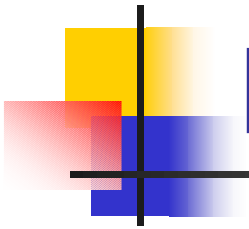


MOBIES
Project Progress Report

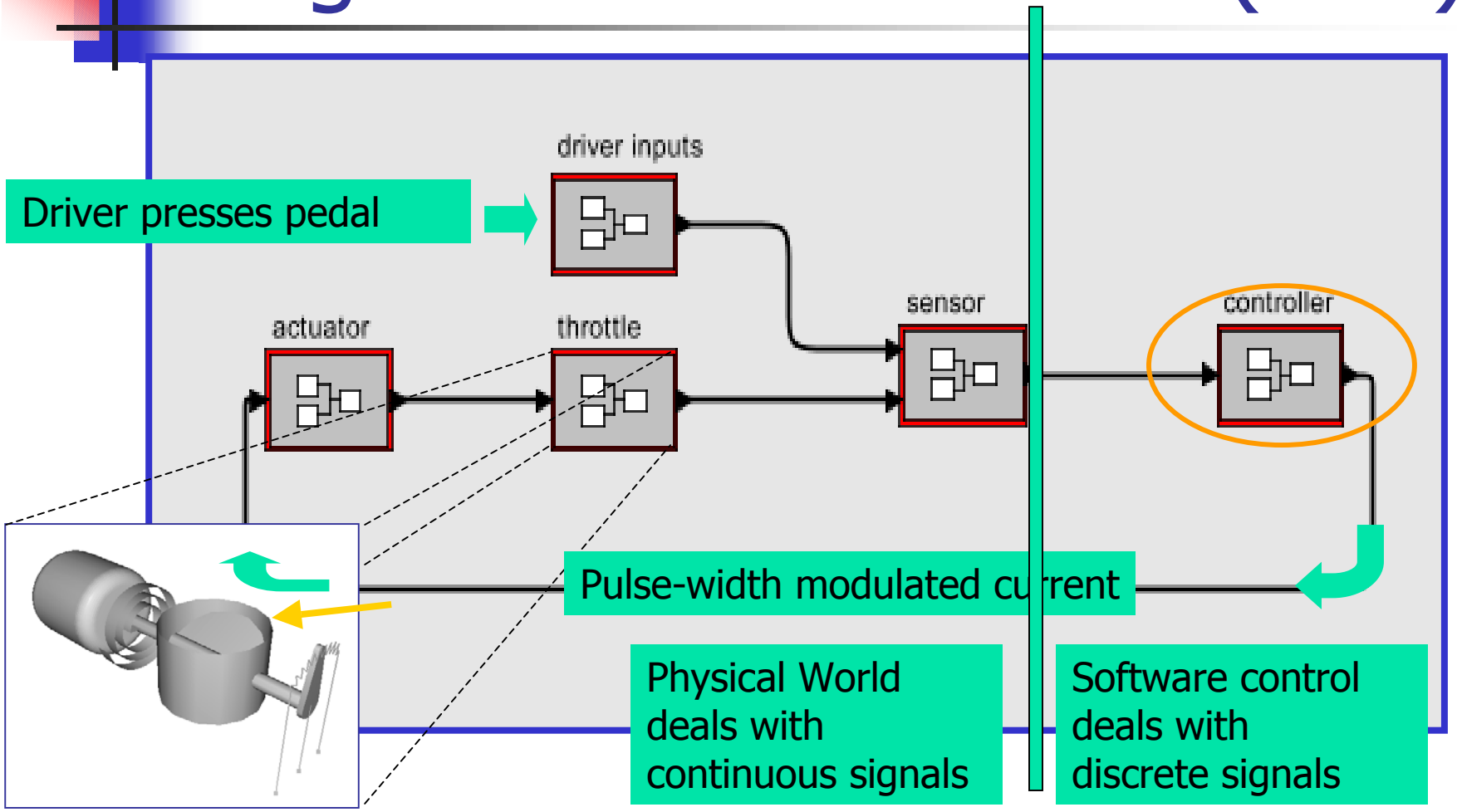
Engine Throttle Controller Design Using Multiple Models of Computation

