Integrating Graph Transformations and Modal Sequence Diagrams for Specifying Structurally Dynamic Reactive Systems

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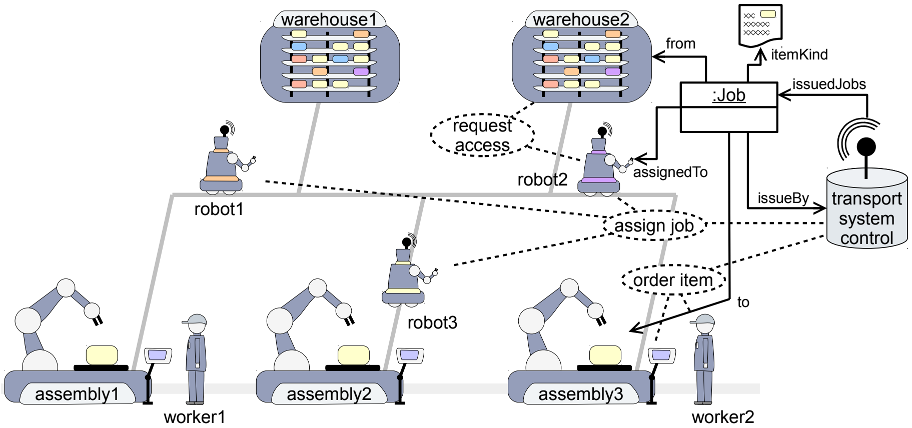
September 29th, 2014

What's happening...?



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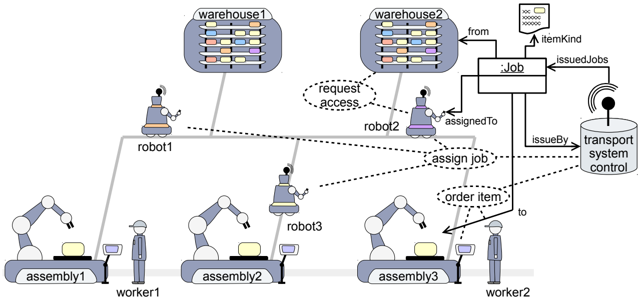

- Multiple physically distributed mechatronic components
- Interaction between these components
- Changes in physical and logical structure

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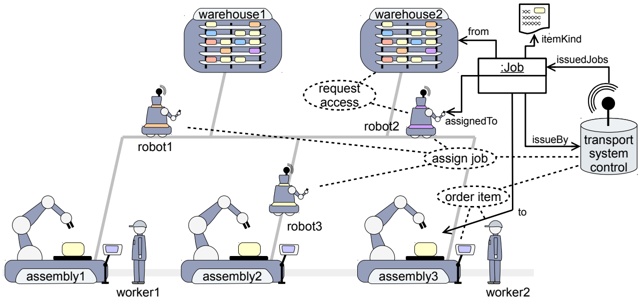

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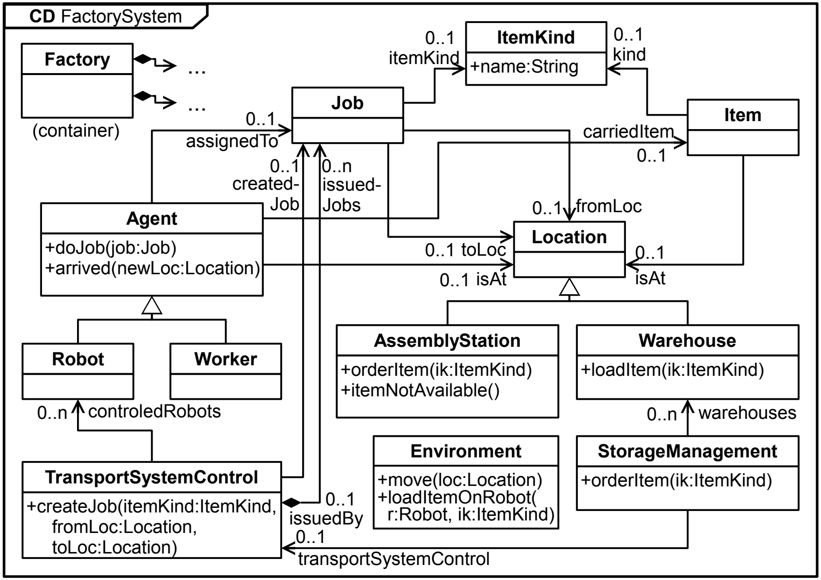
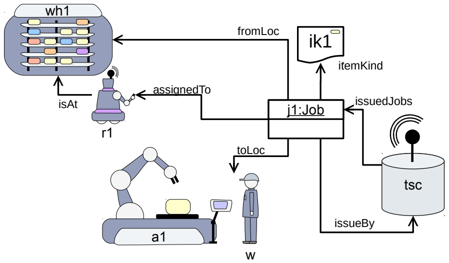
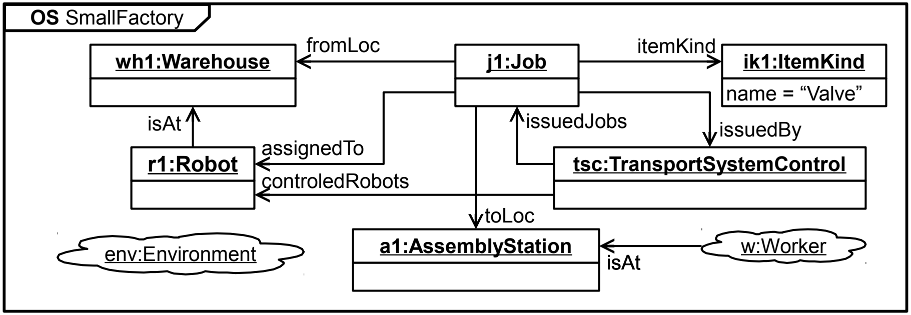
$\Rightarrow$ Structurally dynamic (distributed) reactive system

