# Mobies Ethereal Sting OEP
# The Ptolemy II Experiment


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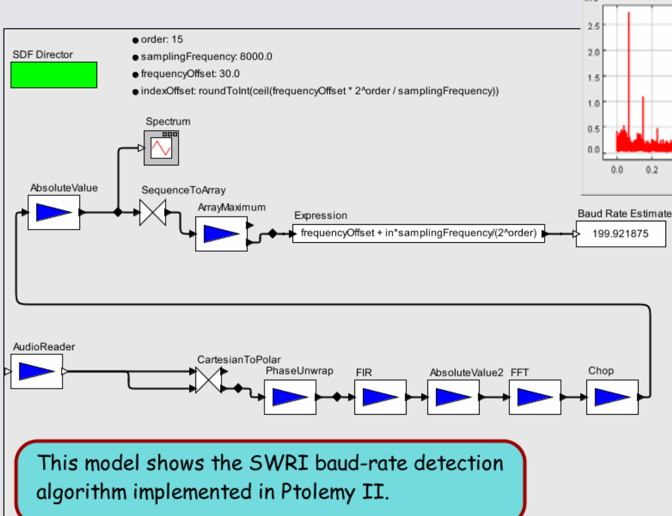
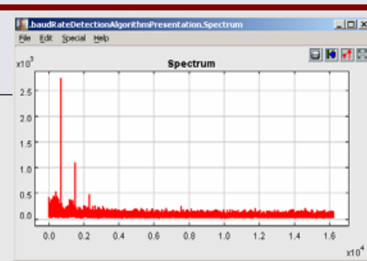
# EO Implementation in Ptolemy II

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Mark Oliver (WPAFB)
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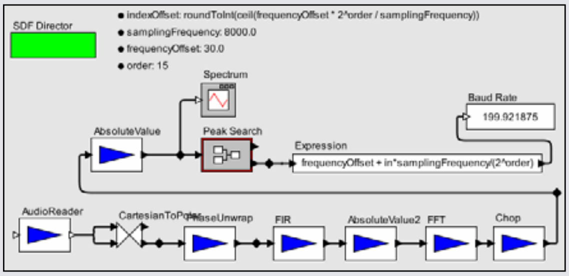
Edward Lee

# Code Generation




Automatic code generation enables rapid implementation from high-level component-based design.

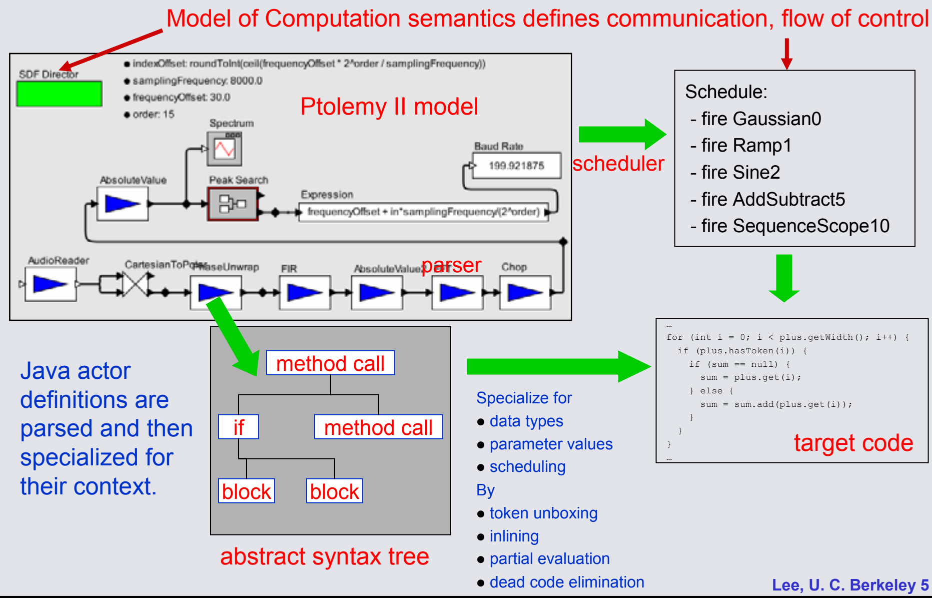
We are developing a code generation technique based on component specialization that transforms Ptolemy II models into a Java system implementation.