Edward Lee
Haiyang Zheng

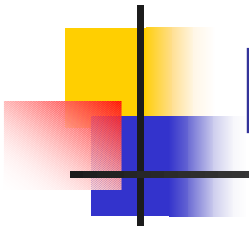
with thanks to Ptolemy Group of UC Berkeley,
Paul Griffiths, Christoph Kirsch, Tunc Simsek, Jason Souder

UC Berkeley, March 12 2002

Engine Throttle Control (ETC)



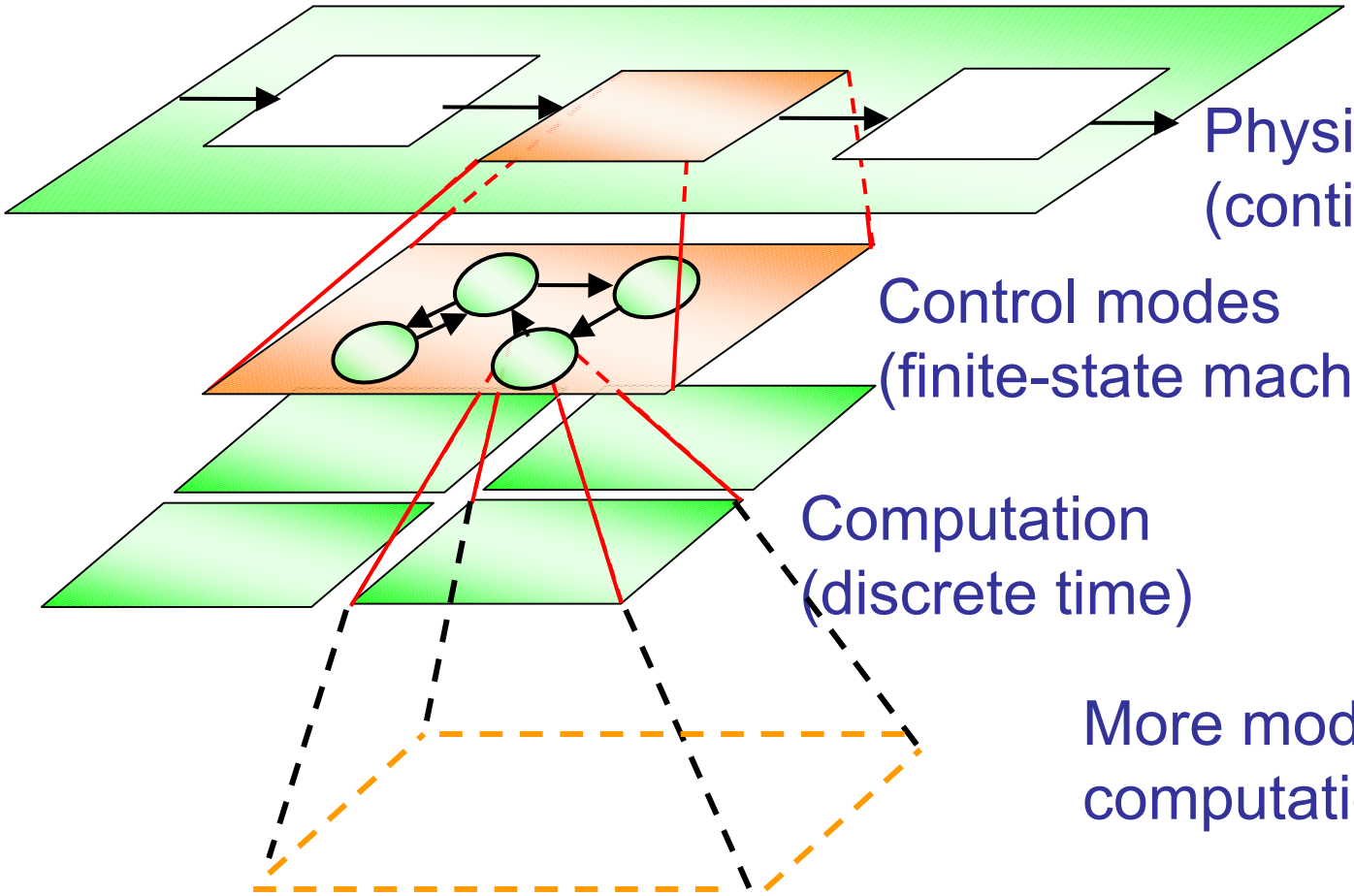
Throttle



Design Challenge

- Create a realistic representation of the ETC system that models …
  - continuous physical signals
  - control modes and their transitions
  - discrete computations
  - task scheduling
  - …