Class Diagram

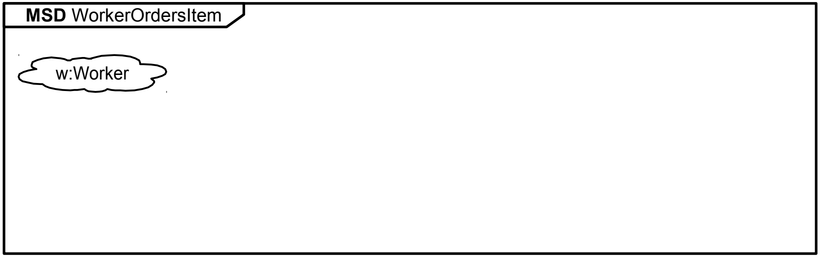


Object System





Modal Sequence Diagrams



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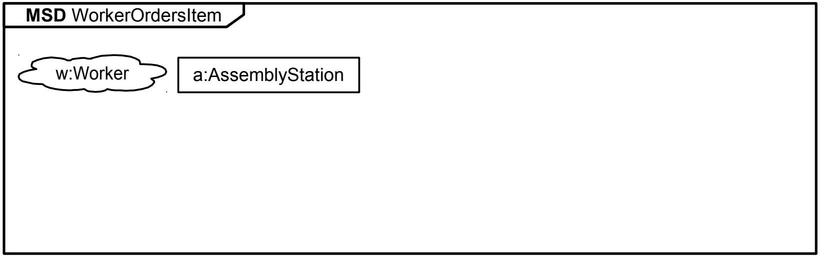

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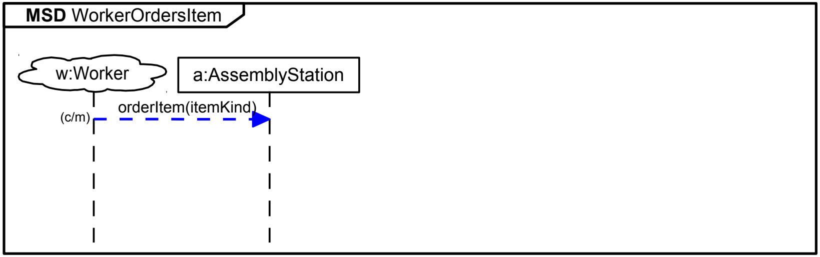

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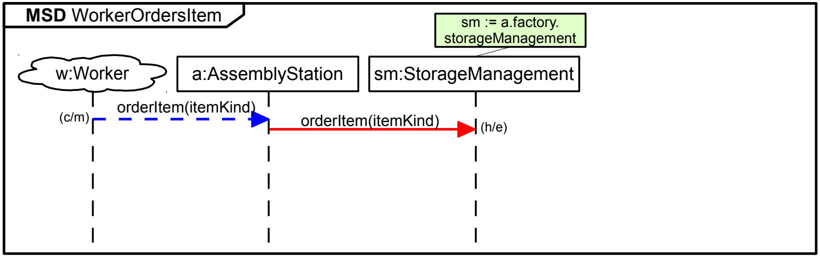

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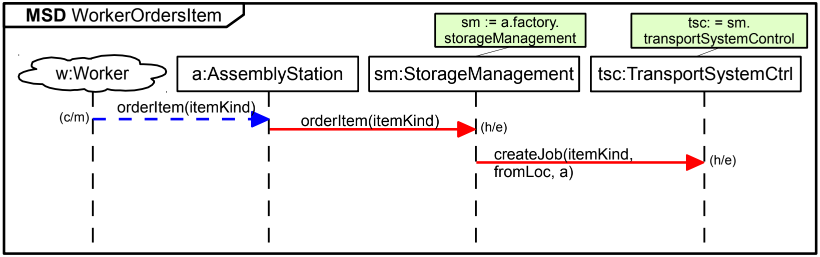

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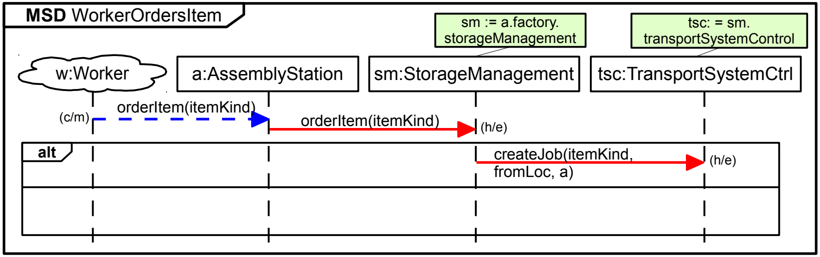

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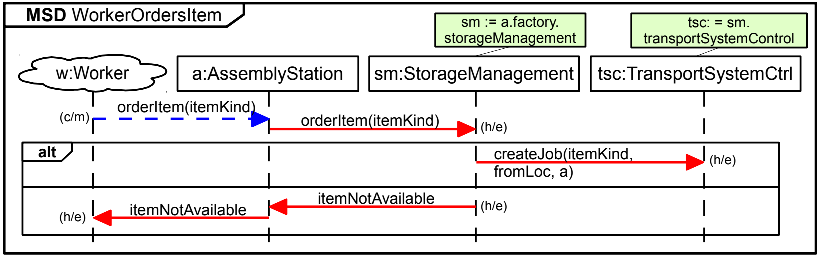

