event
- Tool
- Demo
- Conclusions/Future work

Motivation

- "Top-down" development style: new events and data-refinement of variables during refinements
- Problem: increasing complexity of the refinement process when having to deal with many events and many state variables (and likely many POs)
- Possible solution: Decomposition
  - Splitting a large model into smaller sub-components
  - Design/architectural decision
  - Team development
  - Alleviate the complexity of discharging POs

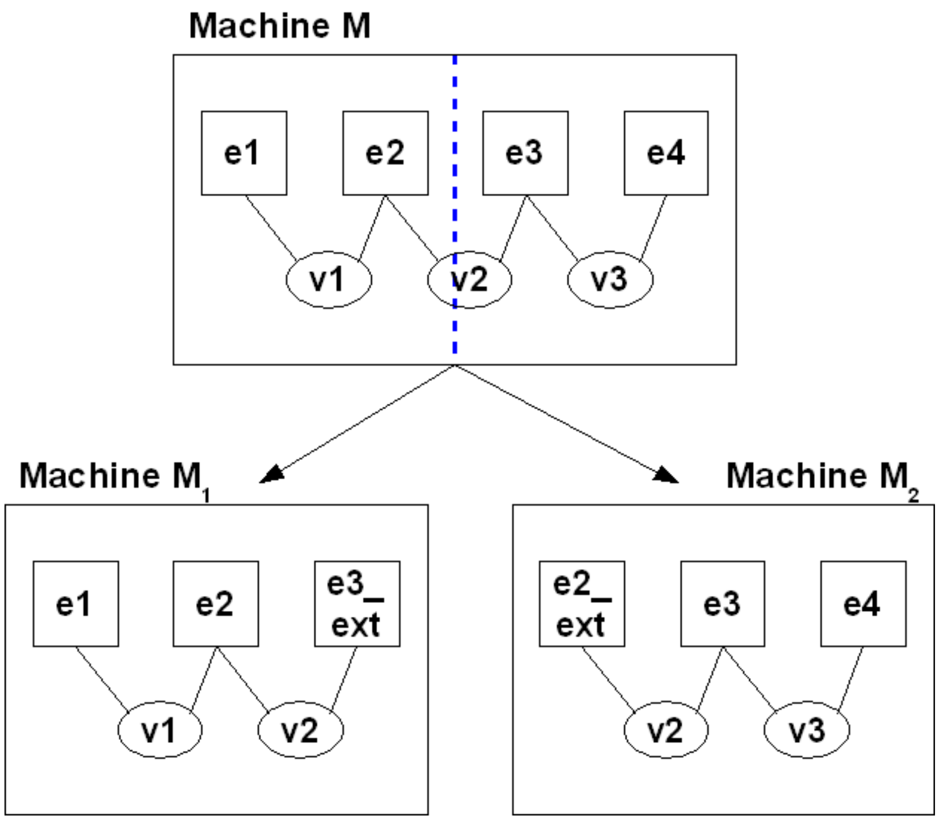
Motivation (cont.)

- Decomposition = “break up” something that is composed.



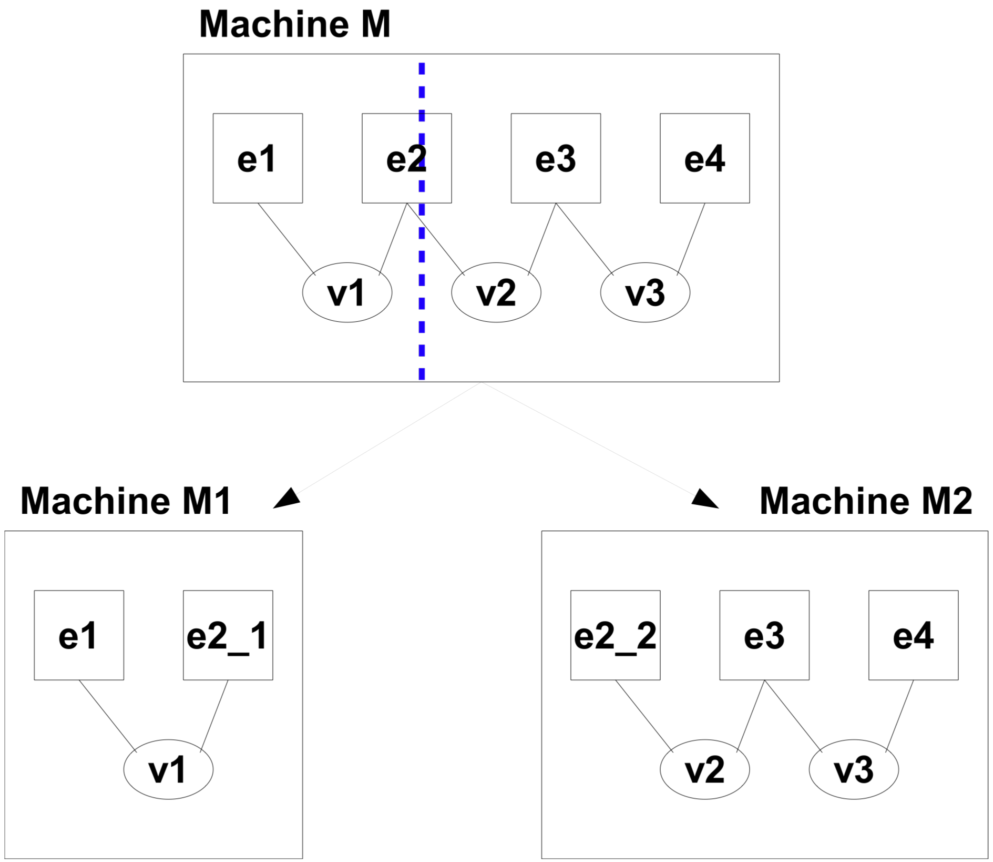
- How to do it?

