Interactive Esterel to SyncCharts Transformation
for executing Esterel with Ptolemy

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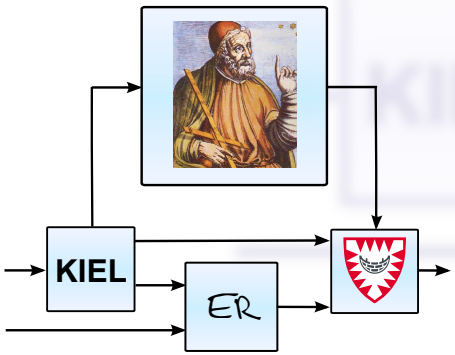
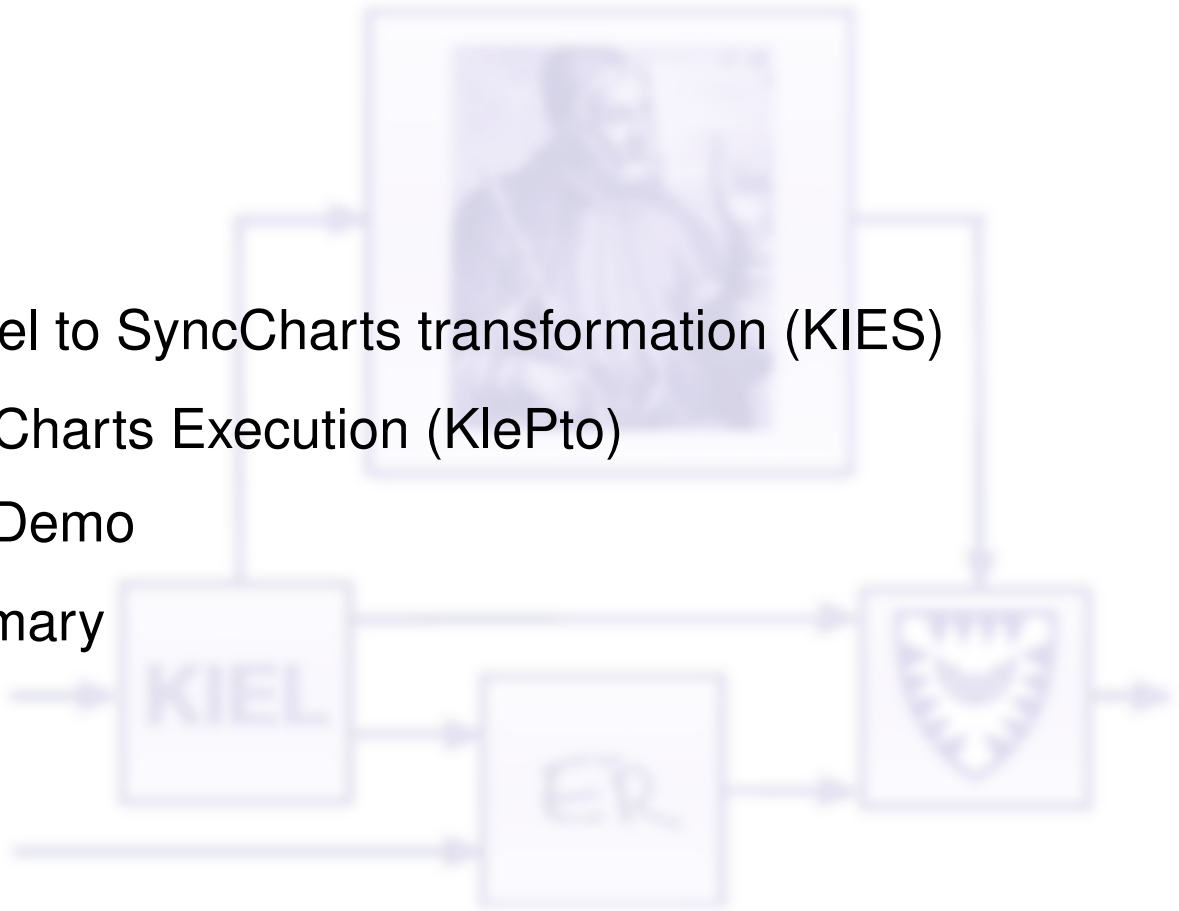


SYNCHRON '11, Dammarie-les-Lys
01. DEC 2011

Motivation

- Synchronous model of computation (MoC):
  - Esterel, SyncCharts, SC (control flow)
  - Lustre, Signal, SCADE (data flow)
  - Ptolemy (SR domain)
- SyncCharts a synchronous statechart dialect
  - $\rightarrow$ Primary example for KIELER framework
