Mobile Robotics Testbed for MBSE Research & Education

Controlling rovers with executable SysML activities

MyroMagic Development Team
- Brian Aikens (main software and concepts)
- Selcuk Cimtalay (testing and feedback ideas)
- Drew Martin (Myro python samples and concepts)
- Russell Peak (objectives, requirements, and concepts)

Institute for Personal Robots in Education (IPRE)

www.roboteducation.org

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ipre

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IPRE Robot Kit - Bryn Mawr College, Spring 2009

This site was cre
(IPRE) for discus
including:

Software
Hardware
Curriculum
Assessment, Ou
Events
Publications

Software

- Myro Installation Manual - install instructions for Windows, Linux, and M
- Myro Reference Manual - functions of the Myro robot control system in
- Myro Development - details of the development of the Myro system

Hardware

- Myro Hardware - Robot hardware that currently runs with Myro (Plus ga

Curriculum

- Learning Computing With Robots - a textbook for Myro, Scribbler and F
- Educator Resources - Lecture Notes, Powerpoint slides, Example Assi
- Presentations - Presentations (PowerPoint and other formats) of talks a
- Demo Programs - Simple programs that demonstrate sensors/output or

Assessment, Outreach, and Workshops

- Assessment Tools - Surveys for robots and non-robots classes, consen
- HOWTO Videos - Student Videos demonstrating various aspects of My
- Myro Summer Development - SummerSchedule2007 SummerSchedule
- CREU - Collaborative Research Experience for Undergraduates Bryn Ma
- Python Excursions - Deepak's Python Excursions. Some neat little Pyt

Events, Past and Future

- Symposium - Presymposium at SIGCSE 2009 on the **Future of Rob**
- IPRE Facutly Enhancement Workshop UNLP September 2008
- IPRE Summer Faculty Enhancement Workshop at Georgia Tech, Jul
- IPRE Summer Faculty Enhancement Workshop at Bryn Mawr Colleg
- ICRA Tutorial by IPRE, May 18-23, 2008 in San Diego, CA.

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Robots Available!

The robots we have developed for use in our curricula are now available for sale. The entire robot kit (robot + Fluke add on board) is available for $199.98 at Georgia Robotics.

Check out the list of schools who are testing the IPRE Robot.

Our Mission

The Institute for Personal Robots in Education (IPRE) applies and evaluates robots as a context for computer science education. IPRE is a joint effort between Georgia Tech and Bryn Mawr College sponsored by Microsoft Research. At Georgia Tech, IPRE is associated with Robotics and the College of Computing. At Bryn Mawr College, IPRE is associated with the Computer Science Department.

Our old site is here in case you need to find something that isn't on the new site yet.