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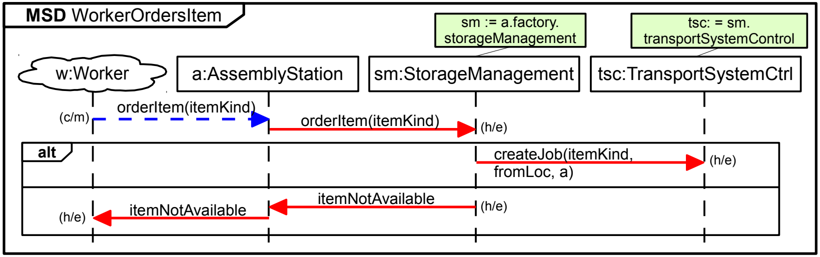
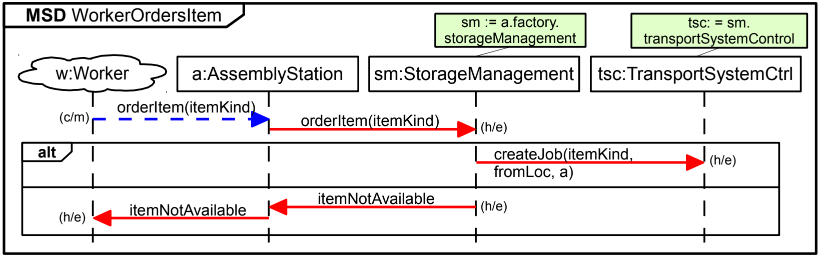


- Requirements

Modal Sequence Diagrams



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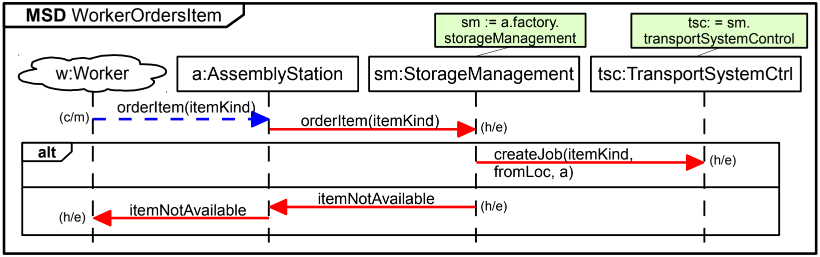

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- Assumptions
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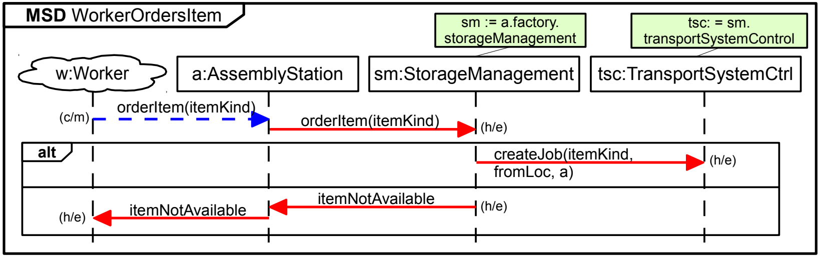

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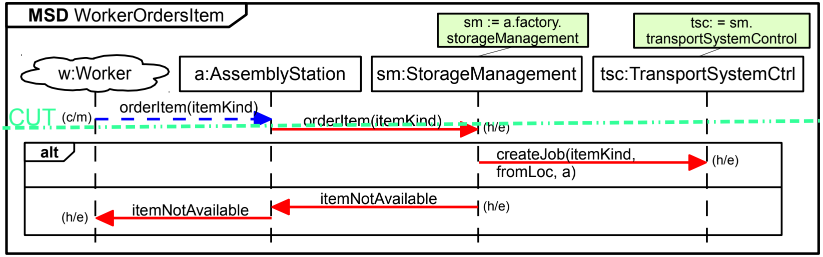

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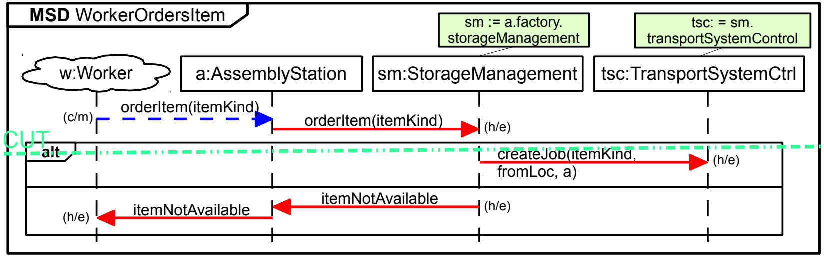

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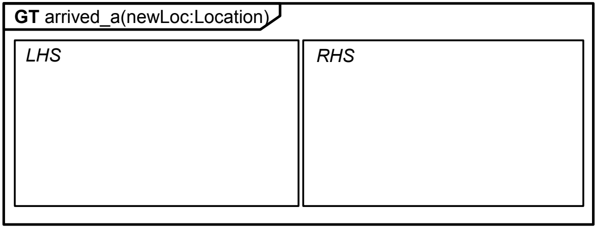
Graph Transformation Rules



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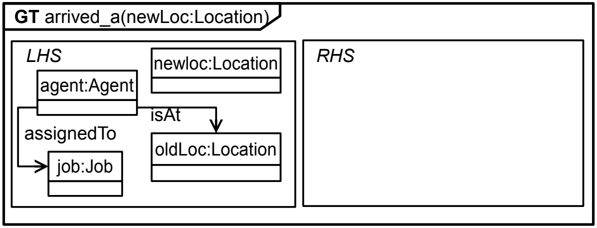

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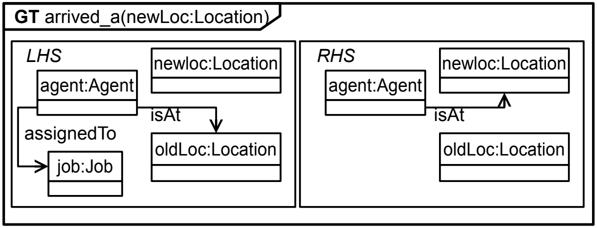

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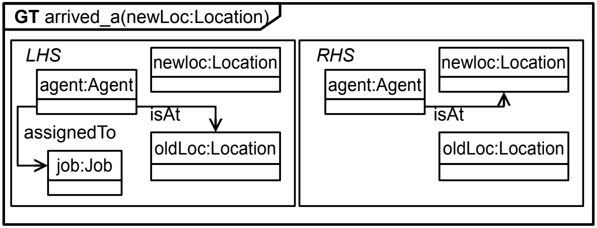
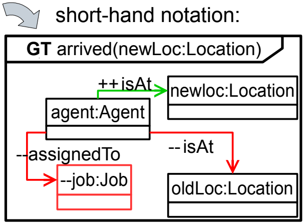


short-hand notation:



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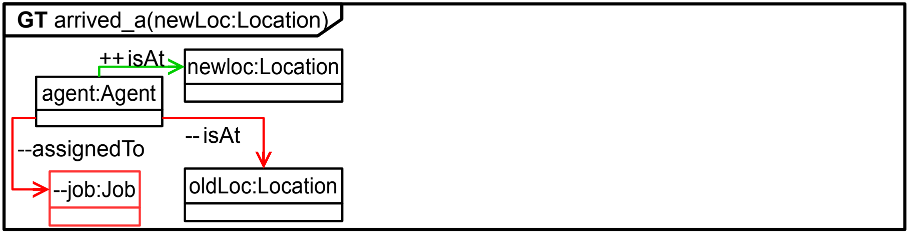

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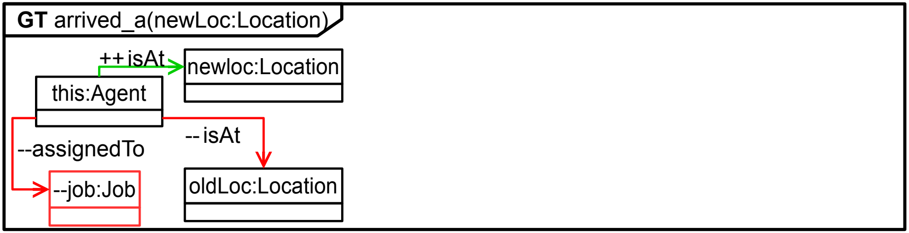

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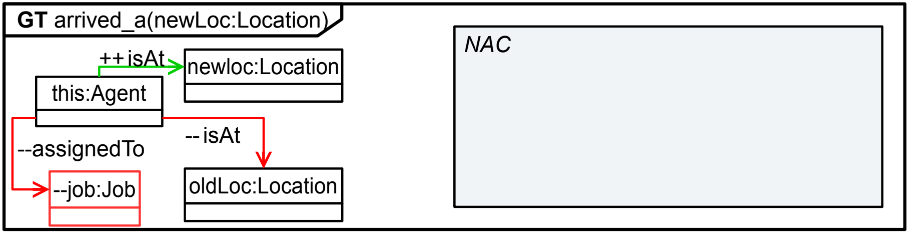

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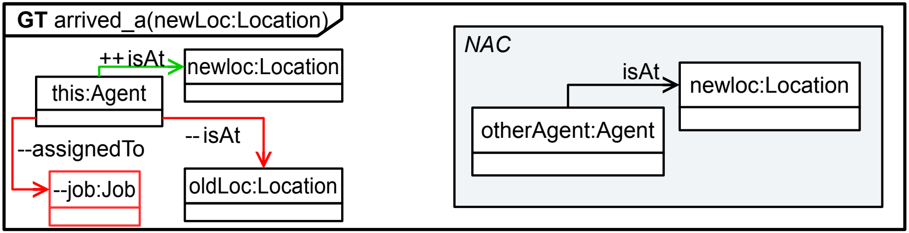

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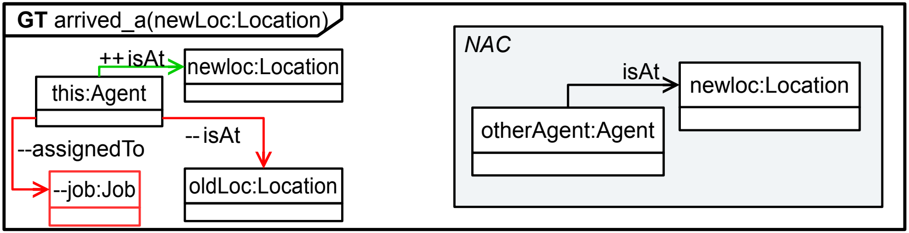
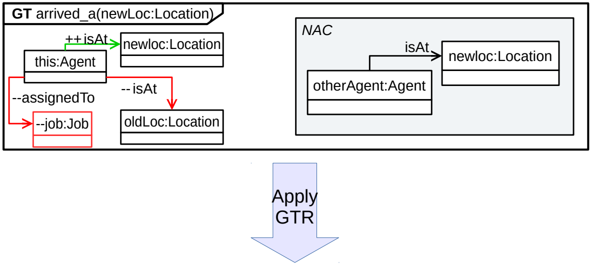
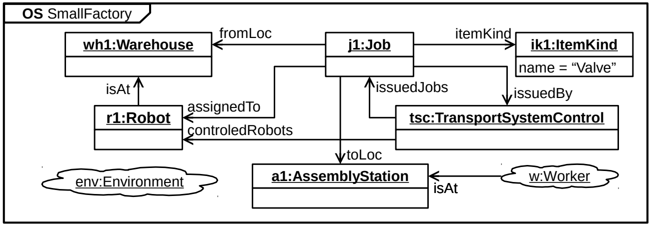


- Complex structural changes (as implementation of an operation)

Applying Graph Transformation Rules





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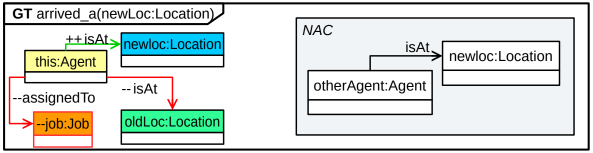