- KlePto: Executing SyncCharts w/ Ptolemy
- KIES: Esterel to SyncCharts transformation
- $\Rightarrow$ Execute Esterel w/ Ptolemy

Overview



- Esterel to SyncCharts transformation (KIES)
- SyncCharts Execution (KlePto)
  - Demo
- Summary

Esterel

```
module ABRO:

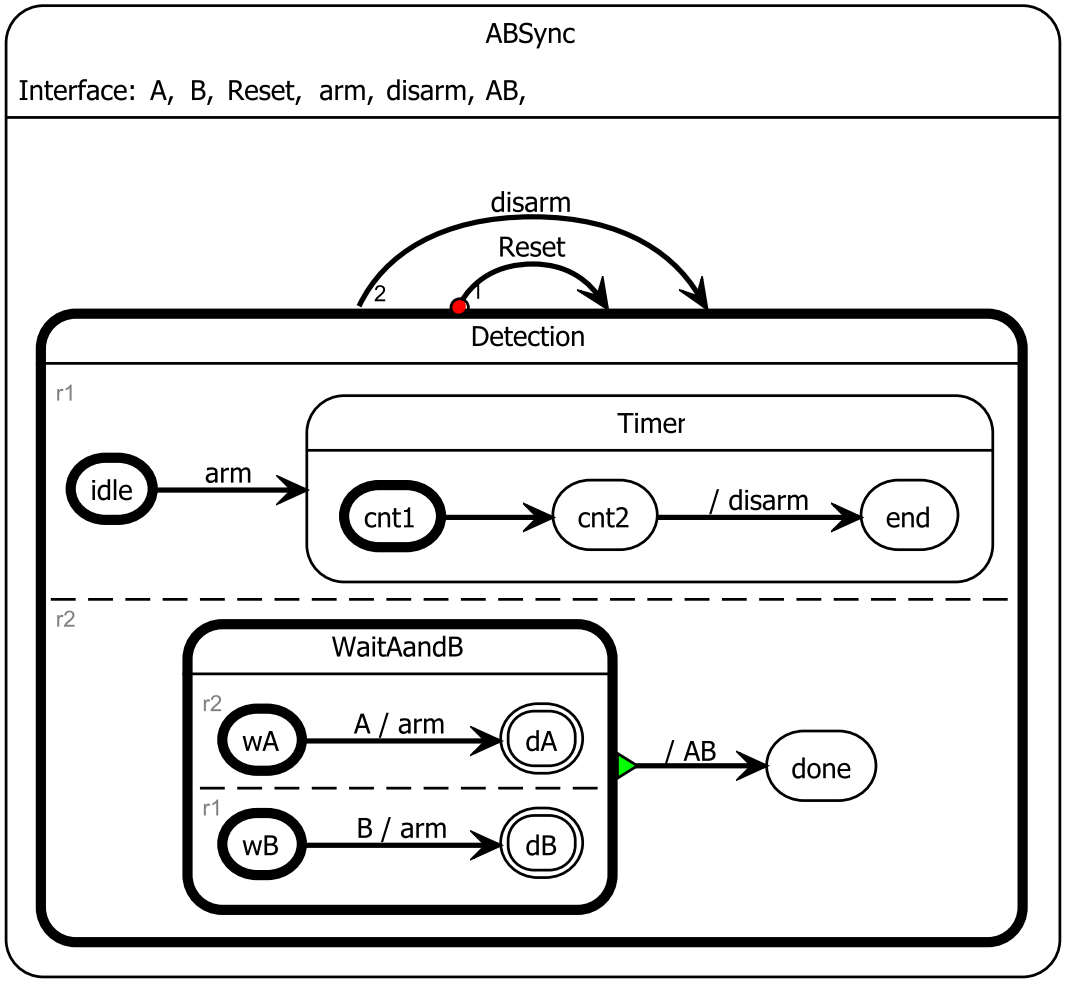
input A, B, R;
output O;

loop
    [ await A  || await B ];
    emit O;
each R

end module
```

- Synchronous, imperative, control flow language
  - Developed by J.-P. Marmorat and J.-P. Rigault