Robotics@GT & Intelligent Machines | BRYN MAWR | Microsoft Research

Background

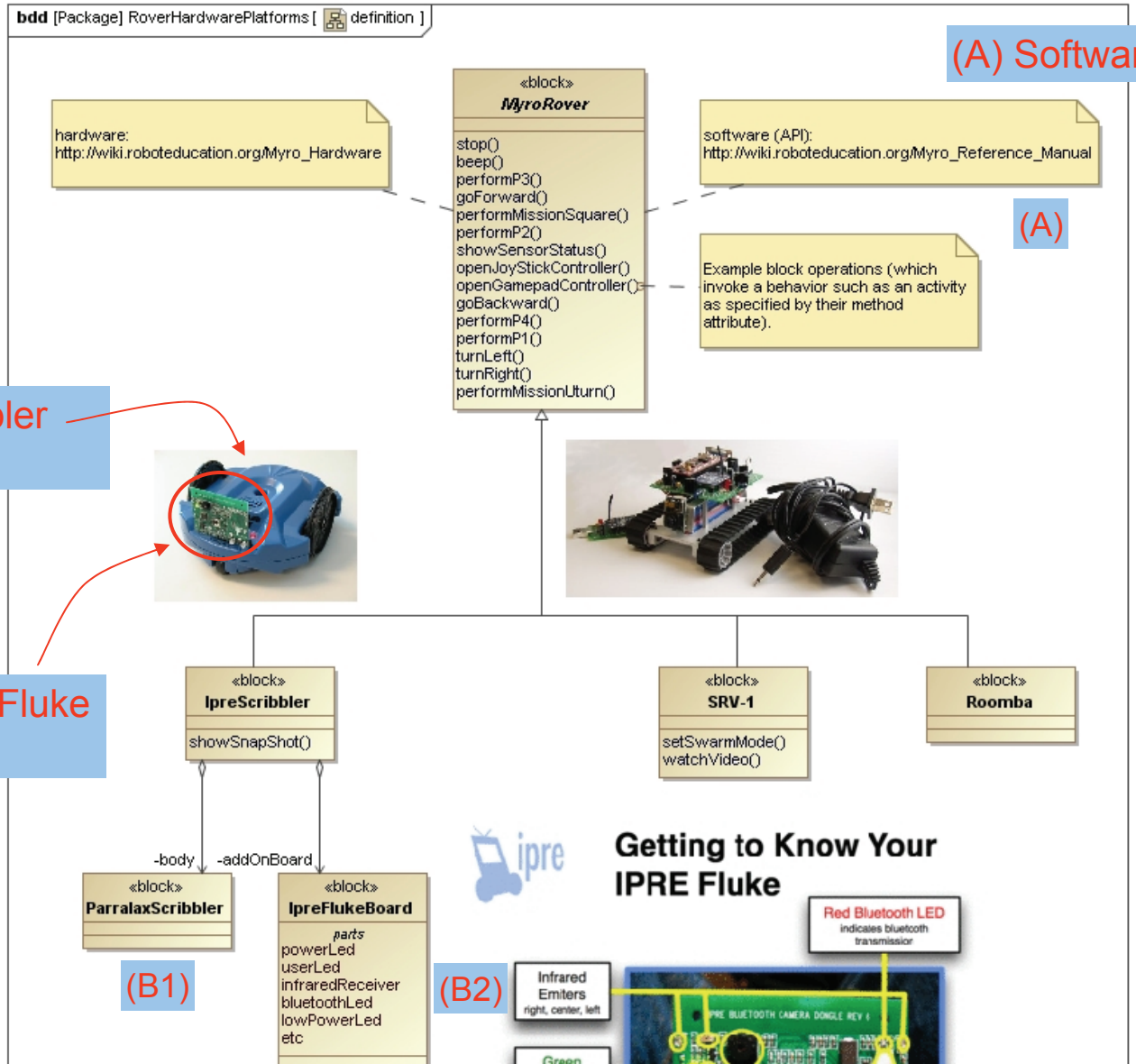
- Leveraging Institute for Personal Robots in Education (IPRE) — *http://www.roboteducation.org/*
  - Multi-university/corporation educational environment
  - Ex. Used in intro comp sci course @ GIT (CS1301)
- Key elements
  - Mobile robot hardware: IPRE Scribbler, Roomba, SRV-1
    - Sensors, cameras, Bluetooth, firmware, PCB ECAD, ...
  - Mobile robotics s/w platform: Myro (Python-based libraries)
    - Primitive operations ... image processing, intro ~AI, ...
  - Domain context
    - Multi-unit systems, command & control, reusability, ...
- Low-cost and open (non-proprietary)

Objectives

- Education platform: Learning SysML activities
  - Used in hands-on courses
    (industry short courses, university courses, ...)
  - Model it and run it!—"*It's not just for documentation anymore!*"
- System run-time operation demo aided by SysML
- Research & demonstration testbed
  - A mechatronics system — a type of cyber-physical system
  - INCOSE MBSE Modeling & Simulation Team and other projects
- Embedded software / firmware
  - Hardware-software relations, real-time factors, ...
- Executable SysML across multiple constructs
  - Activities, parametrics, state machines ...
- Misc: instance levels, versioning/config mgt.