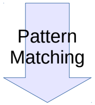

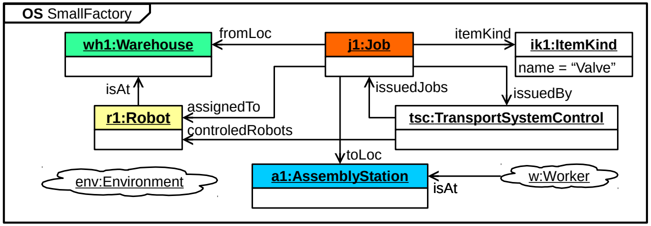

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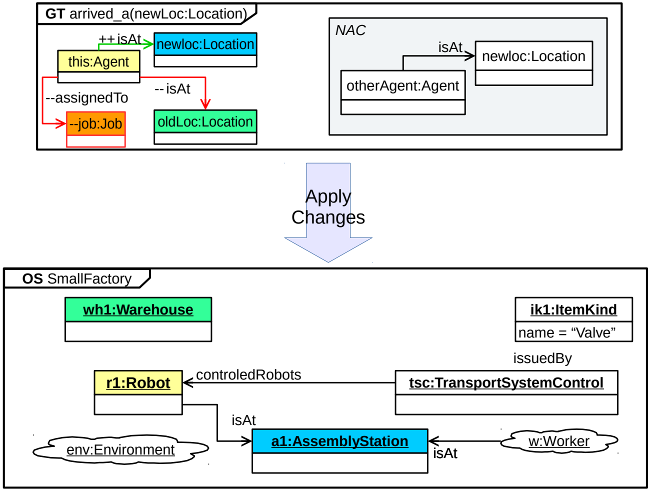
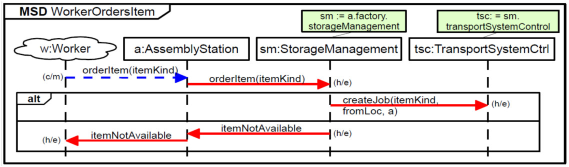


Integration?



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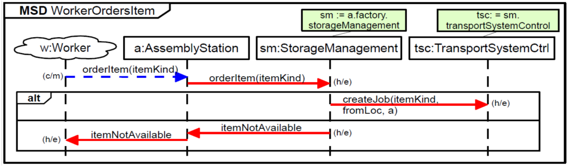

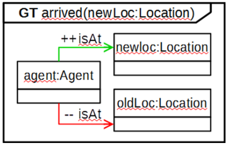

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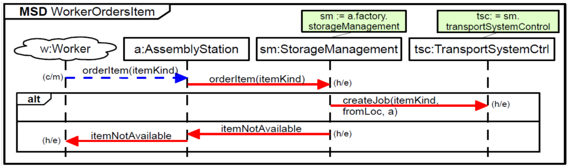

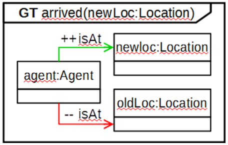

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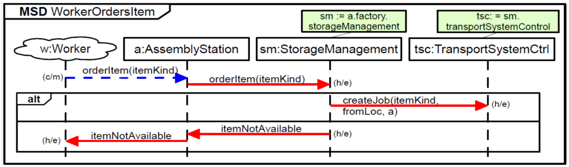

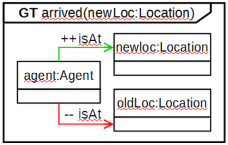

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Integration by influence: MSDs and GTRs influence each other!

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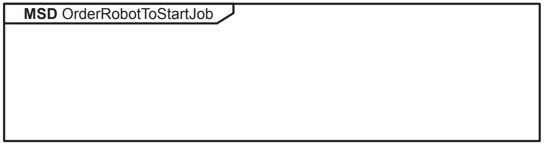
$\Rightarrow$ **Events trigger GTRs**

- GTRs constrain allowed sequences of events
- If precondition for applying a GTR is not satisfed

$\Rightarrow$ **An inexecutable GTR leads to a safety violation**

Integration by Example: Order a Robot to Start a Job



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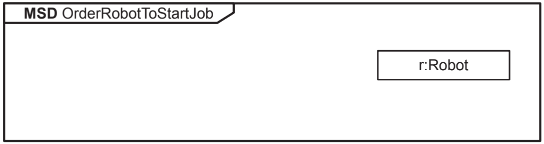

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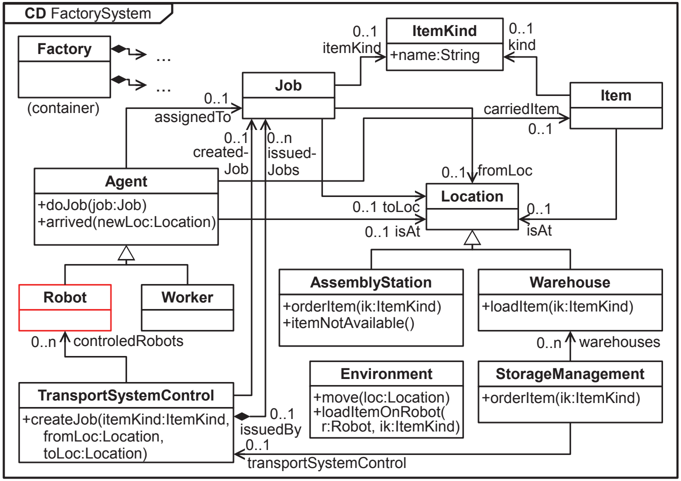

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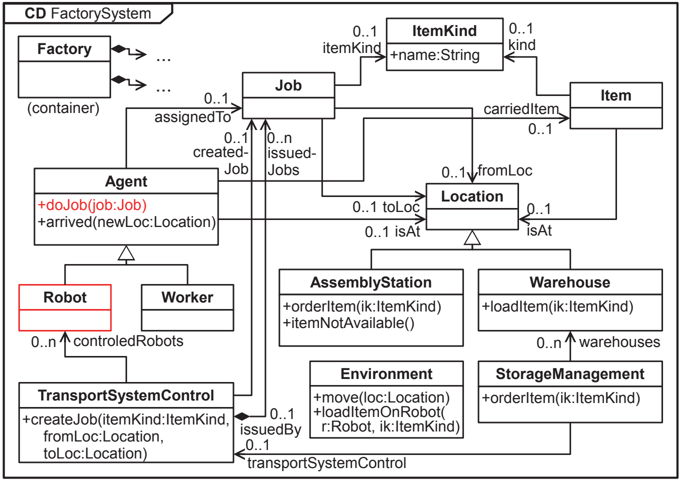