Design Overview



Physical signals
(continuous time)

Control modes
(finite-state machine)

Computation
(discrete time)

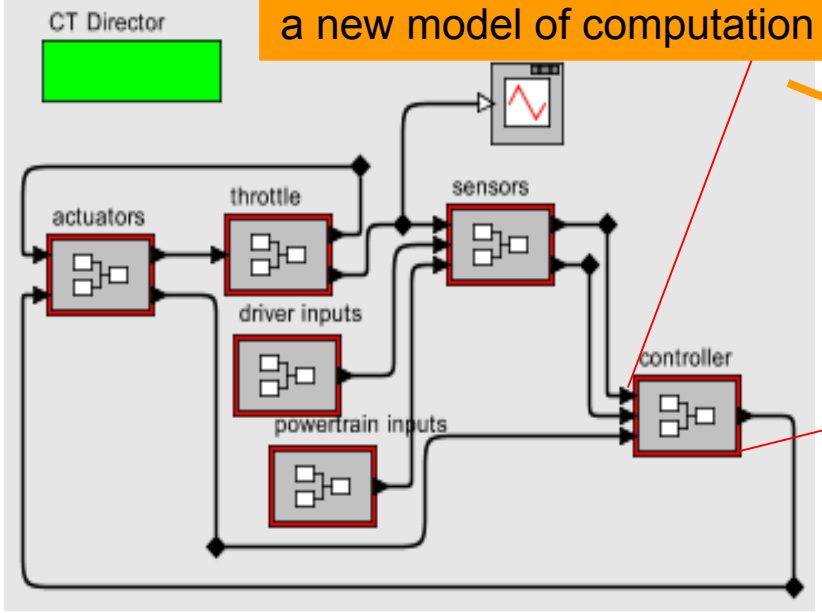
More models of
computation …

Engine Throttle Control Model

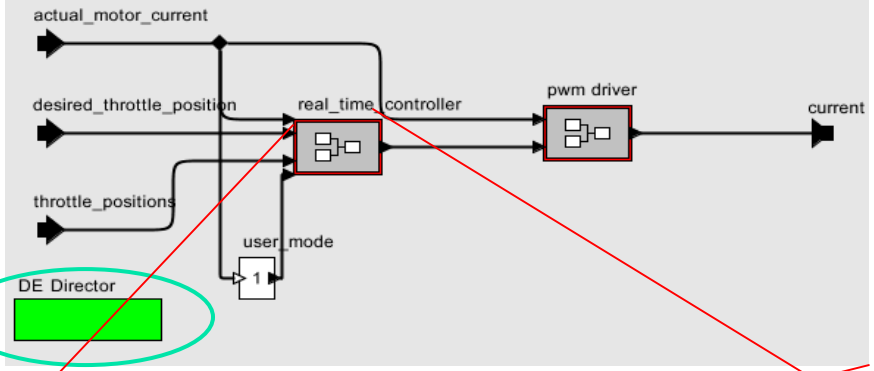
Heterogeneous model of the UC Berkeley Vehicle Dynamics Lab
Electronic Throttle Controller.

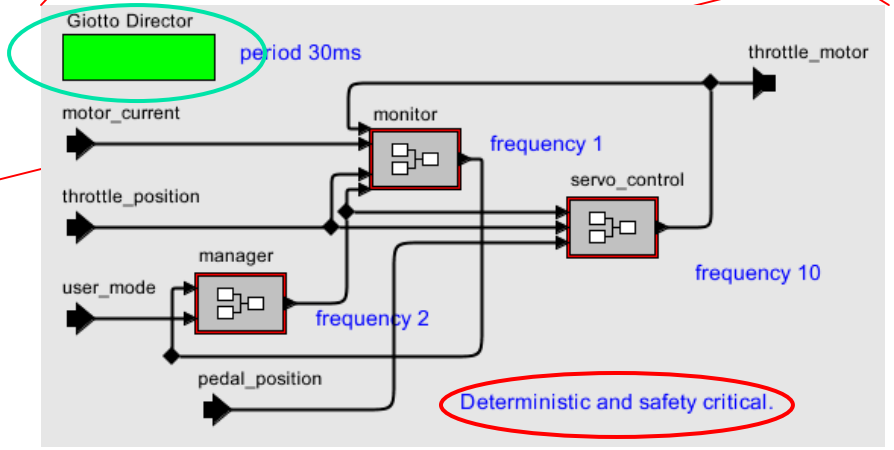
by Paul Griffiths, Christoph Kirsch, Tunc Simsek, Jason Souder
Last updated January 15, 2002
Edward Lee, Haiyang Zheng
Last updated March 6, 2002