Resources for Myro Software & Rover Hardware

wiki.roboteducation.org



Georgia Institute of Technology

Scribbler / MyroMagic Demo

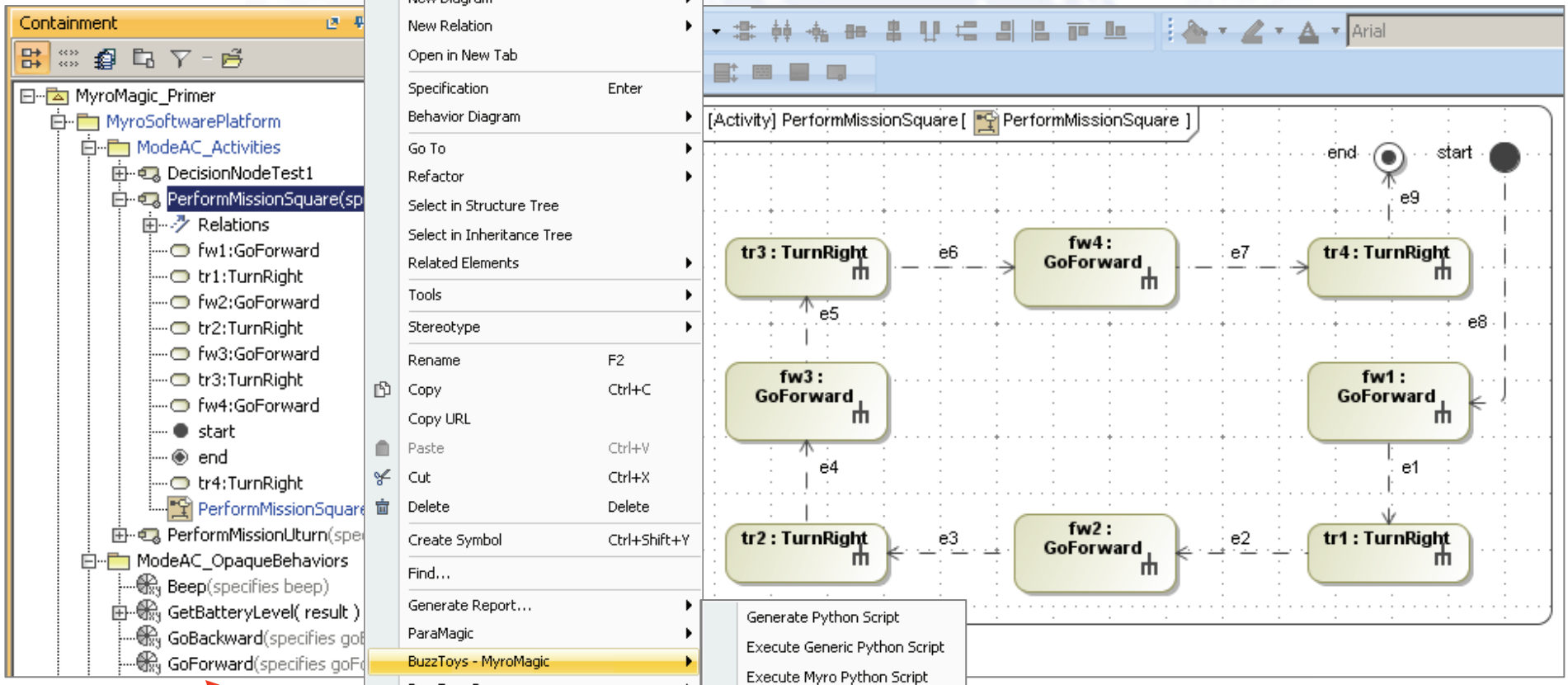
Executable SysML Activity Model [1 - original]

Resulting python script →

(simplified view; see actual in later slide)

```
from myro import *
initialize("com29")

forward(1, 1)
turnRight(1, .4)
forward(1, 1)
turnRight(1, .4)
forward(1, 1)
turnRight(1, .4)
forward(1, 1)
turnRight(1, .4)
```



opaque behaviors (native code segments)

Scribbler / MyroMagic Demo

Executable SysML Activity Model [2 - after live update]