  - G. Berry developed a formal semantics for Esterel in 1983
- Synchrony hypothesis
  - Discrete ticks
  - Computations take no time
- Signal coherence rule

SyncCharts



Charles André, Computing SyncCharts Reactions, 2003

- Invented by Charles André
- Statechart dialect
- Mealy machine with
  - Parallelism, hierarchy, compound events, broadcast
- Built on Esterel semantics

Example: ABRO

```
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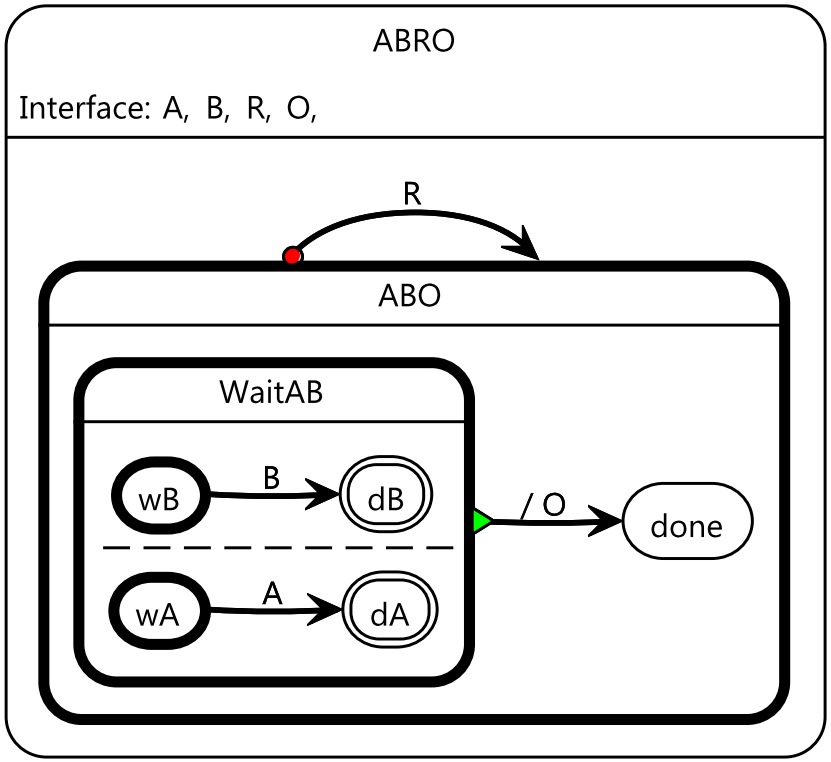