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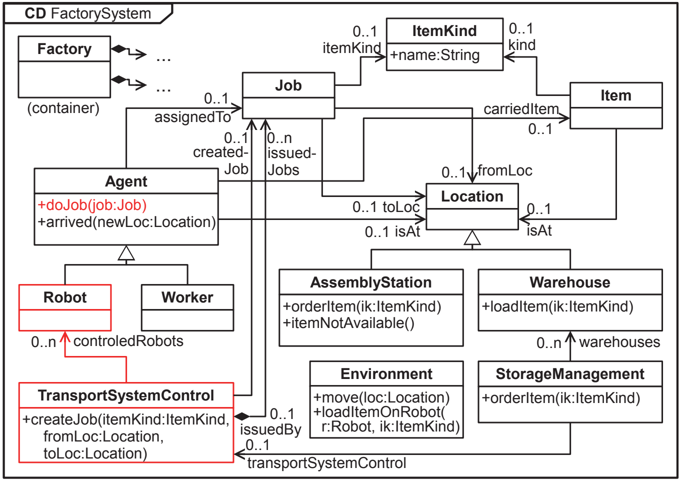

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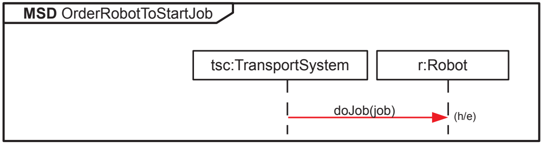

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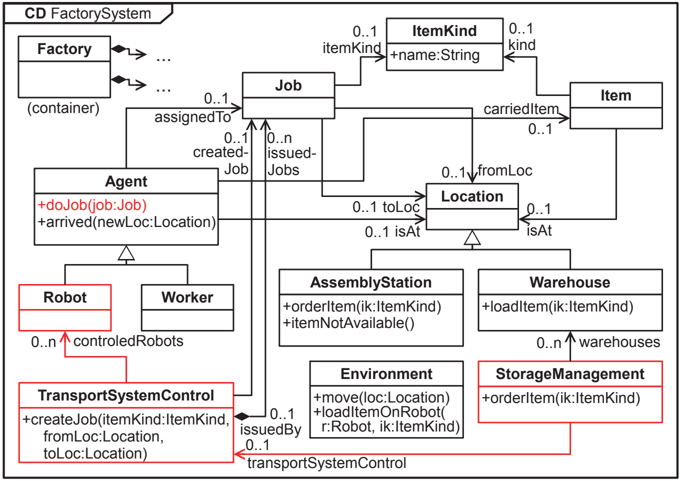

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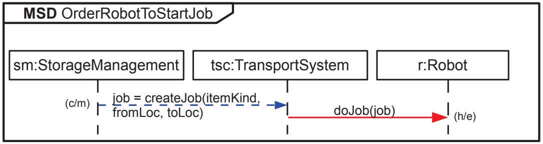

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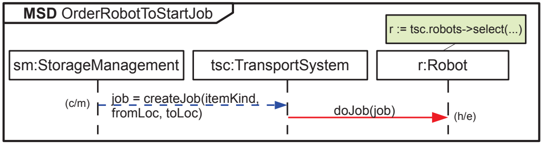

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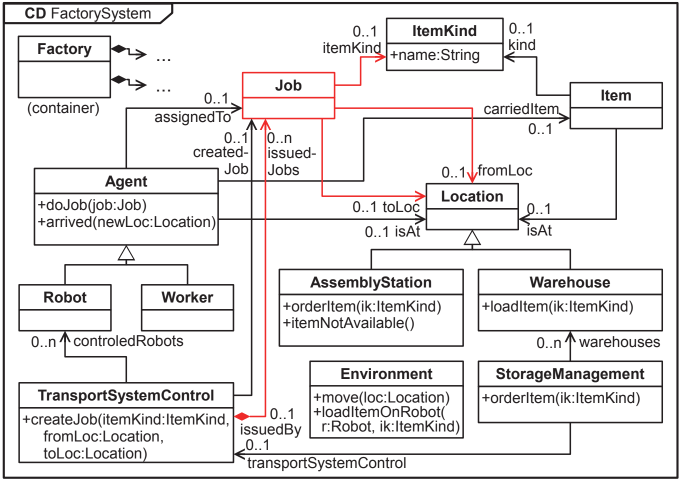

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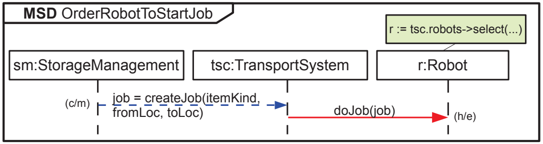

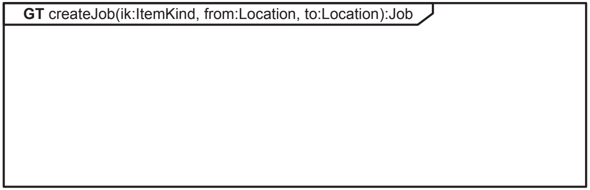

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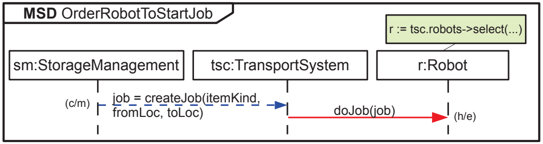

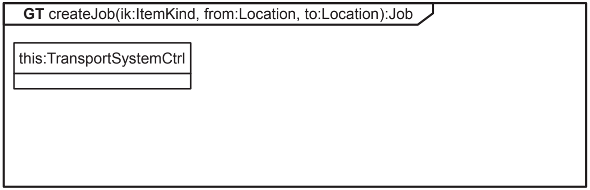

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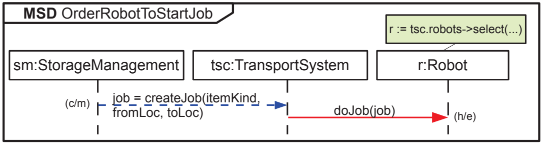