Shared Variable decomposition



- Events of M are first partitioned into M1, ..., Mn.
- Variable partition is a consequence of the event splitting.
- Shared variable: variable accessed by events of distinct sub-machines (in opposition to private variable).
- External event: event of a sub-machine which is built from an event of the non-decomposed machine and simulates the way the shared variables are handled in the non-decomposed machine (in opposition to internal event).

Shared Event decomposition



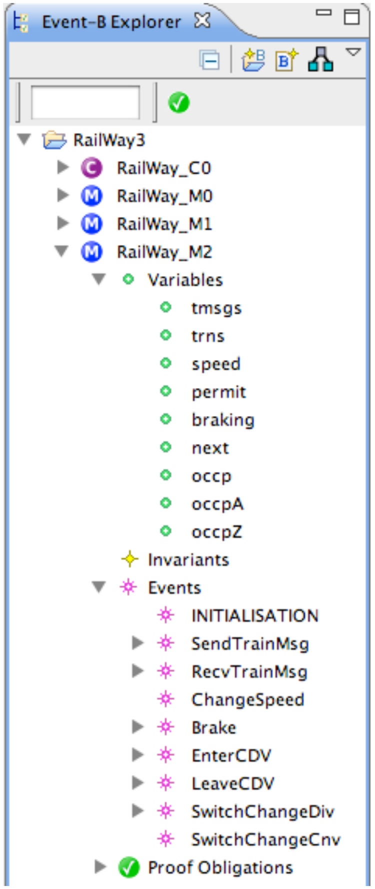
- Variables of M are first partitioned into M1, ..., Mn. Variables are not shared.
- Event partition is a consequence of the variable splitting.
- No notion of external events.
- If an event shares variables belonging to different sub-models, that event (parameters, guards, actions) is split over the sub-models (*validation is required*).
- Interaction between sub-components: synchronized events communicate via shared parameters.

Which decomposition is better?

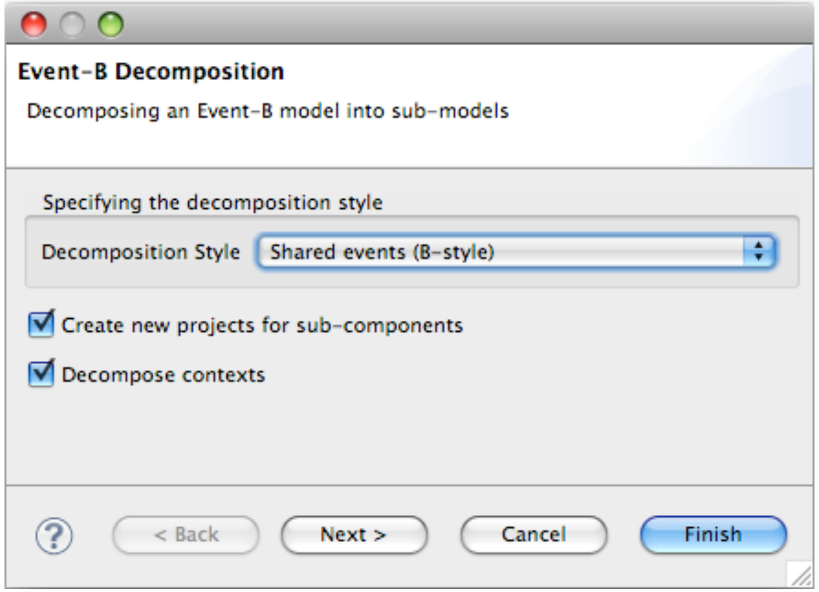
- It depends on :
  - the system being developed
  - user habits
- Shared Variable:
  - Variables being shared suggest use in parallel applications
- Shared Event:
  - Suggests the use in message passing distributed systems or middleware systems.