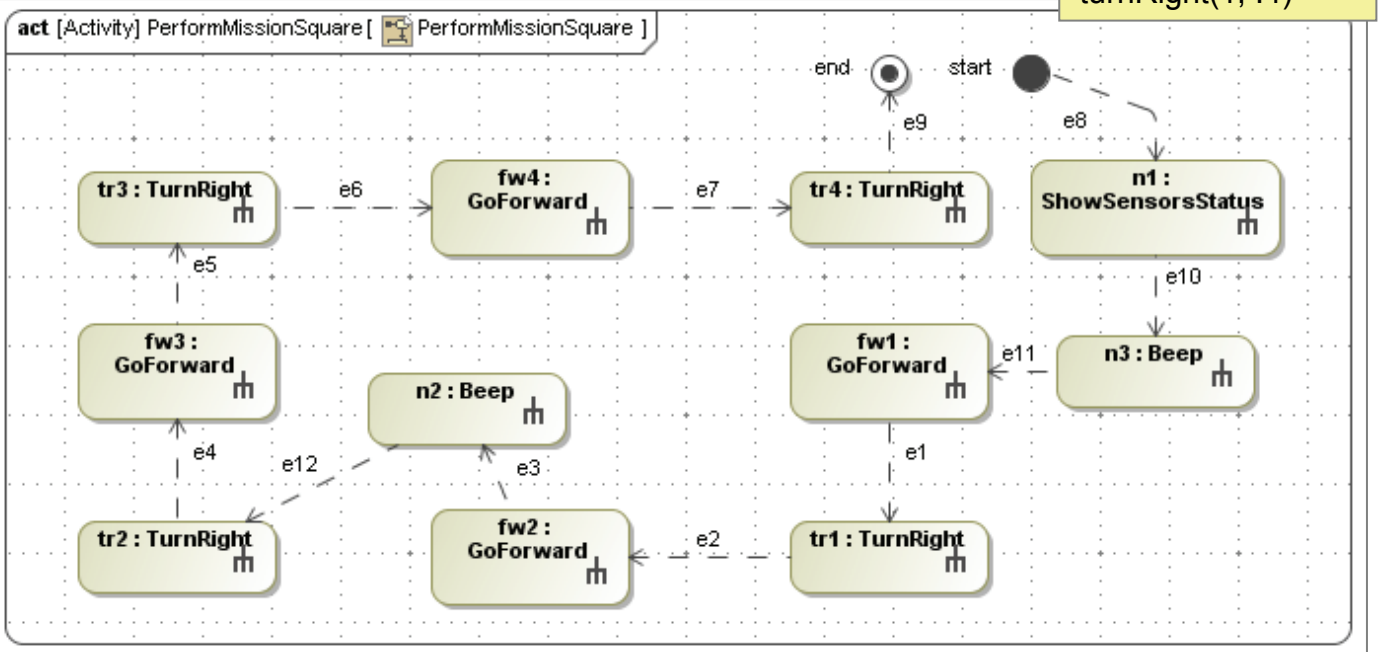
```
from myro import *
initialize("com29")

senses()
beep(1, 440)
forward(1, 1)
turnRight(1, .4)
forward(1, 1)
beep(1, 440)
turnRight(1, .4)
forward(1, 1)
turnRight(1, .4)
forward(1, 1)
turnRight(1, .4)
```

Resulting python script →
(simplified view)

Containment

- MyroMagic_Primer
  - MyroSoftwarePlatform
    - ModeAC_Activities
      - DecisionNodeTest1
      - PerformMissionSquare(spec
        - Relations
        - fw1:GoForward
        - tr1:TurnRight
        - fw2:GoForward
        - tr2:TurnRight
        - fw3:GoForward
        - tr3:TurnRight
        - fw4:GoForward
        - start
        - end
        - tr4:TurnRight
        - n1:ShowSensorsStatus
        - n2:Beep
        - n3:Beep
        - PerformMissionSquare
      - PerformMissionUturn(specif
    - ModeAC_OpaqueBehaviors
      - Beep(specifies beep)
      - GetBatteryLevel(result)
      - GoBackward(specifies goBa
      - GoForward(specifies goFor