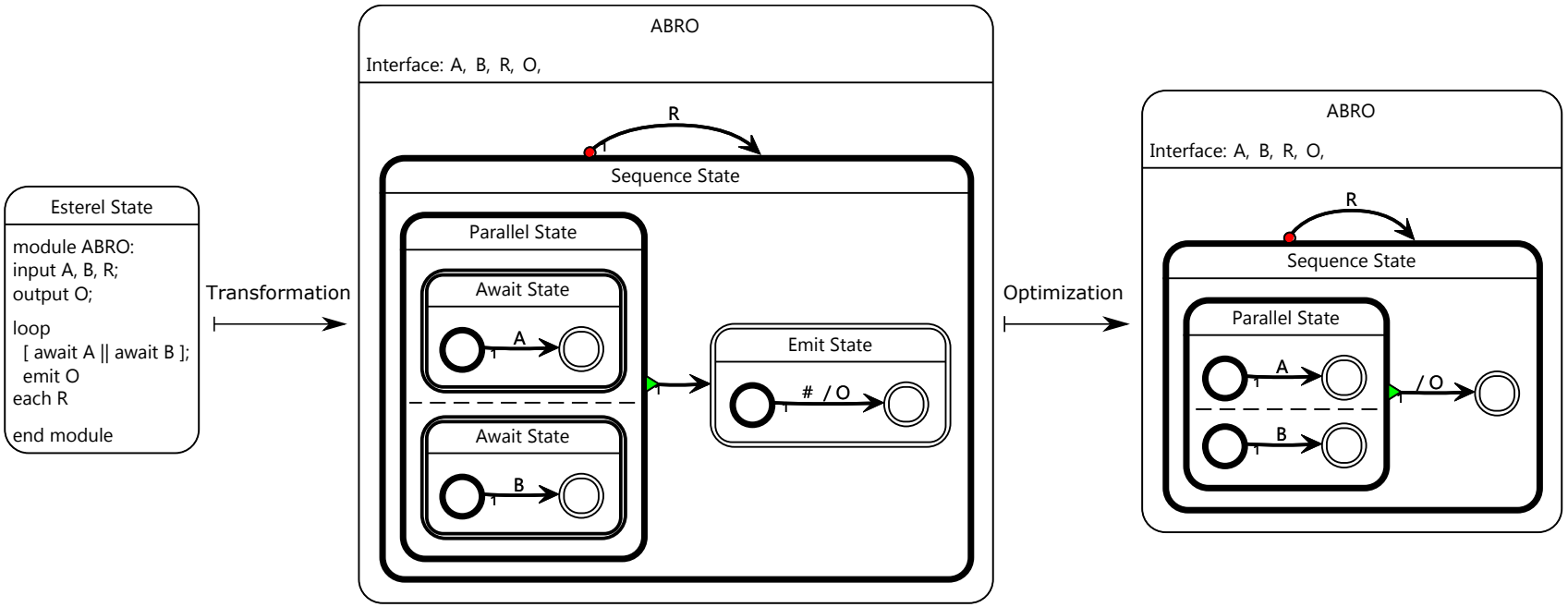


Model transformations

- Applications
  - Synthesize multiple (graphical/textual) views from one model
  - Edit a model (refactoring, optimization)
  - Code generation
  - Simulation desires
- Drawbacks
  - Large and inflexible
  - Hard to visualize
  - Hard to debug
  - Not interactive
- Goal of KIES: Address the above drawbacks
  $\rightarrow$ Use case: KIELER Esterel to SyncCharts transformation

Esterel to SyncCharts

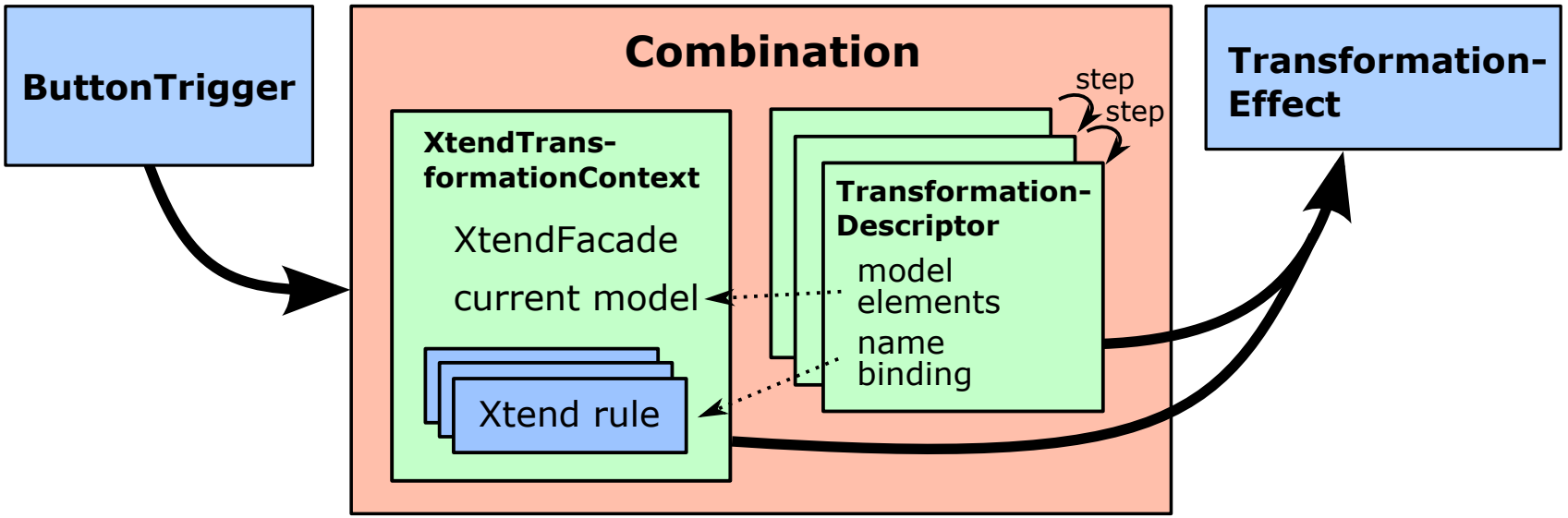