a new model of computation

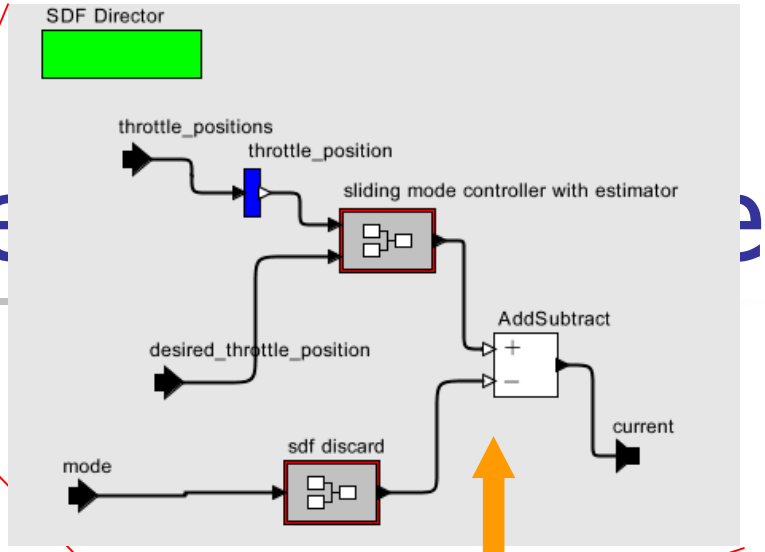


The discrete-time controller consists of two abstract parts. The first is the controller itself which is a sampled modal sliding-mode controller and the second is the drivers for the pulse-width modulated (pwm) actuators.