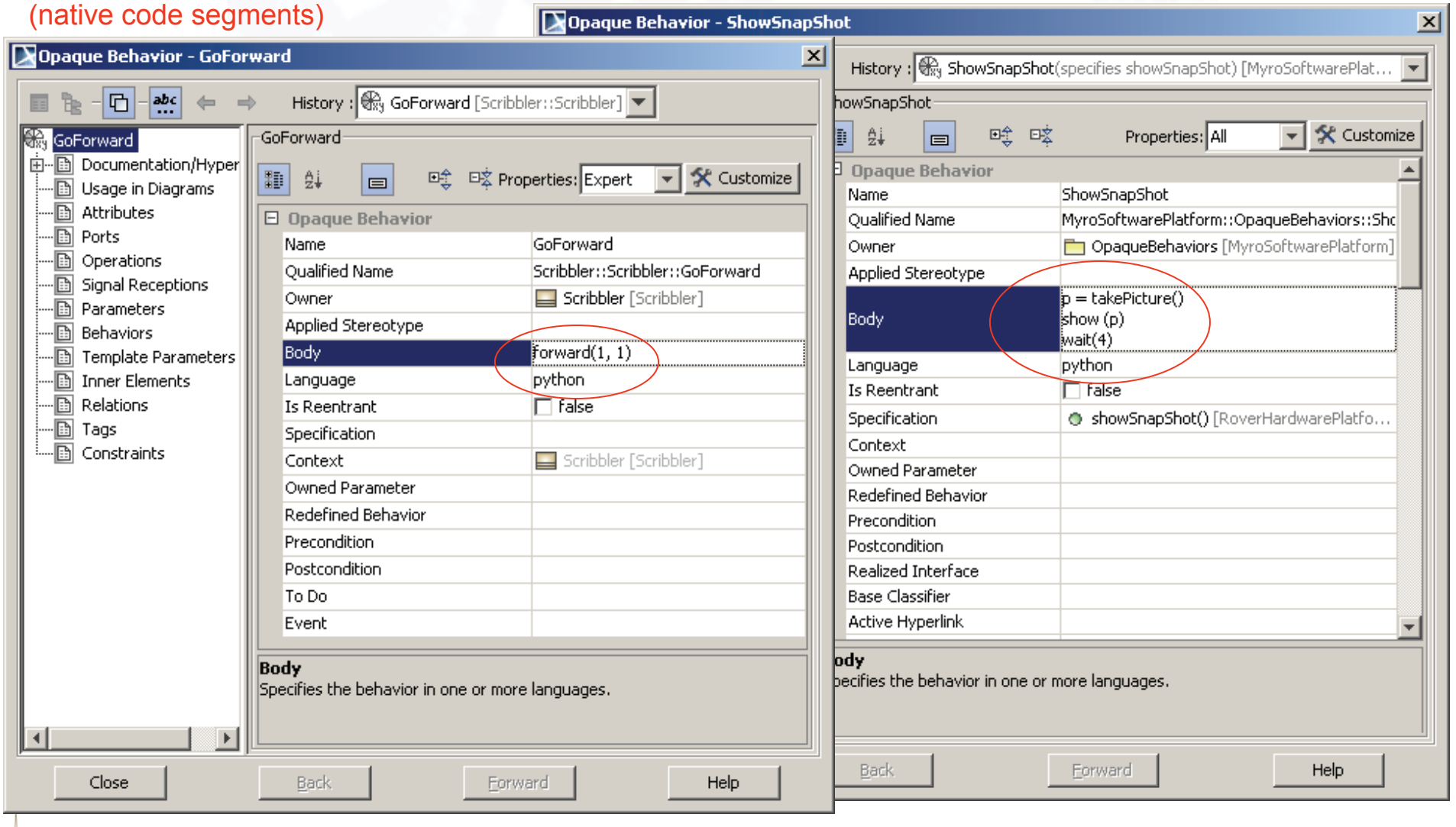


opaque behaviors (native code segments)

