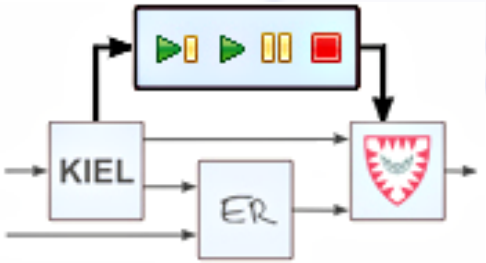
Model Execution and Meta Layout in Eclipse

Snapshots of the KIELER Project

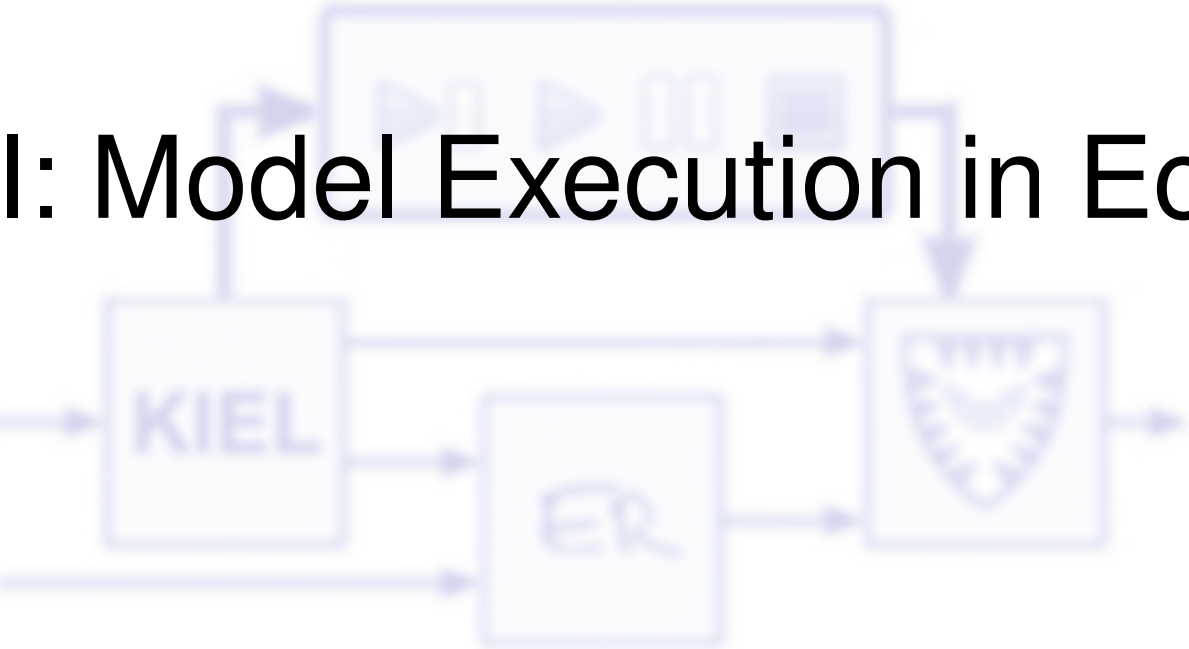
Christian Motika and Miro Spönemann

Real-Time Systems and Embedded Systems Group
Department of Computer Science
Christian-Albrechts-Universität zu Kiel, Germany



Eclipse Summit, 08/27/2009

Part I: Model Execution in Eclipse



Motivation

- EMF and GMF are great frameworks for modeling in Eclipse
- Model implementations, model and diagram editors, ...
- Modeling:
  1. Structural models
     - E.g., class diagrams, component diagrams, ...
  2. Behavioral models
     - E.g., flow charts, state machines, data flow models, ...

Motivation (cont'd)

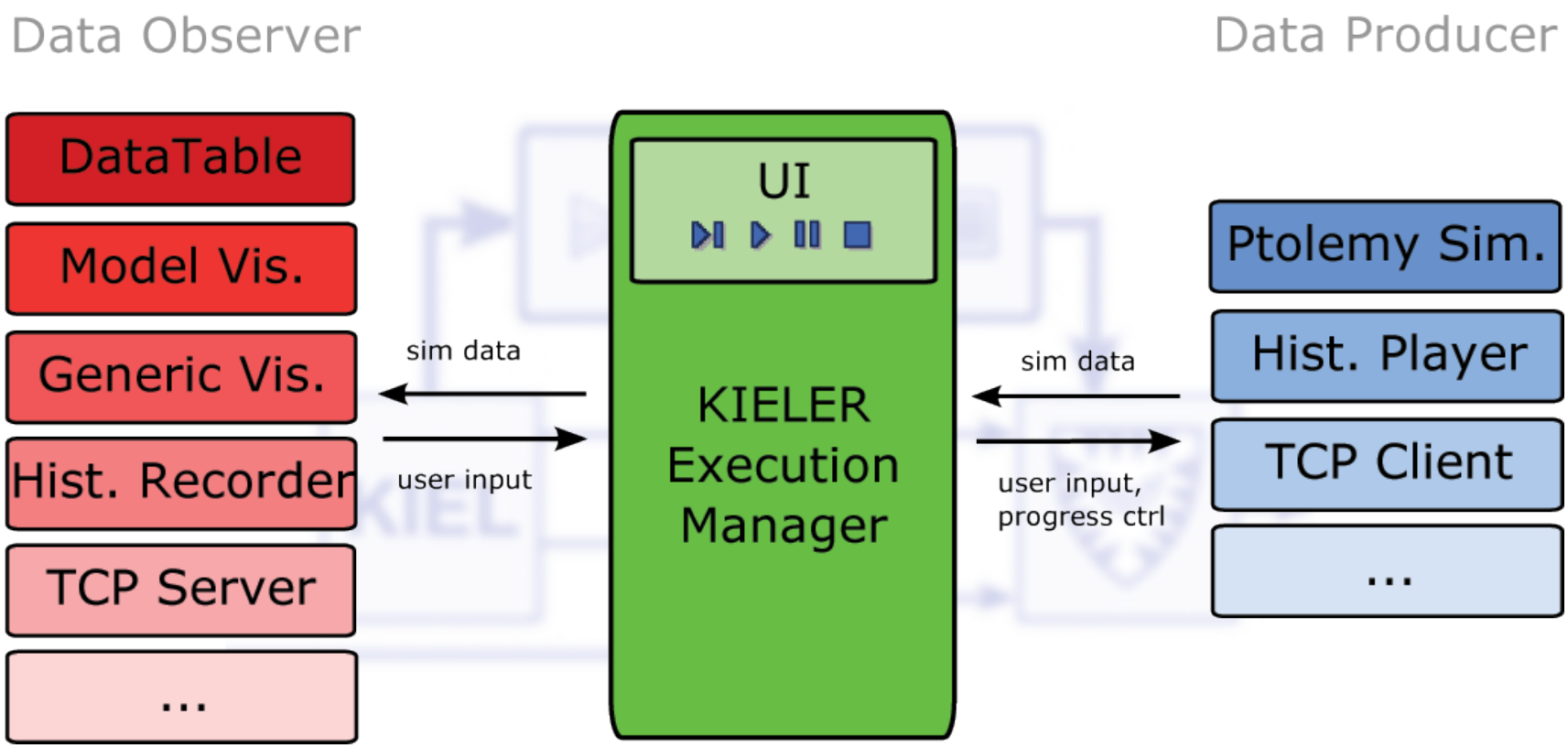
System models are virtual as opposed to physical systems

