Executing SyncCharts with Ptolemy

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SYNCHRON Workshop 2010
Frejús, 29.11.2010
Overview

- KIELER
  - Overview
  - SyncCharts
- Ptolemy
  - Heterogenous Modeling
  - ModalModel and SR Domain
- KIELER leveraging Ptolemy
  - Simulation Approach
  - Transformations
  - Eclipse Integration
- 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)
SyncCharts

- Statechart dialect
- Mealy machine with
  - Parallelism, hierarchy, compound events, broadcast
- Graphical notation for the Esterel synchronous language
- Synchrony hypothesis
  - Discrete ticks
  - Computations take no time

Charles André, Computing SyncCharts Reactions, 2003
Abstract Syntax (EMF)
Overview

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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 → Actor-Oriented Design

- Constructed under a model of computation (MoC)
Model of Computation

- Defines interaction of system components
  - Semantics of a model
- Ptolemy Model can have more than one MoC
- MoC domains/directors:
  - Process Networks (PN)
  - Continuous Time (CT)
  - Finite State Machines (FSM)
  - Synchronous Reactive (SR)
  - ...

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ModalModel Domain

- Entities not actors but states
- Execution: Strictly ordered sequence of state transitions
- Build-in expression language to evaluate guards
- Refinements (multiple)
- Reset and preemptive transitions
Synchronous Reactive Domain

- Zero-Delay blocks
- Instantaneous communication
- Feedback

- Fixed point $\Leftrightarrow$ Stable state
- Values from flat lattice
- Determinism $\Leftrightarrow$ Unique solution
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Ptolemy Simulation Engine

- 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)
  - Transition priorities
  - Normal termination
Transformation Example: Parallelism and Signals

parallelism
Interface: L,

s1 \xrightarrow{L} s2
s3 \xrightarrow{\not L} s4

parallelism
Interface: L,

s1 \xrightarrow{L} s2
s3 \xrightarrow{\not L} s4

transitions_and_signals_918158662_region_1

Lo_COMBINE

transitions_and_signals_918158662_region_2

Lo

s3_71121165 s4_711121165

guard: Li_isPresent

Lo

s1_200530909 s2_200586098

output: Lo=1
Transformation Example: Hierarchy
Schematic Overview

SyncChart 2 Ptolemy
Xtend

Ptolemy Simulator
Data Producer
Data Observer

Execution Manager

M2M description

PtolemyMM
SyncChartsMM

SyncCharts Model
metamodels

model to simulate

produce
load & execute

commands, model inputs
simulation data, model outputs

Ptolemy Model

PtolemyMM
SyncChartsMM SyncChart Model

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Architecture and User Interface

![Diagram of Architecture and User Interface]

- **Execution Manager Runtime**: Data Producer/Observer (Java Simulator), Data Producer/Observer (Generic Simulator), Data Observer (Ptolemy II), Data Observer (Environment Visualization), Data Observer (Model Feedback Visualization), Data Producer (Recorded Trace Player), Data Producer/Observer (TCP/IP Interface), External Appl.

![Screenshot of Execution Manager]

- **Execution Manager**:
  - Component Name/Key
  - Value
  - Type
  - Master
  - Synchronous Signal Resetter
    - Observer/Producer
  - Data Table
    - Observer/Producer
  - ABRO in Java
    - Observer/Producer
  - SyncCharts Ptolemy Simulator
    - Observer/Producer
  - SyncChart Editor
    - Observer/Producer
  - State Name
    - state
      - Observer/Producer
  - SimpleRailCtrl Ptolemy Simulator
    - Observer/Producer
  - Viewmanagement SyncCharts Visualizer
    - Observer
  - DataTable
    - Observer

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KIELER KlePto Simulation Demo

LIVE DEMO
Summary

- KIELER
- Ptolemy
- KIELER leveraging Ptolemy
  - KlePto concept
  - Construct runnable Ptolemy models for EMF based models (Xtend)
  - Ptolemy integration in Eclipse
  - Infrastructure for interactive model execution
  - Also: Visualization, stepwise transformation, model checking, online debugging, regression tests, validation, ...
To Go Further

**ANDRÉ, C.**
Computing SyncCharts reactions.

**MOTIKA, C., FUHRMANN, H., AND VON HANXLEDEN, R.**
Semantics and execution of domain specific models.

**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?