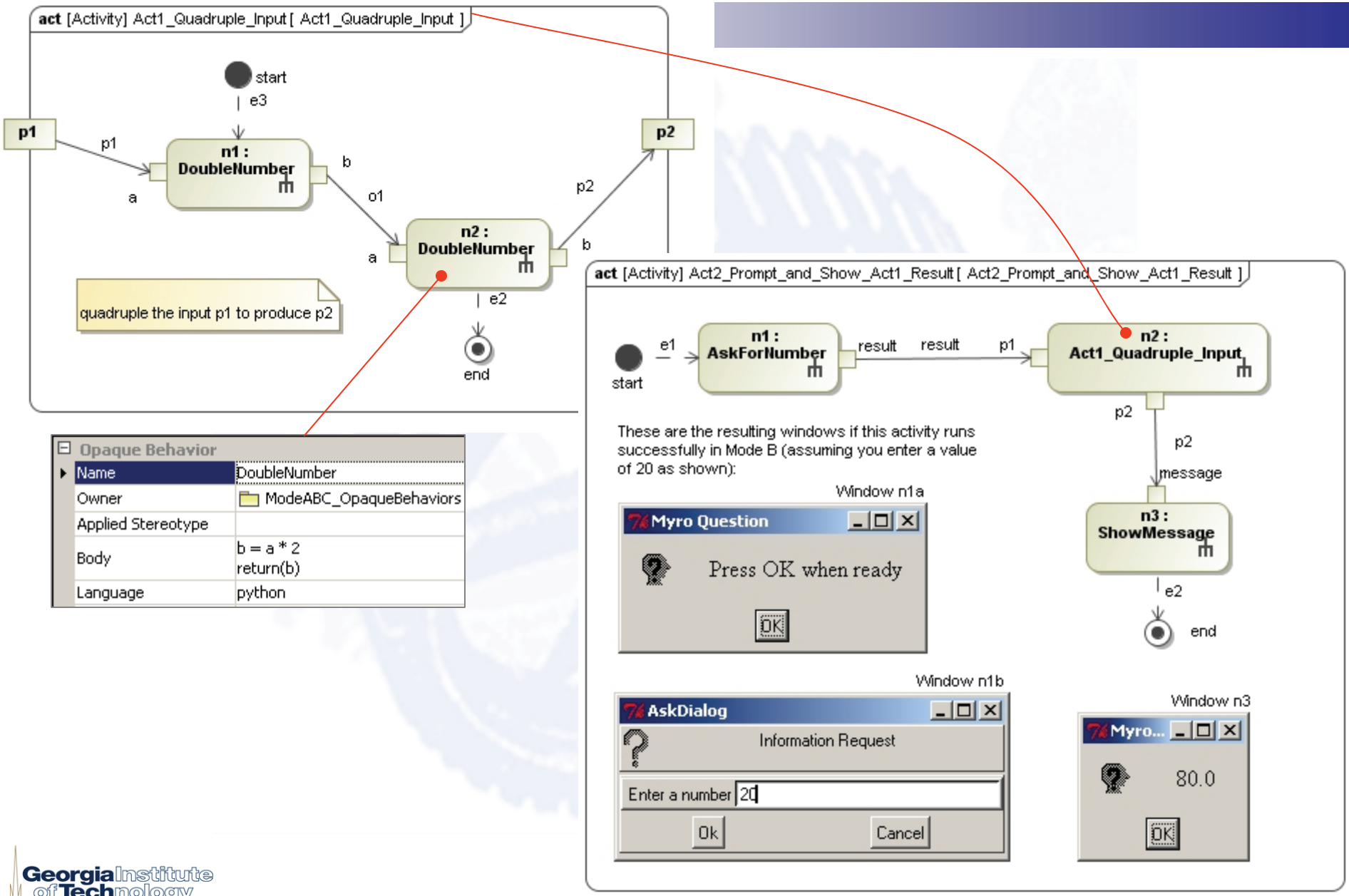
Scribbler / MyroMagic Demo

Executable SysML Activity Modeling [activity building blocks]