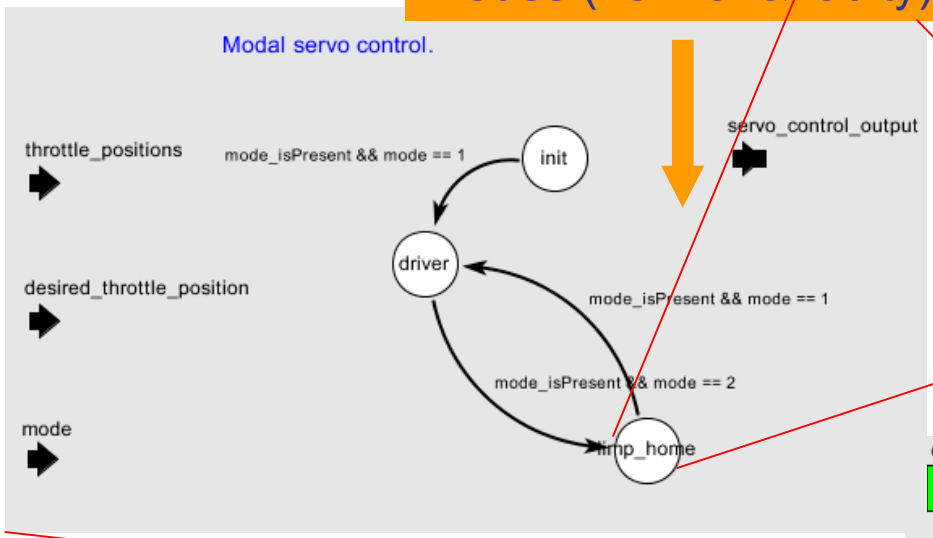


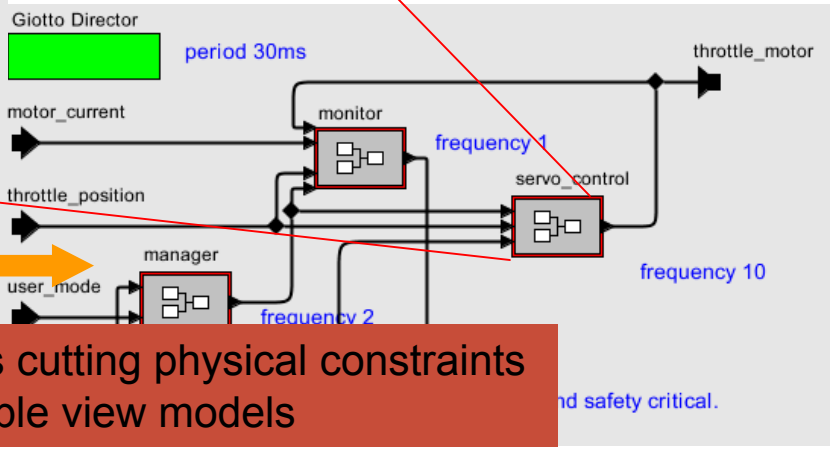
Engine Throttle



Modes (normal & faulty)

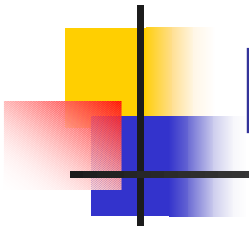
Controller task





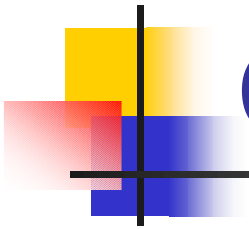
Periodic, time-driven tasks

Task 1.1: Demonstrate ability of modeling cross cutting physical constraints
Task 1.7: Demonstrate ability to compose multiple view models



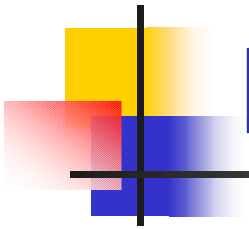
Engine Throttle Control Demo

- We finished the demo of ETC model, our work is focused on controller design