- System models
  - Generate code or documentation
  - System analysis and verification
  - Simulation runs
  - ...
- **Idea:** Flexible definition of semantics and swapping out of simulation computation
- **Solution proposed:** KIELER Execution Manager

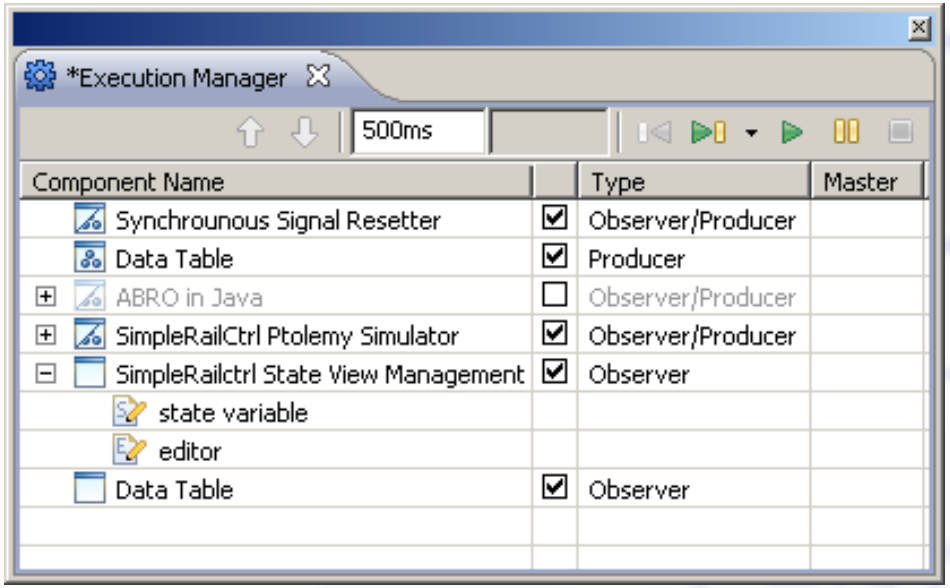
Overview

- KIELER Execution Manager
- Use case: Ptolemy
  - M2M transformation
  - Simulation engine
- Use case: Model Railway
  - Installation
  - Railway Controller DSL
  - SimpleRailCtrl editor *(DEMO)*
- Summary

KIEM Components



KIEM GUI and Threads



- DataObserver vs. DataProducer
- Scheduling & DataPool
- Properties
- Execution Buttons
- Master

Simple Interface

```
1  public interface IDataComponent {
2
3     public void initialize() throws KiemInitializationException;
4
5     public void wrapup() throws KiemInitializationException;
6
7     public boolean isProducer();
8
9     public boolean isObserver();
10
11    public JSONObject step(JSONObject jSONObject)
12                              throws KiemExecutionException;
13
14 }
```

Flexible Extensions

```
1  public abstract class DataComponent implements IDataComponent,
2                                     IExecutableExtension {
3
4     public boolean isMultiInstantiable() {return false;}
5
6     public String[] provideFilterKeys() {return null;}
7
8     public KiemProperty[] provideProperties() {return null;}
9
10    public void checkProperties(KiemProperty[] properties)
11                                throws KiemPropertyException {}
12
13    public String[] provideInterfaceKeys() {return null;}
14
15    public boolean isHistoryObserver() {return false;}
16
17    public boolean isDeltaObserver() {return false;}
18
19    public boolean isMaster() {return false;}
20
21 }
```