Transformation Rule

"A transformation rule is a description of how one or more constructs in the source language can be transformed into one or more constructs in the target language" (Mens and Gorp)

- Esterel to SyncCharts
  - One rule for each Esterel statement
  - Rules presented by Lars Kühl (also formal proofs for Esterel to SyncCharts)
  - [Synthesizing Safe State Machines from Esterel, LCTES 2006]
- SyncCharts Optimization
  - One rule for a SyncCharts meeting certain criteria

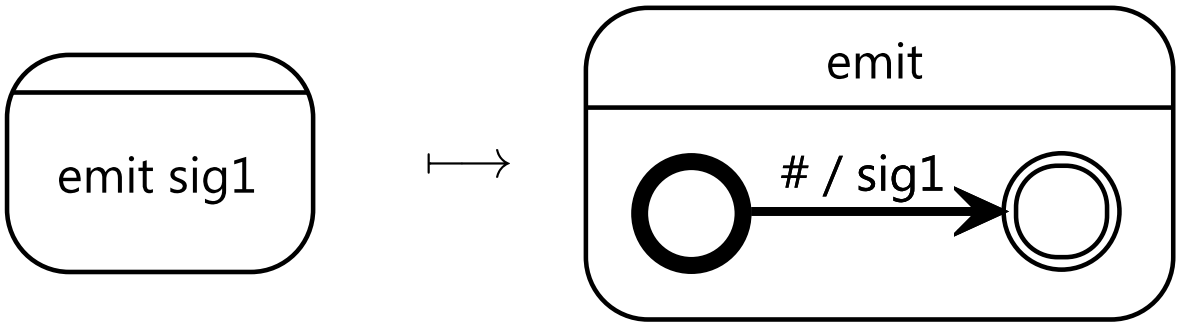
Implementation



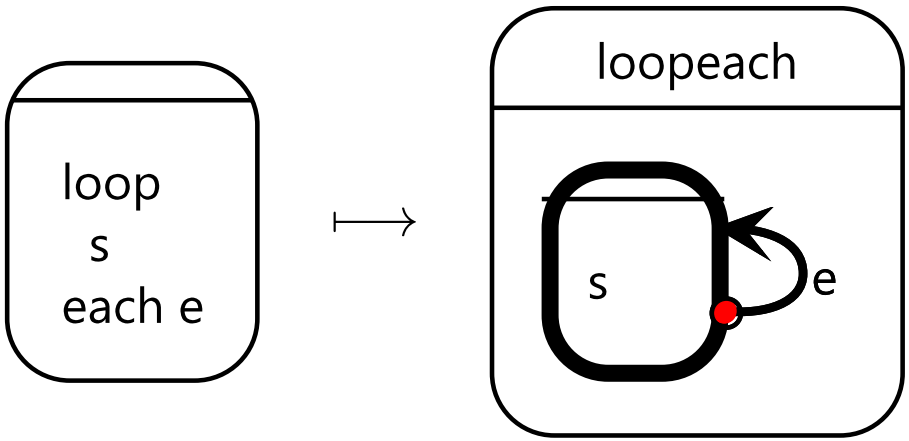
[Interactive Transformations for Visual Models, MEMWe 2011]

Esterel to SyncCharts - `emit`, `loop-each`

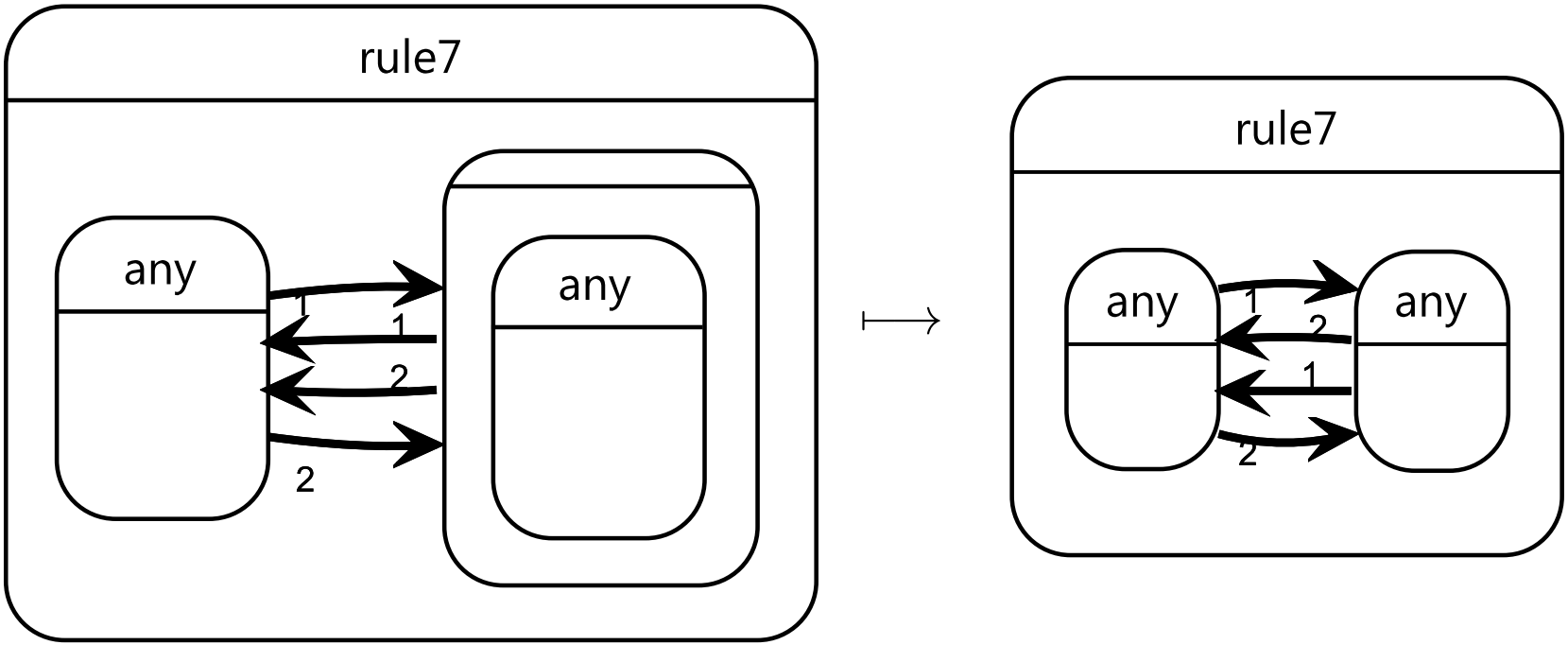
emit



loop-each



SyncCharts Optimization

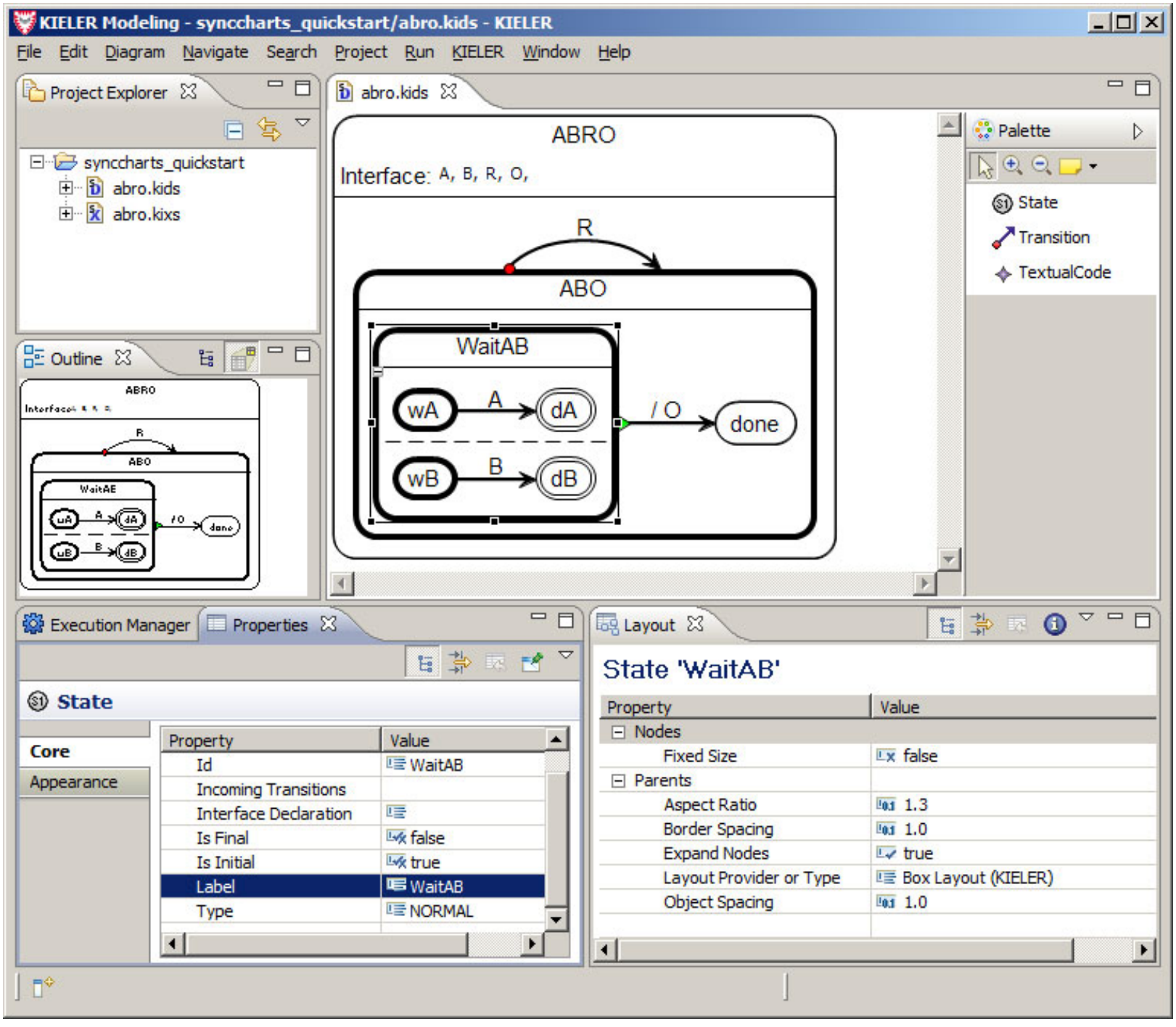


Overview

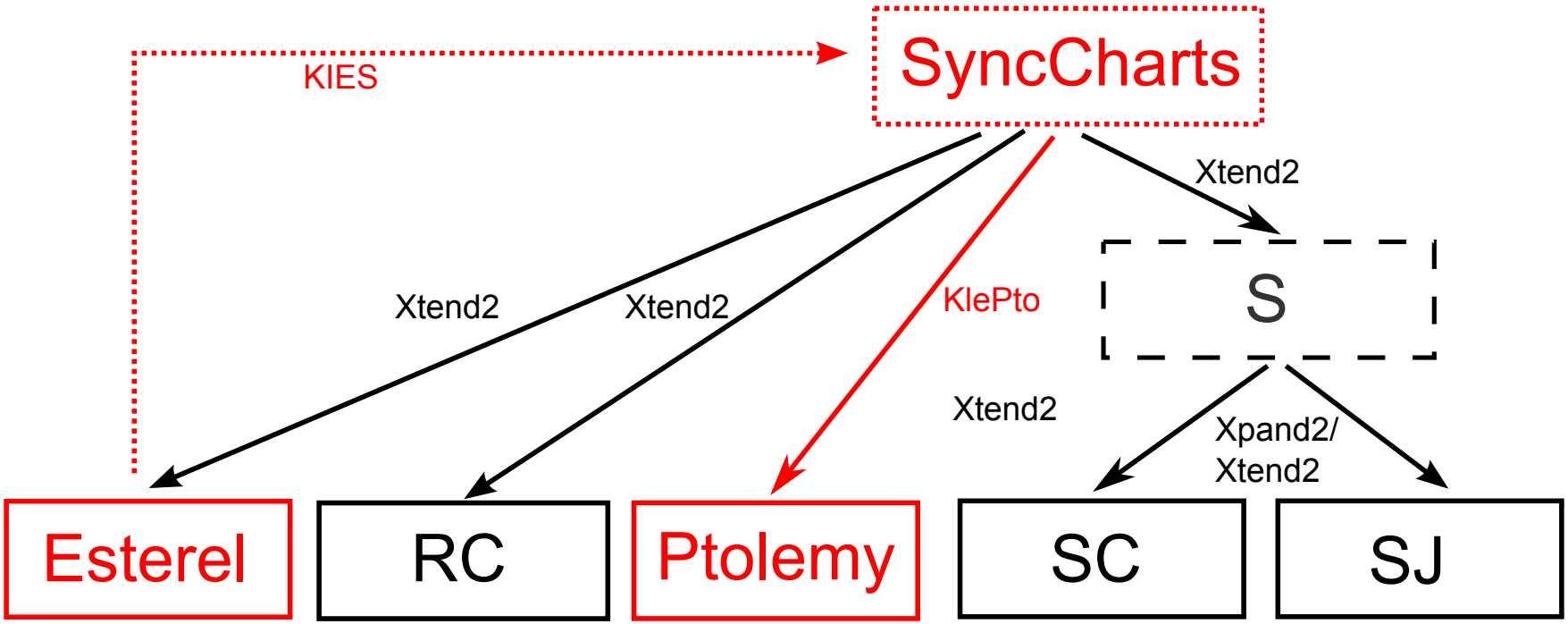
- Esterel to SyncCharts transformation (KIES)
- SyncCharts Execution (KlePto)
  - Demo
- Summary

What is KIELER?