- We introduced and used Giotto model to implement the controller part since we want to meet the time deadlines
- We will use Ptolemy II to study Giotto model and its interactions with other models of computation



Giotto

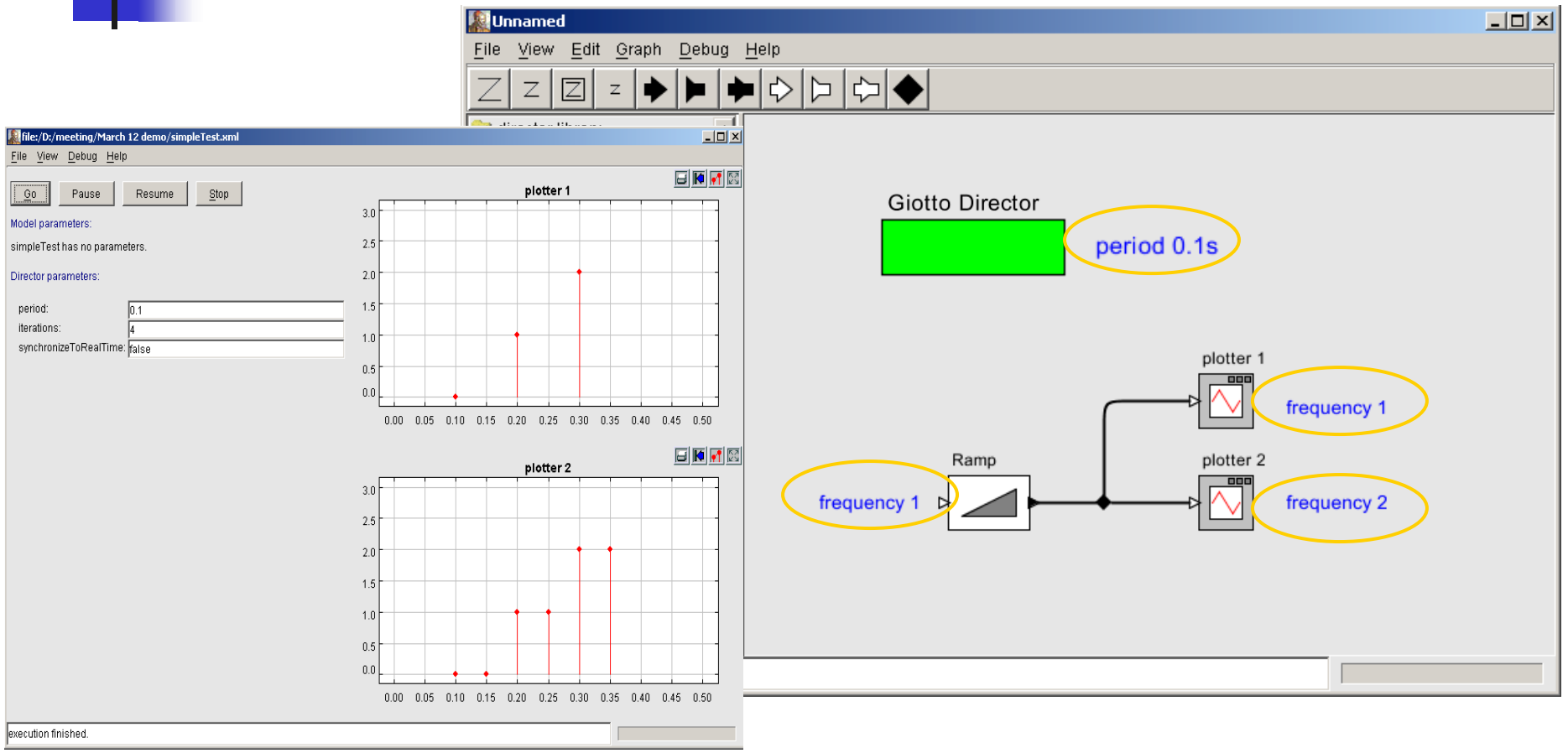
- What is Giotto?
  - Developed by Tom Henzinger and his group
  - A periodic time-triggered semantics
  - Deterministic and predictable behaviors
  - Details will be given by Christoph
- Why Giotto?
  - Make sure the tasks meet deadlines
  - Mobies Phase I tries to use Giotto model to implement the controller part of ETC model