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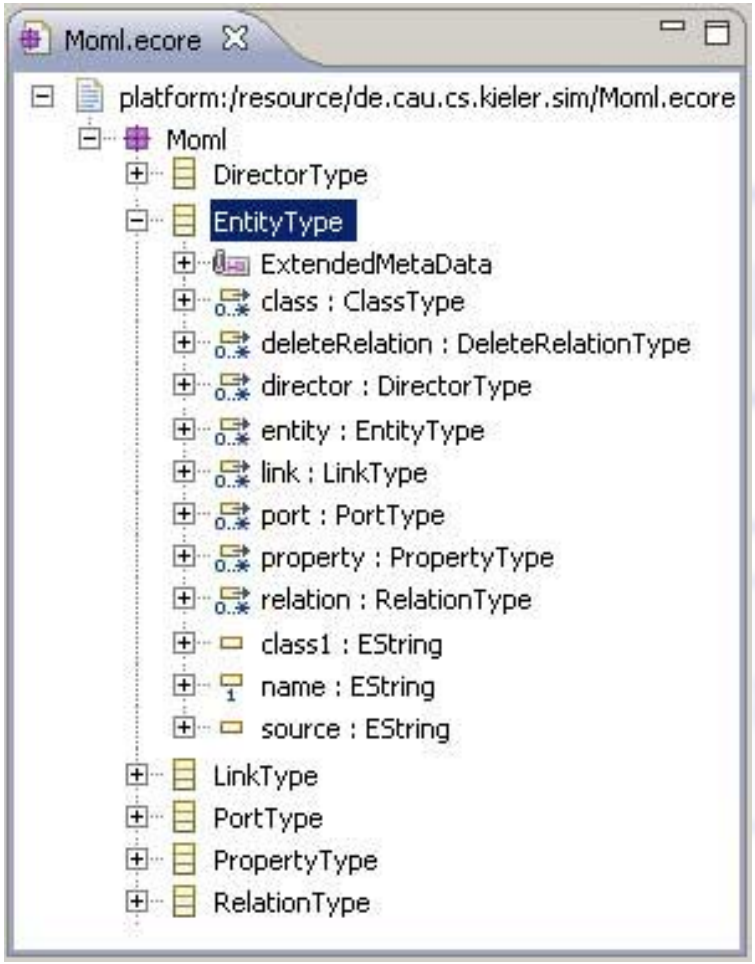
What is Ptolemy?

- „The Ptolemy project studies heterogeneous modeling, simulation, and design of concurrent systems.“

  Introduction to Ptolemy II, UC Berkeley

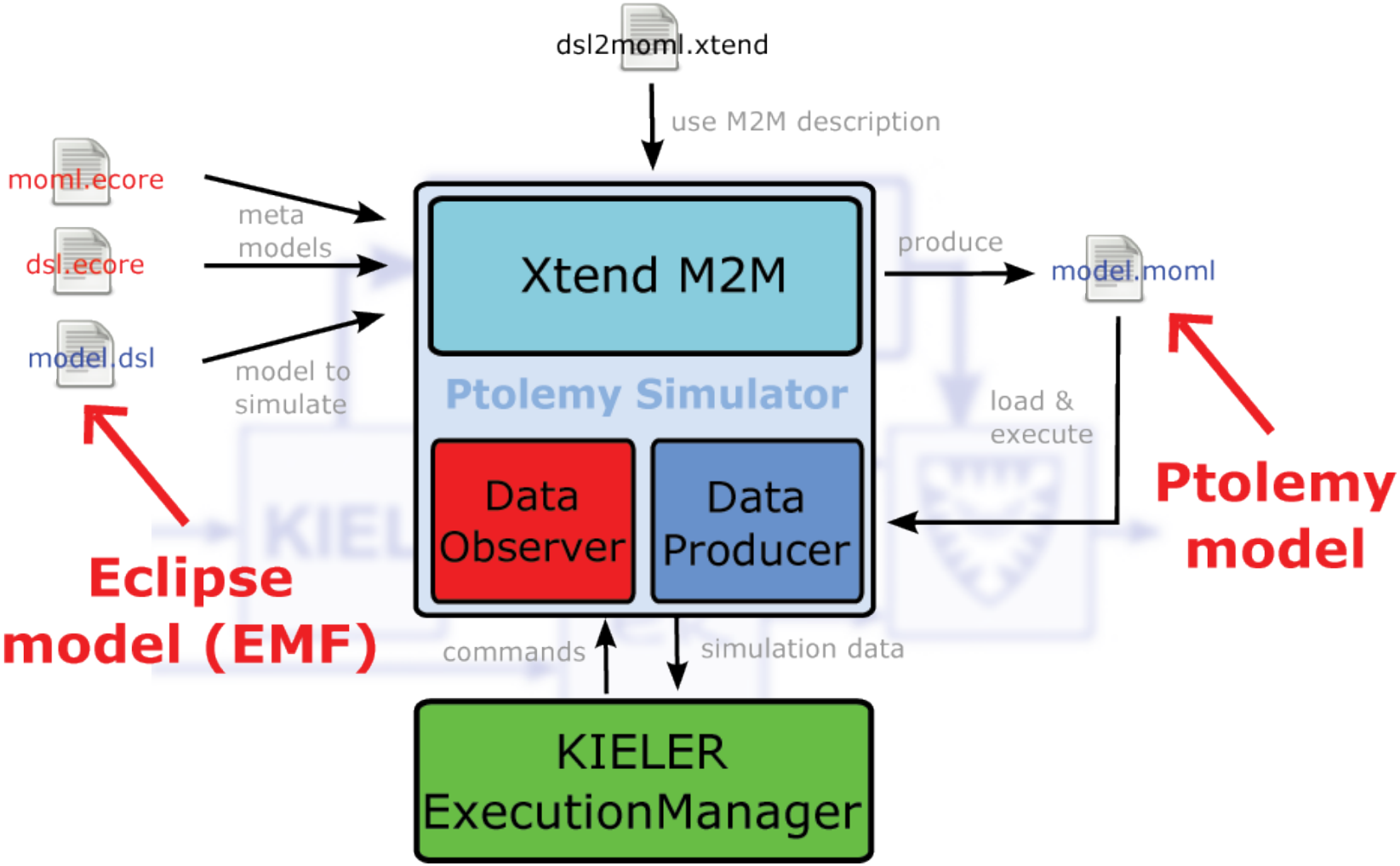
- Executable models to describe behavior of reactive systems
- Set of components interacting under a *model of computation*
- → *Actor-Oriented Design*