- Kiel Integrated Environment for Layout Eclipse Rich Client
- Modeling platform and test bed
  - Improve pragmatics
- Open source and Eclipse based (plug-ins)
- General concepts:
  - Generic approaches
  - Symbiosis w/ Eclipse technologies (e.g., EMF, GMF, TMF, Xpand, Xtend)
  - Interfaces to other tools (Ptolemy, Papyrus)


KIELER Modeling - synccharts_quickstart/abro.kids - KIELER
File Edit Diagram Navigate Search Project Run KIELER Window Help
Project Explorer
synccharts_quickstart
abro.kids
abro.kixs
Outline
abro.kids
ABRO
Interface: A, B, R, O,
R
ABO
WaitAB
wA
A
dA
/ O
done
wB
B
dB
Palette
State
Transition
TextualCode
Execution Manager
Properties
State
Core
Appearance
Property
Value
Id
WaitAB
Incoming Transitions
Interface Declaration
Is Final
false
Is Initial
true
Label
WaitAB
Type
NORMAL
Layout
State 'WaitAB'
Property
Value
Nodes
Fixed Size
false
Parents
Aspect Ratio
1.3
Border Spacing
1.0
Expand Nodes
true
Layout Provider or Type
Box Layout (KIELER)
Object Spacing
1.0

SyncCharts Execution in KIELER



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
- Ptolemy models are a set of interacting components $\rightarrow$ *Actor-Oriented Design*

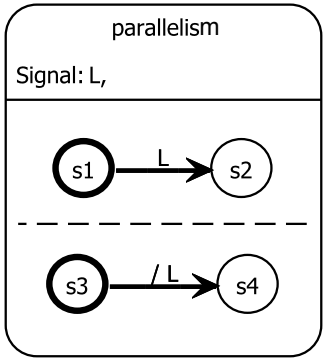
SyncCharts in Ptolemy

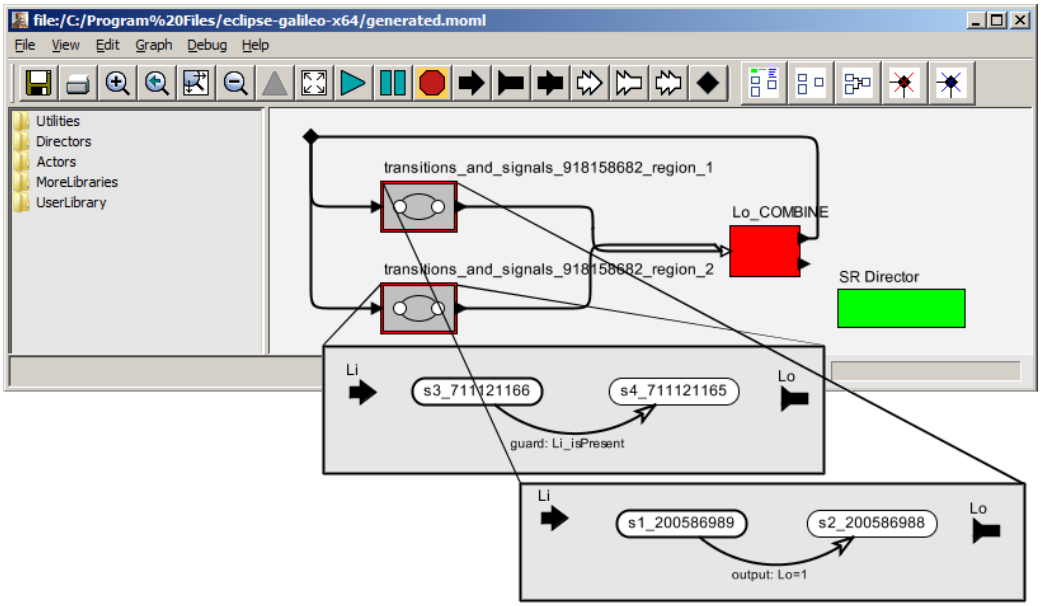
- Mapping SyncCharts to Ptolemy:

Mealy machine	$\leftrightarrow$	ModalModel
Orthogonality	$\leftrightarrow$	Concurrent Actors (inherent)
Hierarchy	$\leftrightarrow$	Compound Actors, state refinements
Compound events	$\leftrightarrow$	Expression language

- Interesting:
  - Implicit broadcast vs. explicit signal representation
  - Signal coherence (must/cannot analysis)

SyncCharts in Ptolemy - Example





KIELER Demo

LIVE DEMO

Summary

- Research goals (long term)
  - Investigate on synchronous languages
  - Bringing together graphical and textual syntax
  - Integrate Esterel in KIELER
    - Improve pragmatics
    - Validation purposes (SC and KlePto)
    - Current work in progress: Simulation/Debugging with CEC
- Research goals (short term)
  - Modular and interactive transformations
    - Understand
    - Debug
  - Teaching
- Acknowledgements: Ulf Rüegg

To Go Further

CHARLES ANDRÉ.