Ptolemy II

- We use Ptolemy II to study the Giotto model of computation
- Ptolemy II studies heterogeneous modeling, simulation and design of concurrent systems
- Emphasis on building a framework supporting experimentation with models of computation and their interactions

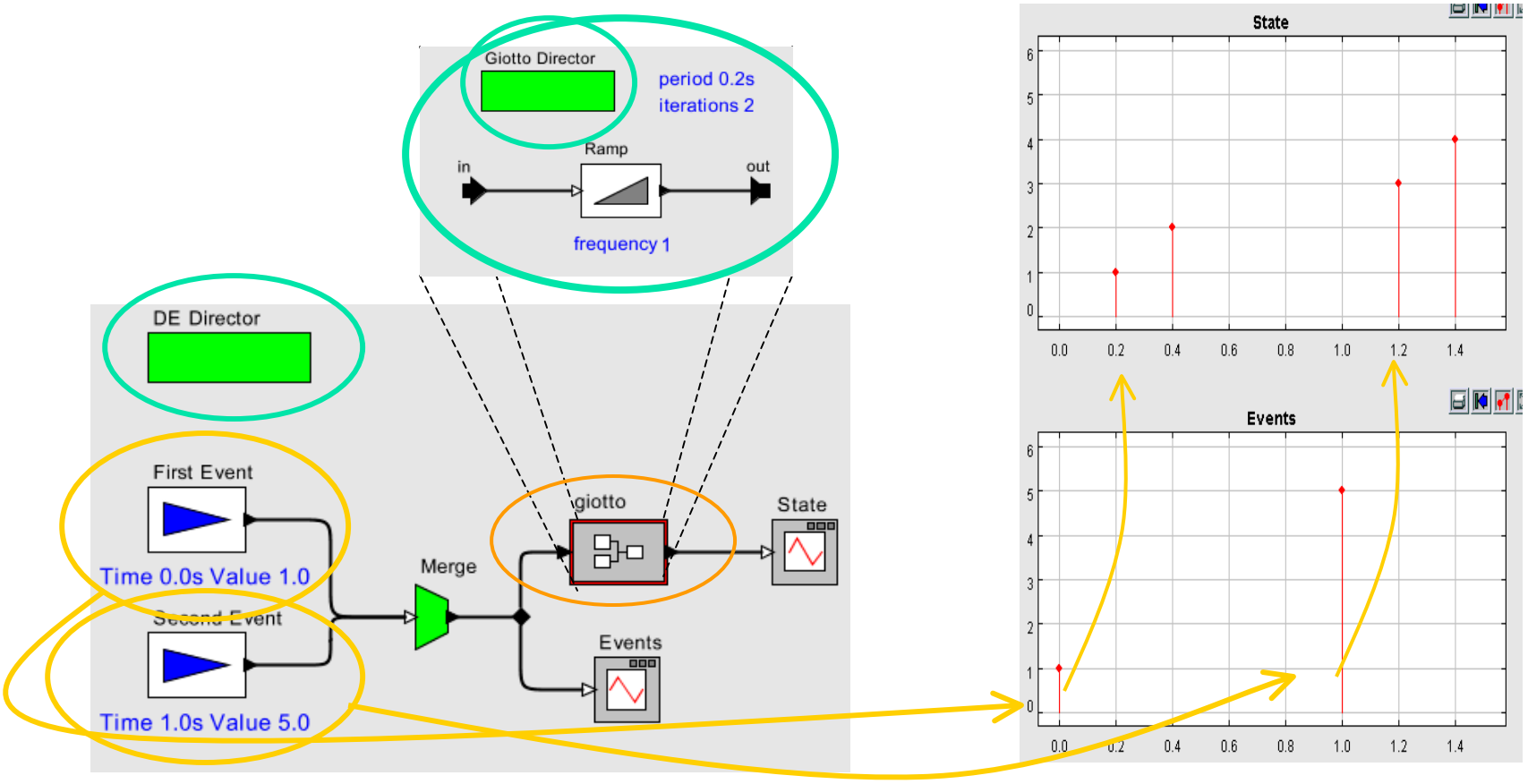
Giotto Model Implemented in Ptolemy II

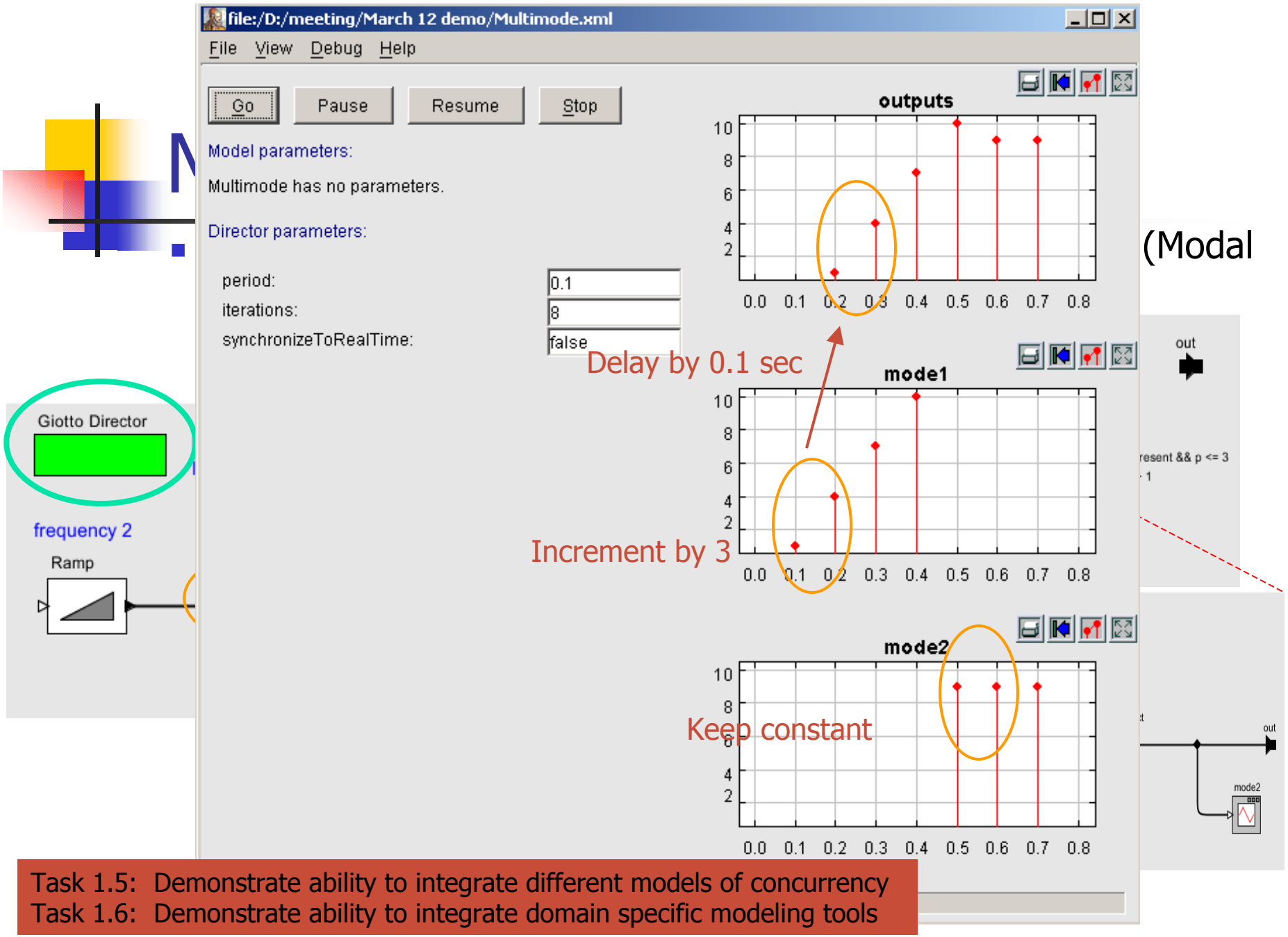


Task 1.2: Demonstrate ability to customize generic modeling tools
Task 1.3: Demonstrate ability to model domain specific model semantics

Models Interactions I

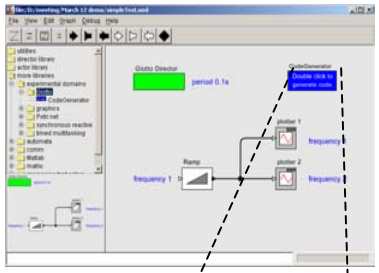
- Giotto model embedded in Discrete Events (DE) model



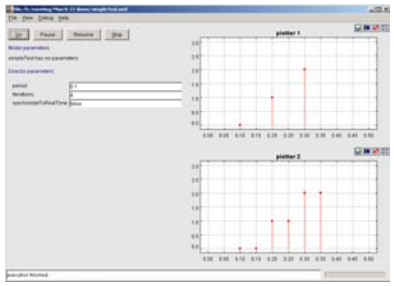


Task 1.5: Demonstrate ability to integrate different models of concurrency
Task 1.6: Demonstrate ability to integrate domain specific modeling tools

Software Control Design Flow



Simulate



Refine

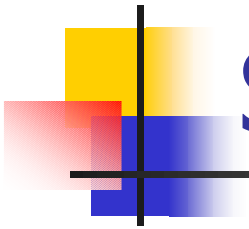
CodeGenerator

Double click to generate code.

Giotto code

Executable Controller Code

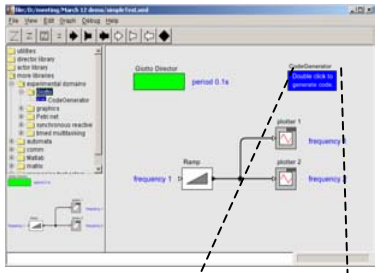
Giotto
E-Compiler
E-Machine
Runtime Library



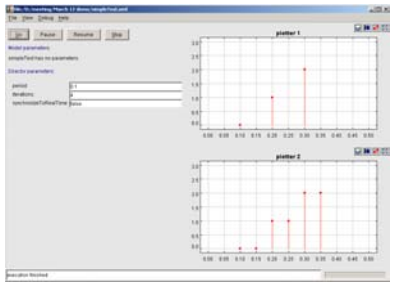
Summary

- Complex ETC model is designed and simulated in Ptolemy
- Multiple models of computation involved as necessary
- Hierarchically heterogeneous structure
- Ptolemy II as a framework supports experimentation with models of computation and their interactions

Software Control Design Flow



Simulate



Refine

CodeGenerator

Double click to generate code.

Giotto code

Executable Controller Code

Giotto
E-Compiler
E-Machine
Runtime Library

Tool Integration with Giotto

- Visual block diagram design
- Simulation for design refinement
- Giotto code generated from Giotto model of Ptolemy II
- Giotto code schedulability analysis by E-Compiler
- Task code manually generated for E-Machine

Task 2.2: Demonstrate ability to customize frameworks with generators
Task 2.4: Demonstrate ability to generate embedded software from models
Task 4.2: MIDTERM DEMONSTRATION: Generate embedded software for avionics/vetronics systems using model-based environment

Tool Integration with Charon

- Visual block diagram design of Hybrid Systems
- Simulation to refine design
- Generated Charon code from Hybrid Systems models in Ptolemy II for verification tools of Univ. of Penn

Task 2. 7. Demonstrate ability to guarantee properties of generated systems