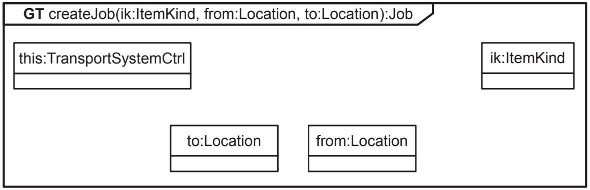

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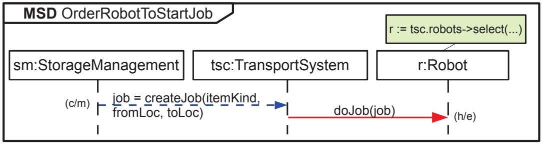

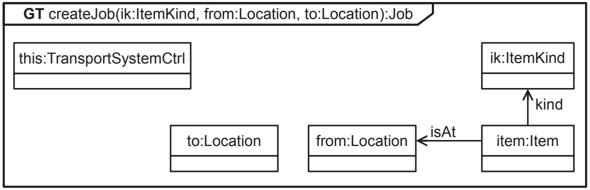

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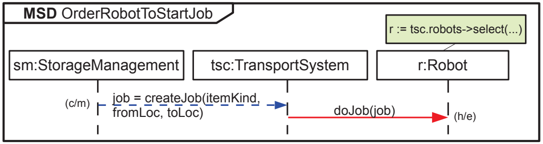

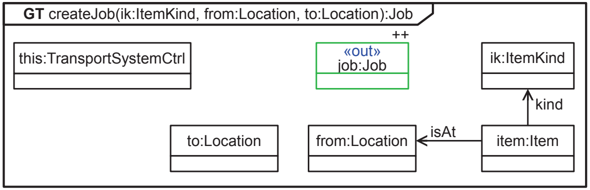

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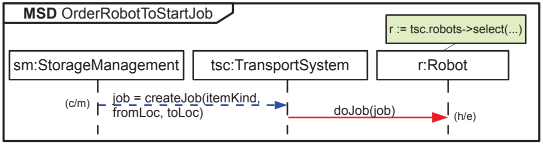

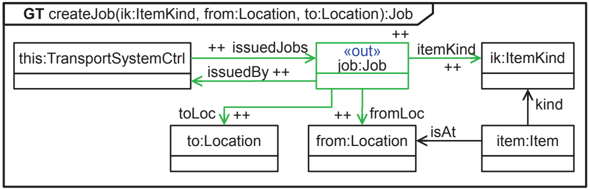

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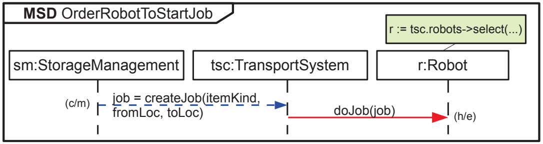

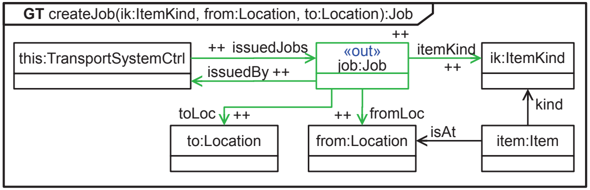

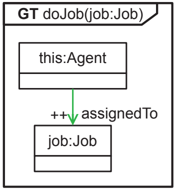

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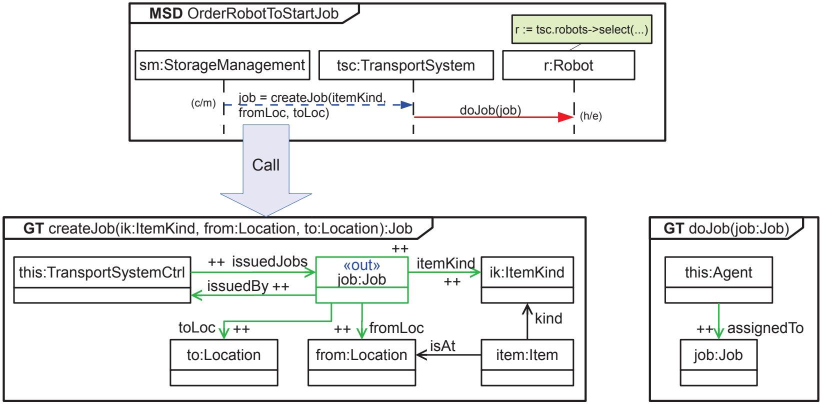

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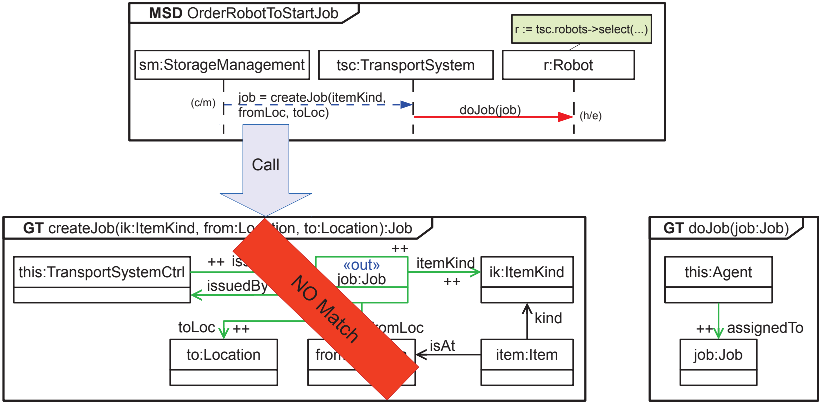
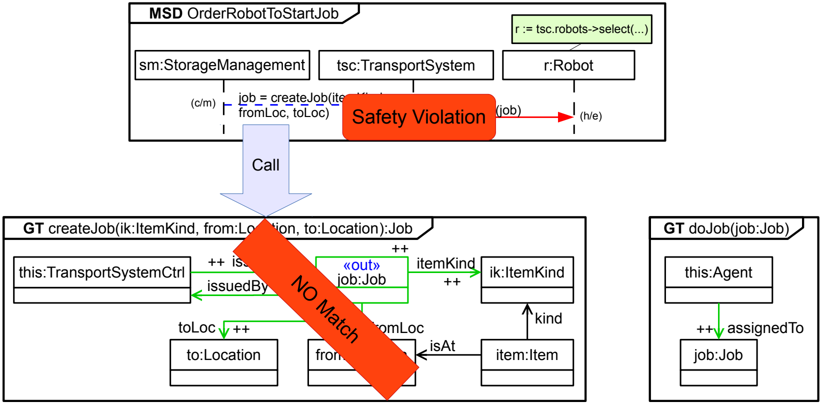