Semantics of SyncCharts, 2003.

GÉRARD BERRY.

The Esterel v5 Language Primer, 2000.

RÜEGG, U., MOTIKA, C., AND VON HANXLEDEN, R.

Interactive transformations for visual models.

In *3rd Workshop Methodische Entwicklung von Modellierungswerkzeugen (MEMWe 2011) at conference INFORMATIK 2011* (Berlin, Germany, Sept. 2011), GI-Edition – Lecture Notes in Informatics (LNI), Bonner Köllen Verlag.

UC BERKELEY, EECS DEPT.

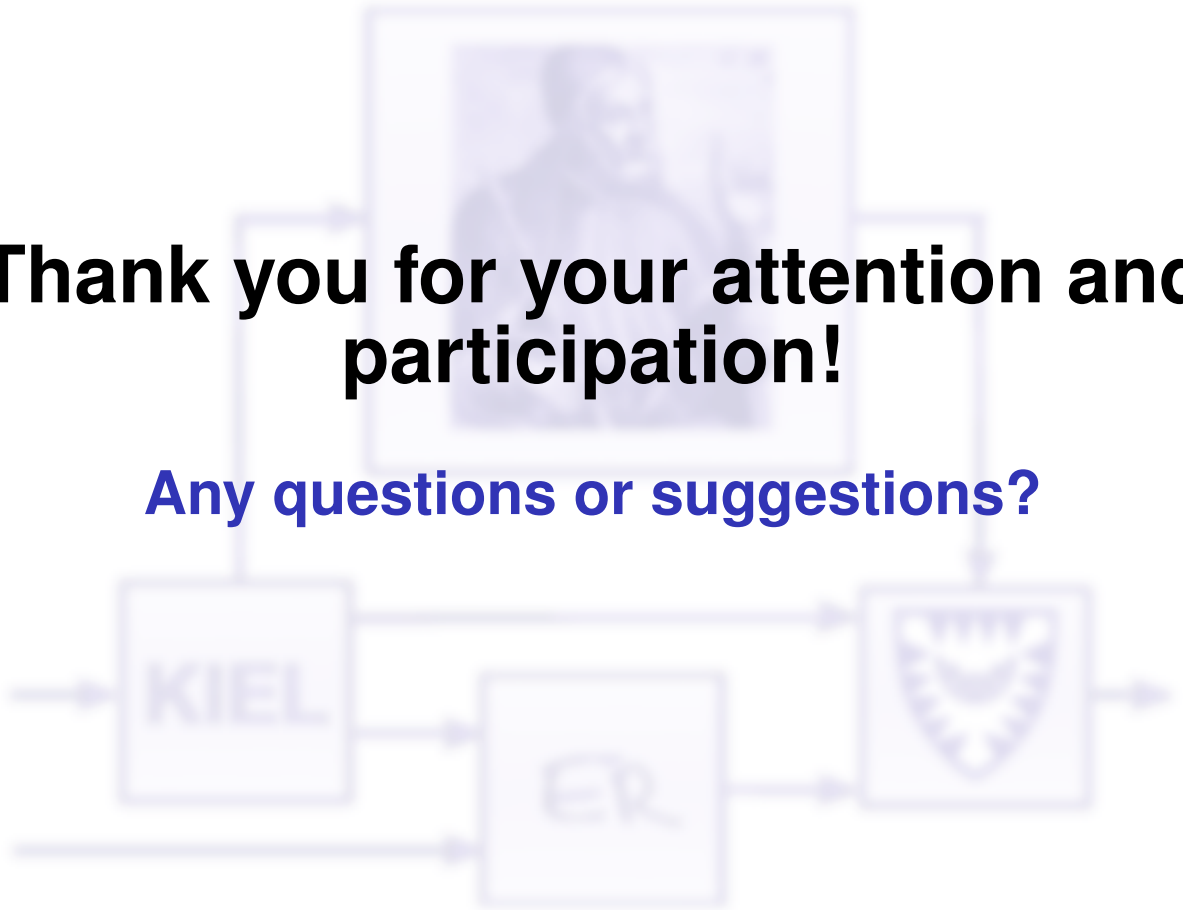
Ptolemy webpage.

http://ptolemy.eecs.berkeley.edu/.

UNI KIEL, REAL-TIME AND EMBEDDED SYSTEMS GROUP.

KIELER webpage.

http://www.informatik.uni-kiel.de/en/rtsys/kieler/.



Thank you for your attention and participation!

Any questions or suggestions?