Ptolemy EMF Model



- Ptolemy models can be executable
- DTD of the Ptolemy XML representation *(MOML)*
  - Acquire EMF model
  - M2M transformation
  - Execute Ptolemy models
  - Back mapping of data/states

Simulation with Ptolemy



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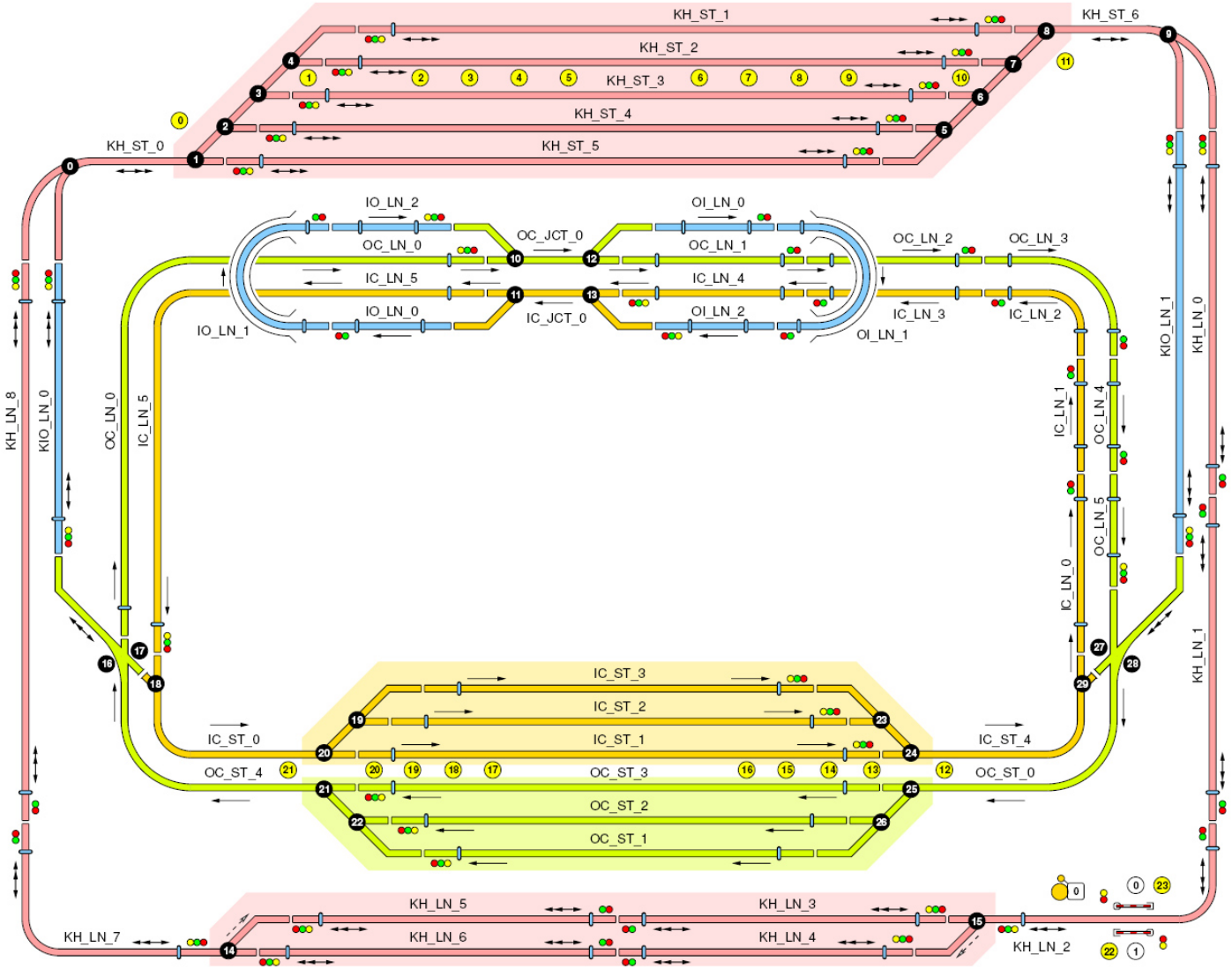
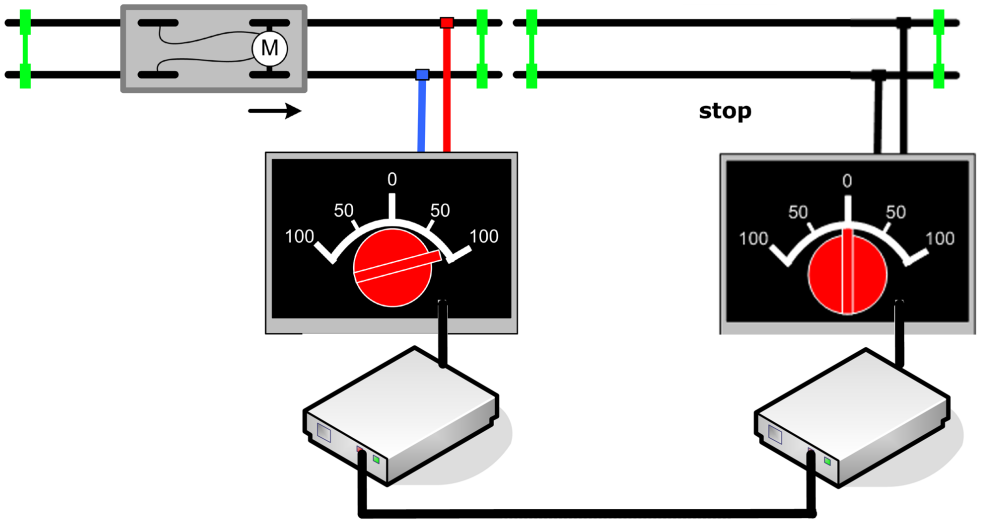
Installation