Tool

- A single plug-in for both styles in the Rodin platform.
- Usage of extension mechanisms: wizard, menu, editor, static checker.
- Decomposition wizard:



```
▼ RailWay3
  ▶ RailWay_C0
  ▶ RailWay_M0
  ▶ RailWay_M1
  ▼ RailWay_M2
    ▼ Variables
        tmsgs
        trns
        speed
        permit
        braking
        next
        occp
        occpA
        occpZ
      Invariants
    ▼ Events
        INITIALISATION
      ▶ SendTrainMsg
      ▶ RecvTrainMsg
        ChangeSpeed
      ▶ Brake
      ▶ EnterCDV
      ▶ LeaveCDV
      ▶ SwitchChangeDiv
        SwitchChangeCnv
    ▶ Proof Obligations
```



Event-B Decomposition

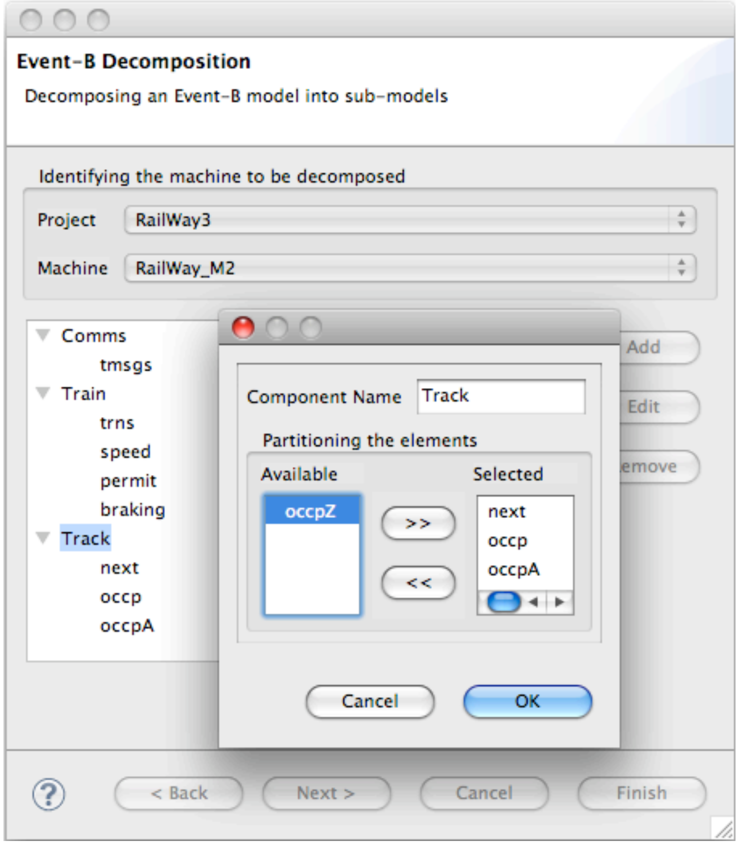
Decomposing an Event-B model into sub-models

Specifying the decomposition style

Decomposition Style: Shared events (B-style)

☑ Create new projects for sub-components

☑ Decompose contexts



Event-B Decomposition

Decomposing an Event-B model into sub-models

Identifying the machine to be decomposed

Project: RailWay3

Machine: RailWay_M2

```
▼ Comms
    tmsgs
▼ Train
    trns
    speed
    permit
    braking
▼ Track
    next
    occp
    occpA
```

Component Name: Track

Partitioning the elements

Available	Selected
occpZ	next occp occpA

Demo

- Select machine to be decomposed
- Select decomposition style
- Select where to store the sub-components. Also option to to decompose contexts
- Define sub-components and respective elements
- Save decomposition file
- Run decomposition

Conclusion

- Decomposition: used to decrease the complexity and increase the modularity of large systems
- Main benefits:
  - Further refinement of independent sub-models in parallel (monotonicity).
  - Allow team development for each sub-model (attractive option for the industry)
  - Distribution of POs

Conclusion (cont.)

- Decomposition in Event-B:
  - Shared Variable approach: seems more suitable for modelling parallel systems*
  - Shared Event approach: seems more suitable for modelling messaging-passing distributed systems**
- Decomposition tool is available since the release 1.2 of the Rodin platform.
  - Already used in several case studies with positive feedback ☺

* Hoang, T., Abrial, J.R.: Event-B Decomposition for Parallel Programs. Abstract State Machines, Alloy, B and Z (2010) 319–333

** Butler, M.: An Approach to the Design of Distributed Systems with B AMN. In: Proc. 10th Int. Conf. of Z Users: The Z Formal Specification Notation (ZUM), LNCS 1212. (1997) 221–241

Future work

- Visual perspective of decomposition
    - It seems easier to partition a system by visualising how to allocate the elements in the sub-components
    - Option: using Graphical Modelling Framework (GMF)
- Application of more complex case studies and analyse the results (Ongoing work)
- Integration of the decomposition plug-in with other plug-ins (compatibility problems): Records, Modularisation plug-in, etc

Questions?

Thank you