Integration by Example: Execution



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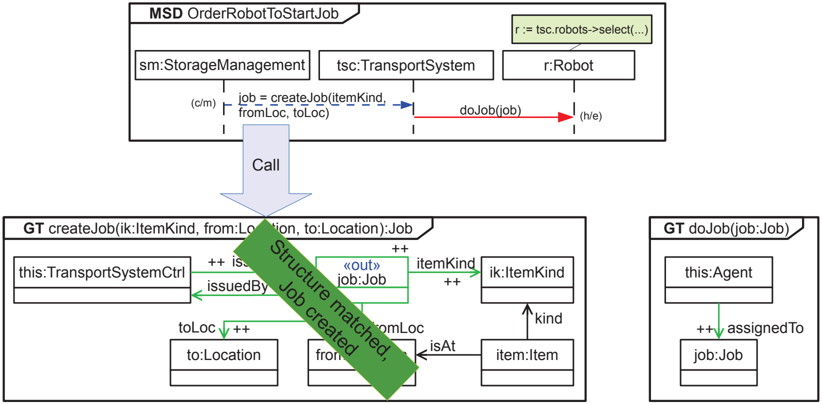
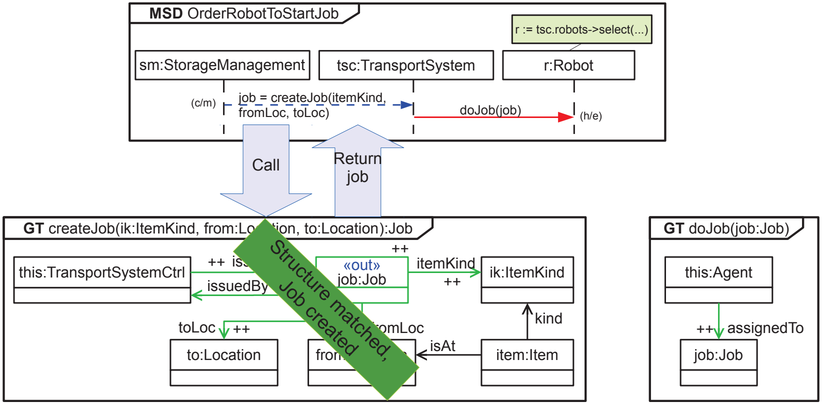
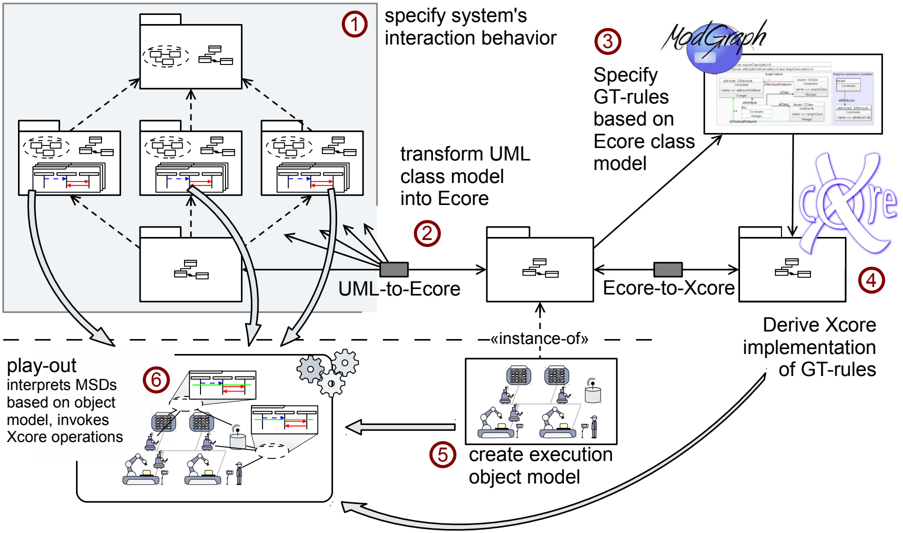


Integration by Example: Execution



Tool Interaction


1
specify system's interaction behavior
2
transform UML class model into Ecore
UML-to-Ecore
3
Specify GT-rules based on Ecore class model
ModGraph
Xcore
4
Ecore-to-Xcore
Derive Xcore implementation of GT-rules
«instance-of»
5
create execution object model
6
play-out
interprets MSDs based on object model, invokes Xcore operations

Related Work

- MechatronicUML:
  - A design method for self-adaptive mechatronic systems
  - Interaction is defined by intra-component state machines

$\Leftrightarrow$ We use inter-component scenario models

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  - Use a set of simple graph transformation scenarios as input
  - All similar graph transformations are mapped to a common state in the state machine
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$\Leftrightarrow$ The two-folded interaction of GTRs and MSDs is one of our main considerations

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None of the them rigorously supports the reconfiguration of the participating objects or components at run-time

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$\Rightarrow$ Support for interactive and incremental specification of message-based interaction behavior and structural system reconfiguration behavior

$\Rightarrow$ **Integration of intuitive modeling paradigms, supported by prototype Tool.**

Thanks!

Thank you for your attention!

Questions