- Standard model railway equipment combined with
- Over 200 sensors and actuators
- Controlled by distributed computer system

Track Layout

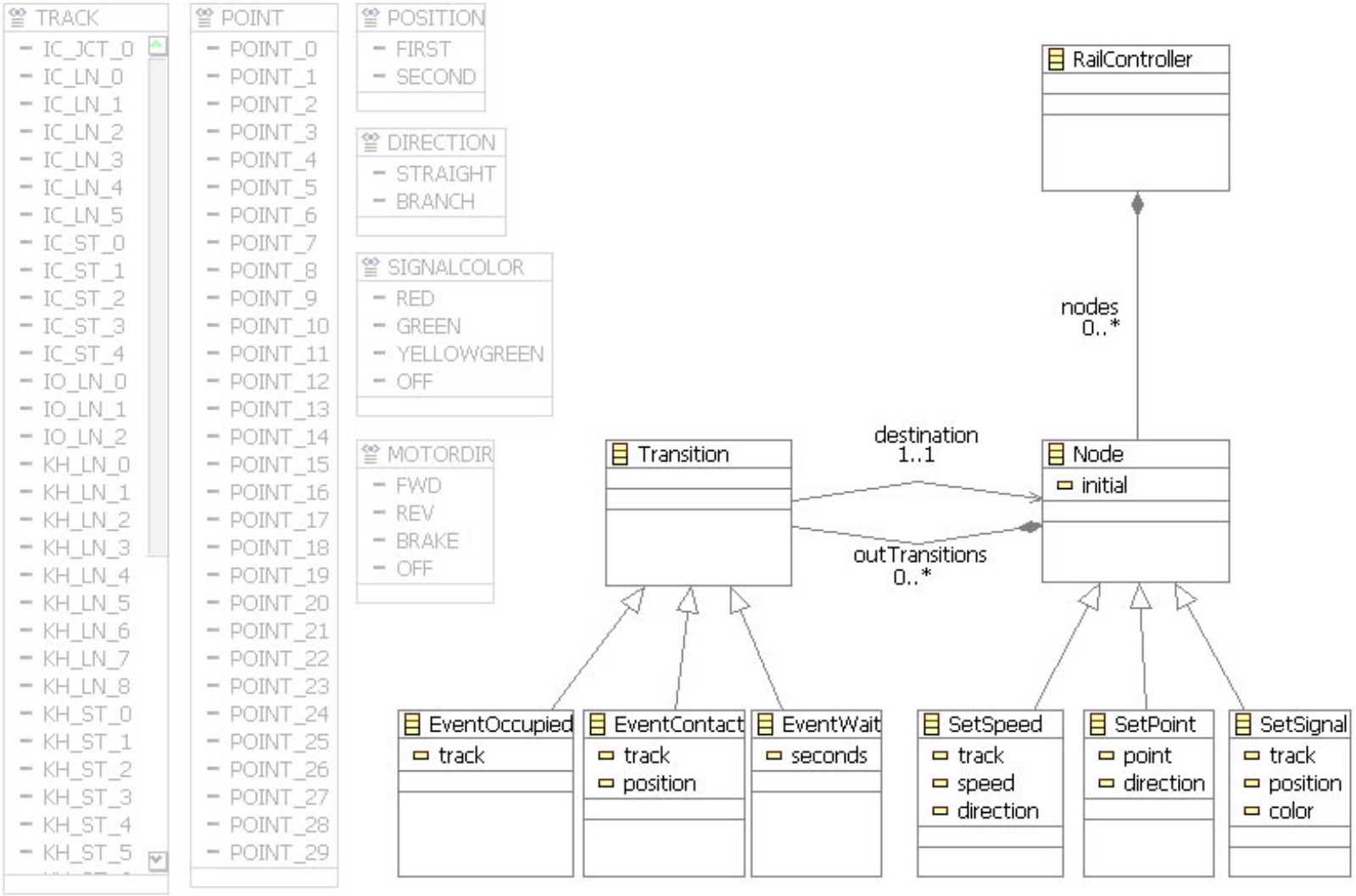


Train Movement

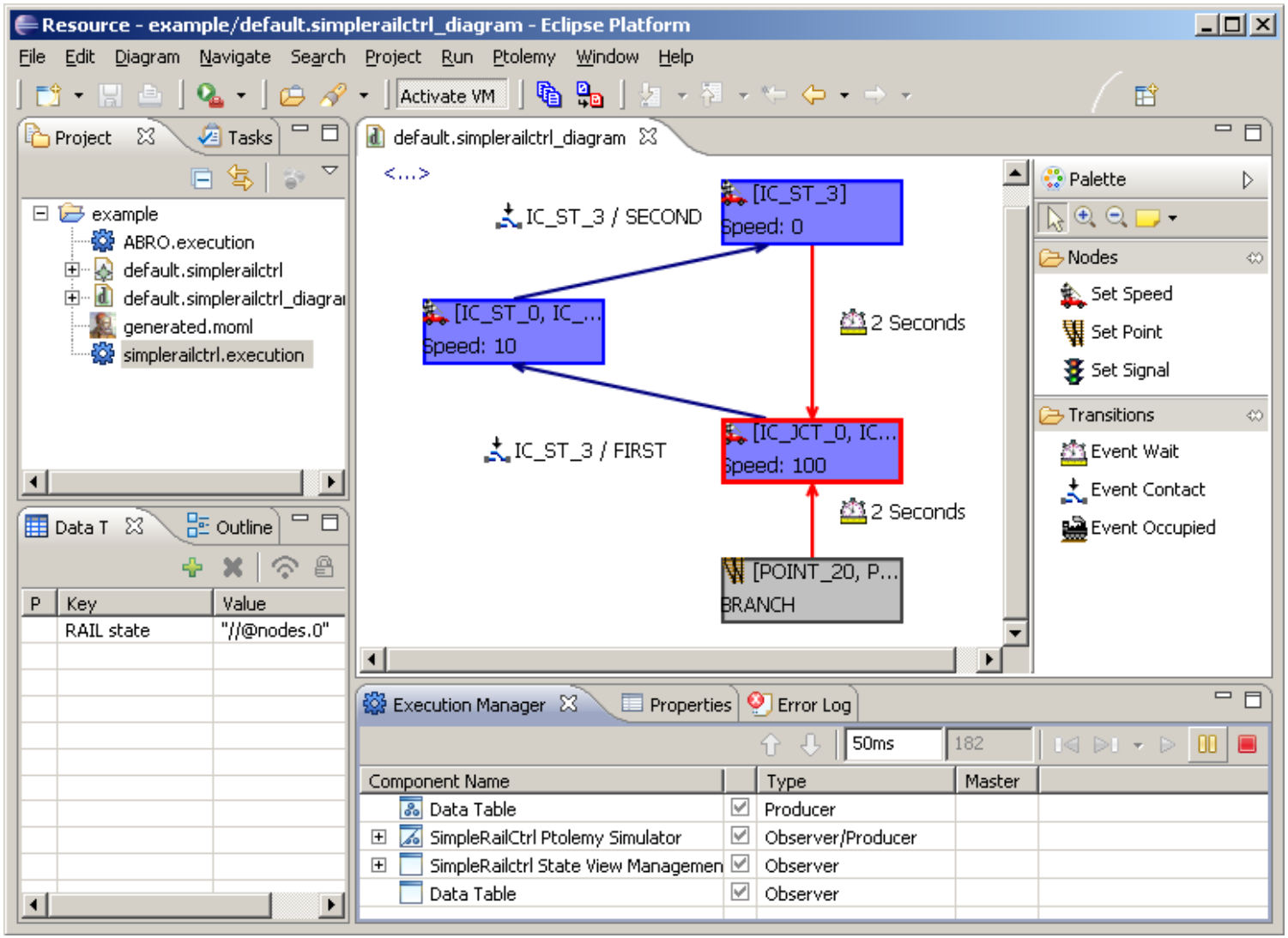


- Several track segments individually controlled
- Computers get sensor information (instantaneous train positions) and control voltage
  - ⇒ Actions: SetSpeed, SetPoint
  - ⇒ Trigger: EventContact, EventTimeout