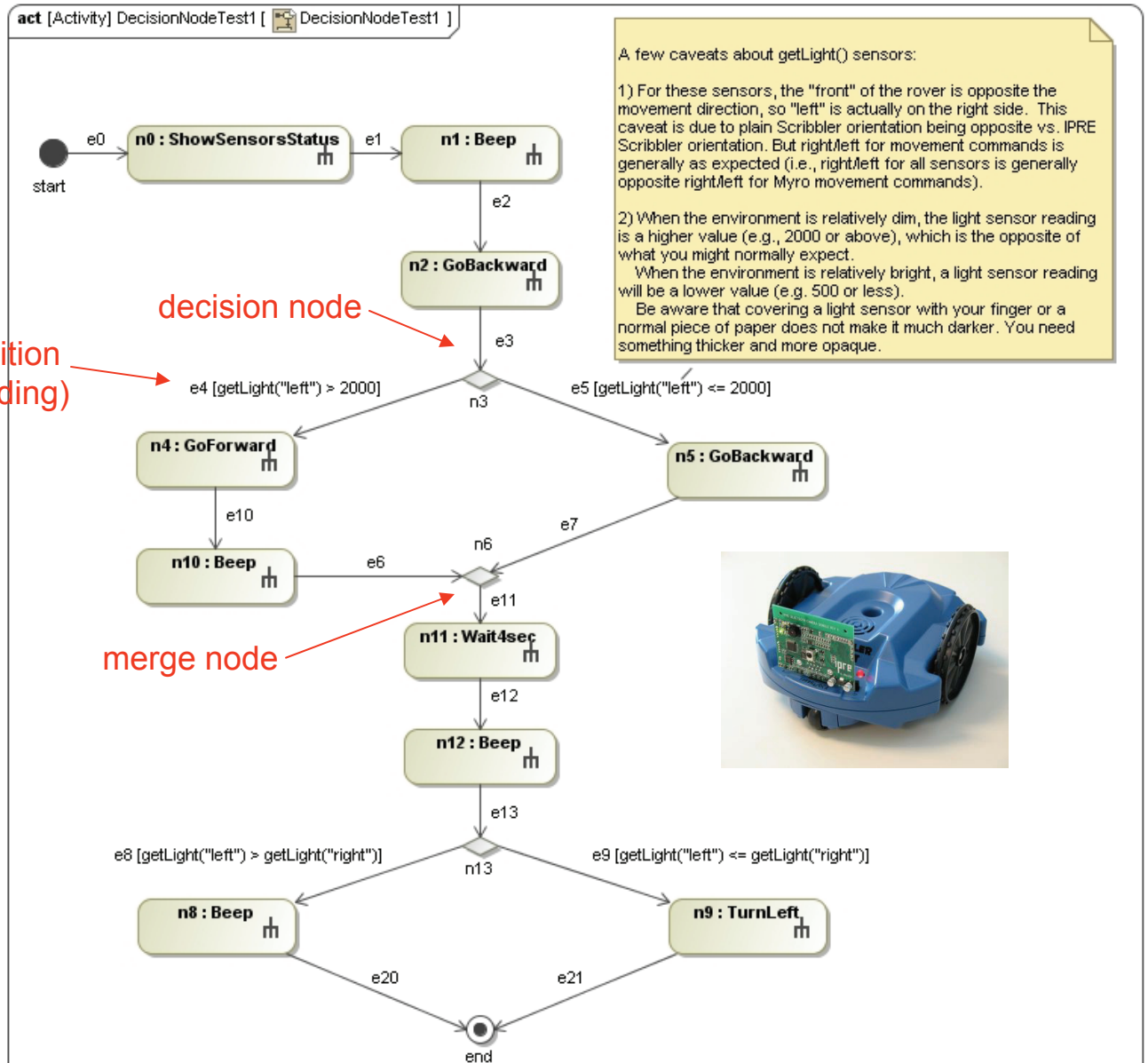
opaque behaviors
(native code segments)



Support for Basic Object Flows (as of MM v0.3.4)



Decision Nodes / Guard Conditions and Merge Nodes



decision node

guard condition (with sensor reading)

merge node

Python IDLE Viewer/Editor

Resulting Script for DecisionNodeTest

main.py - C:\temp\MyroMagic\main.py

File Edit Format Run Options Windows Help

```
# autogenerated 2011/02/01 09:02:21 by MyroMagic v0.3.4 build 05.01
from myro import *
initialize("com10")

DecisionNodeTest1()

def DecisionNodeTest1():

        # path e0 to action n0
        ShowSensorsStatus()

        # path e1 to action n1
        Beep()

        # path e2 to action n2
        GoBackward()

        # path e3 to decision node n3
        DecisionNodeTest1_DecisionNode_n3()


def DecisionNodeTest1_DecisionNode_n3():

        # path e4 branch
        if getLight("left") > 2000:

        # path e4 to action n4
                GoForward()

        # path e10 to action n10
                Beep()

        # path e6 to decision node n6
                DecisionNodeTest1_DecisionNode_n6()

        # path e5 branch
        if getLight("left") <= 2000:

        # path e5 to action n5
                GoBackward()

        # path e7 to decision node n6
                DecisionNodeTest1_DecisionNode_n6()
```

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main.py - C:\temp\MyroMagic\main.py

File Edit Format Run Options Windows Help

```
def DecisionNodeTest1_DecisionNode_n6():
        # path e11 to action n11
        Wait4sec()

        # path e12 to action n12
        Beep()

        # path e13 to decision node n13
        DecisionNodeTest1_DecisionNode_n13()


def DecisionNodeTest1_DecisionNode_n13():
        # path e8 branch
        if getLight("left") > getLight("right"):

        # path e8 to action n8
                Beep()

        # path e9 branch
        if getLight("left") <= getLight("right"):

        # path e9 to action n9
                TurnLeft()

# Opaque behavior library

def ShowSensorsStatus():
        senses()

def Beep():
        beep(1, 440)

def GoBackward():
        backward(0.6,1.3)

def GoForward():
        forward(0.6,1.3)

def Wait4sec():
        wait(4)

def TurnLeft():
        turnLeft(1, .27)
```

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SysML Activities Exercise @ JPL

Team Contest Using MyroMagic Plugin & Scribbler Rovers