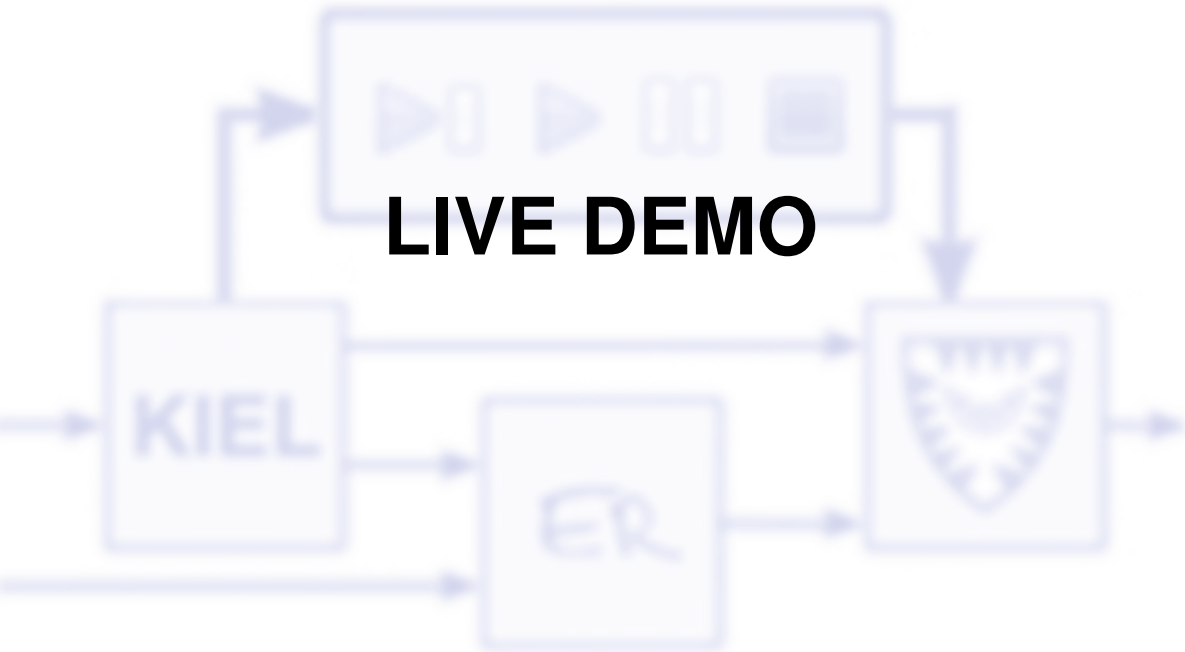
EMF Meta Model



Generated GMF Editor



Eclipse Model Execution Demo



LIVE DEMO

Summary

- DSLs in Eclipse represented by EMF models
  - Often only implicit execution semantics!
- Ptolemy models can be executable
  - Xtend M2M transformation helps making semantics explicit
- Other simulator DataComponents imaginable
- KIELER Execution Manager seamlessly integrates execution into the Eclipse RCP

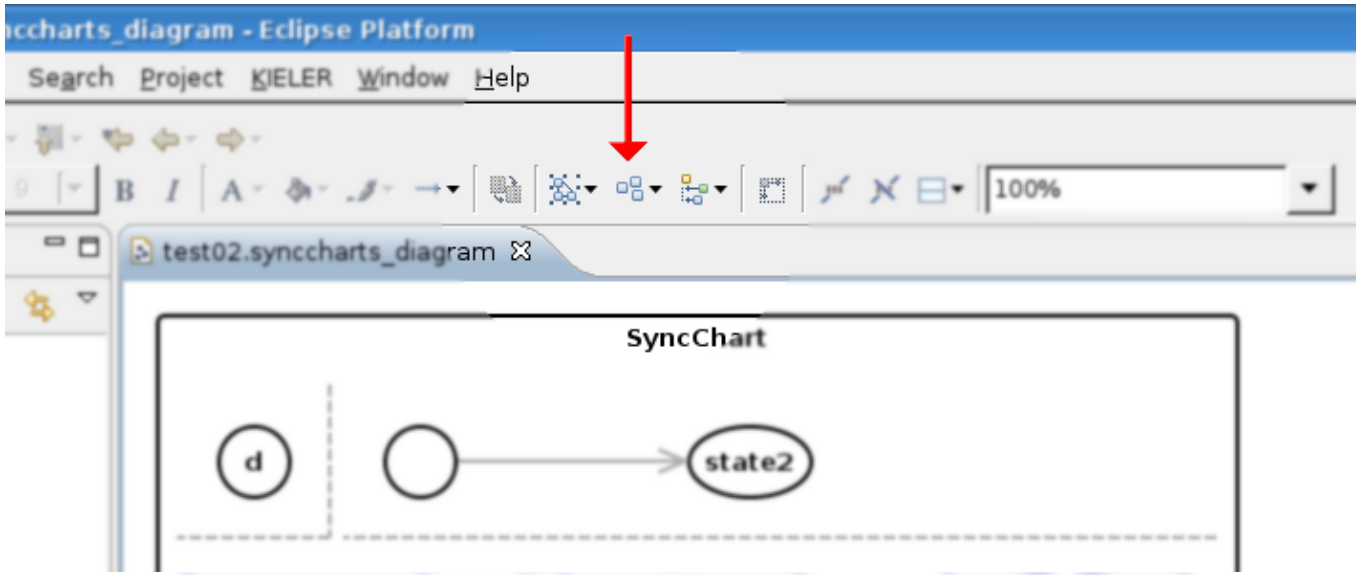
To Go Further

- UC BERKELEY, EECS DEPT.
  Ptolemy webpage.
  http://ptolemy.eecs.berkeley.edu/.
- UNI KIEL, REAL-TIME AND EMBEDDED SYSTEMS GROUP.
  KIELER webpage.
  http://www.informatik.uni-kiel.de/en/rtsys/kieler/.

Part II: Meta Layout of Graphical Models

Automatic Layout in GMF

- GMF supports automatic layout...



- ...but is not very flexible
  - No selection of different layout algorithms
  - No customization of layout options
  - No deep layout of compound structures

KIELER Meta Layout

- Meta Layout: Allow fully flexible automatic diagram layout
  - Contribute new layout algorithms using extension points
  - Customize layout options in the properties view
  - Layout compound structures recursively
  - Layout different parts of a diagram with different options, or even with different layout algorithms
- Development of special layout algorithms, e.g. for data flow diagrams

Layout Providers

Extension points are used to

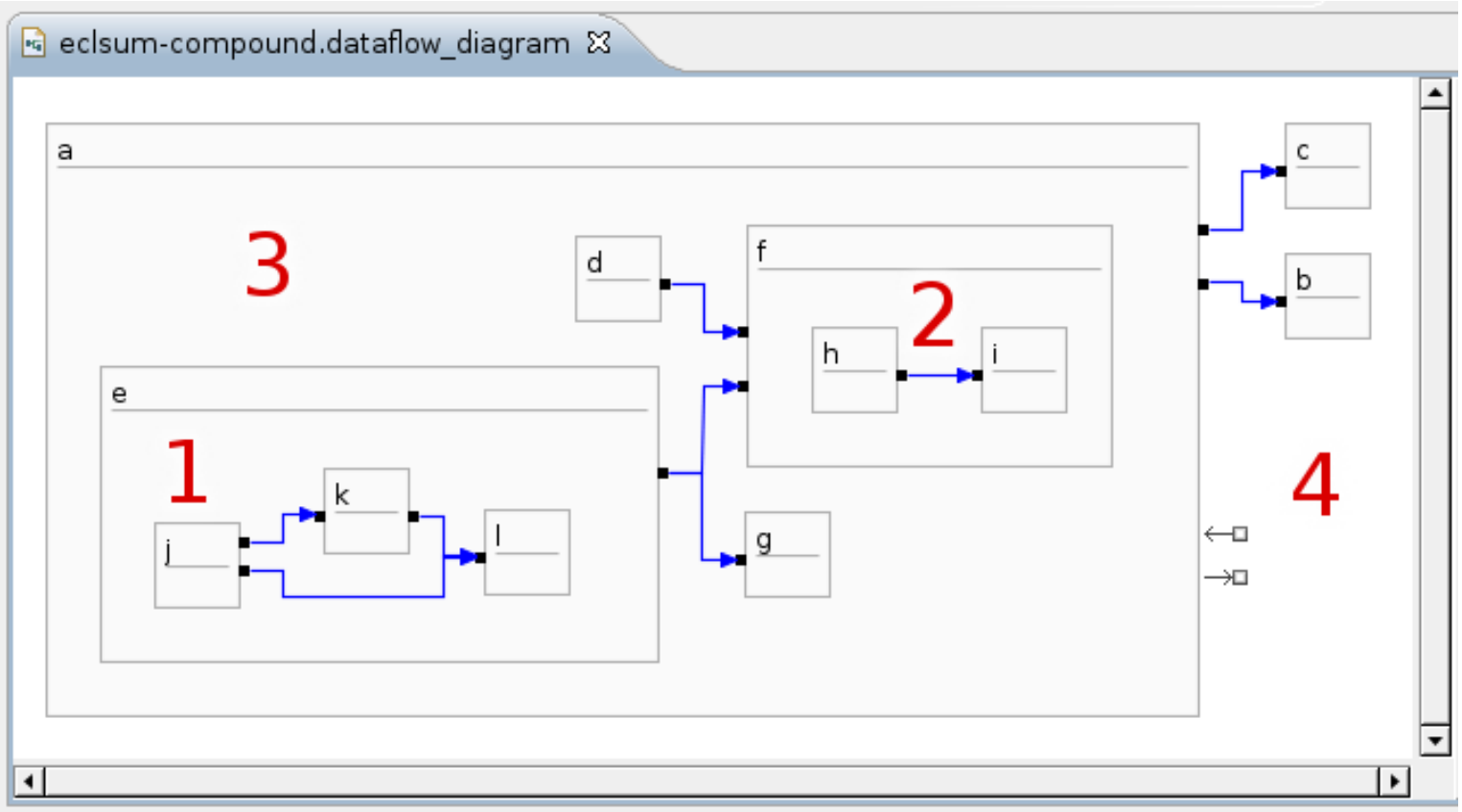
- define diagram types
  - state machine, class diagram, etc.
- assign diagram types and layout options to specific parts of a GMF diagram
  - e.g. assign the “class diagram” type to the diagram edit part of a class diagram editor
- contribute new layout algorithms
  - call these contributions layout providers
- define which diagram types are supported by the layout provider
- define new layout options and specify which options are understood by a layout provider

Custom Layout Options

- To be implemented soon...

Compound Structures

- Apply layout providers recursively



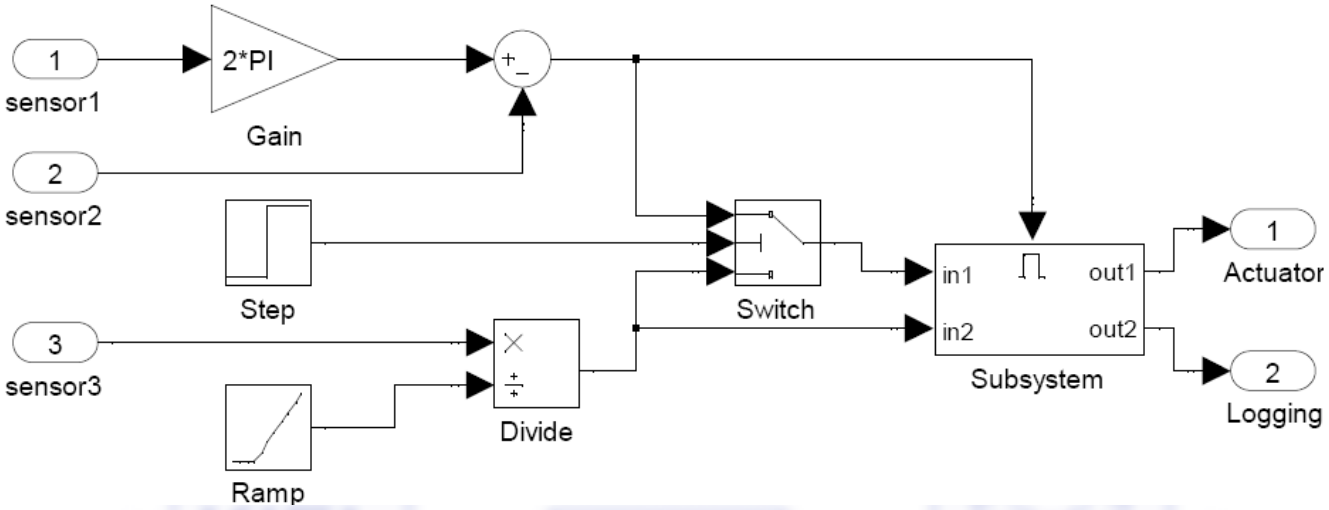
Meta Layout

Live Demo...

Diagram Layout

- Layout providers work on an internal graph structure generated with EMF
- Need to map the contents of a diagram to the internal structure and back
- Done by Layout Managers using the GEF command / request pattern
- Currently only a layout manager for GMF is implemented
  - Analyzes the edit part structure at runtime
  - Recursively go into the contents of an edit part to explore compound structures
- Extension to other diagram editor generation frameworks is possible

Data Flow Diagrams



- Operators exchange data through ports
- Layout algorithms must respect these ports when routing connections

Data Flow Diagrams: Special Algorithm

- Developed a special algorithm to layout data flow diagrams
- Internal graph structure supports ports
- Integrated in the KIELER Meta Layout
- Also available as stand-alone library, successfully applied to Ptolemy

Summary

- KIELER Meta Layout provides flexible automatic diagram layout
  - Customize layout algorithms and layout options
- Current implementation is able to layout all GMF diagrams
- Implemented a special layout algorithm for data flow diagrams