# From Model to Implementation

- Generator-based code generation
  - Done in Ptolemy Classic
  - Library maintenance is very expensive
- Native Java compiler
  - Drags in the development environment
  - Result is large, and has unpredictable timing
- Component specialization
  - Produce minimized Java implementation
  - Minimize or eliminate dynamic memory management
  - Compile to the target platform using one of:
    - Java to C translation
    - Native Java compiler
    - Just-in-time compiler
    - Native Java platform (e.g. Dallas Tini boards)

# Component Specialization






# Limitations Exposed by the Experiment

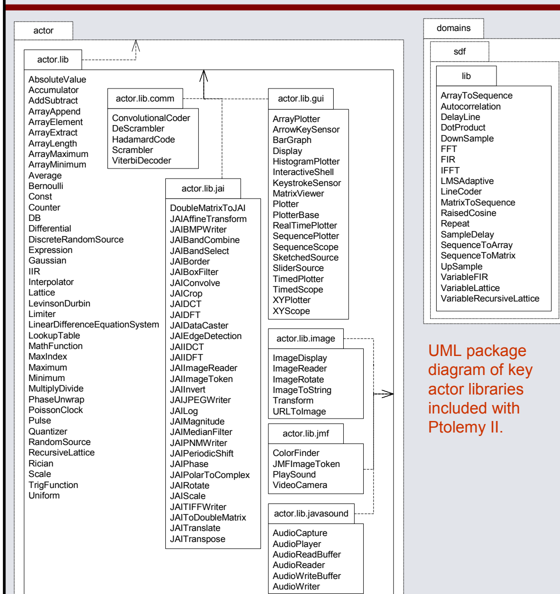
- No actor for array maximum
  - Added later by Mark Oliver, built into library
  - Easy workaround used very wide signal busses
- Type resolution was very slow when using very wide signal busses
  - Fixed by Steve Neuendorffer
- AudioReader actor was unfinished
  - Didn't use FileAttribute
  - Didn't correctly deliver stereo signals
- FFT actor performs only radix-2 FFTs
  - Could use MATLAB interface to generalize
- Component specialization framework limitations
  - Didn't handle FileAttributes
  - Error handling the absolute() function
  - Error specializing AudioReader

# Log of Effort

- Three active participants, plus some spectators:
  - 0.5 hours examining EtherealSting website and figuring out what to do.
  - 2 hours constructing and experimenting with the model to detect the baud rate. This was built by modifying a model constructed by Edward Lee at the Mobies PI meeting (which took, perhaps, 1.5 hours to build).
  - 1 hour fixing bug in AudioReader actor to use FileAttribute.
  - 4 hours experimenting with component specialization.
  - Total time: 9 hours
- 6.5 hours fixing bugs exposed by the experiment.
- The experiment stimulated further work on comm/signal processing libraries.



# Actor Libraries – Signal Processing



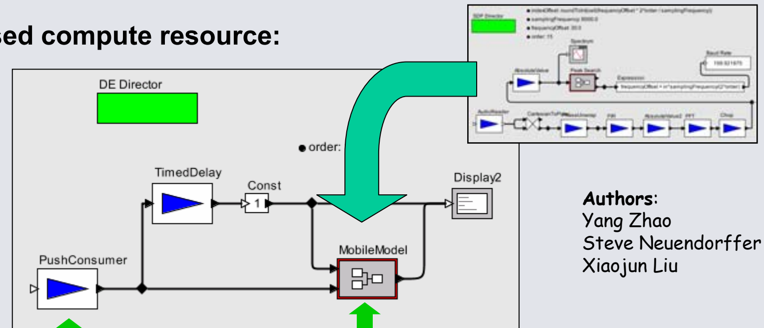

UML package diagram of key actor libraries included with Ptolemy II.

Capabilities:

- filtering
  - multirate polyphase FIR, IIR, lattice, LMS adaptive filter, dot product, up/downsample
- random numbers/signals
  - Bernoulli, Gaussian, Rician, Rayleigh, Uniform, arbitrary discrete distributions.
- linear system generators
- spectral estimation library
  - FFT, periodogram, maximum entropy
- comm functions:
  - Viterbi decoder (MLSE), convolutional/block coder/decoders, PN sequence generation, scrambling/descrambling, raised cosine
- array and matrix operations
- rich expression language / actor
  - extensive function library
  - MATLAB-like matrix comprehension
  - higher-order functional semantics
  - sophisticated, integrated type system
- interpolator, phase unwrap, lookup table, signal generators, trig functions
- signal plotters
- extensive image processing library
  - based on Java JAI, JMF
- audio interfaces

# Supervisory Structure
# Experimental SA Compute Resource

**Model-based compute resource:**

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**PushConsumer actor receives pushed data provided via CORBA, where the data is an XML model of an SA algorithm.**

**MobileModel actor accepts a StringToken containing an XML description of a model. It then executes that model on a stream of input data.**



# Supervisory Structure
# Experimental Task Manager

**Model-based task manager:**

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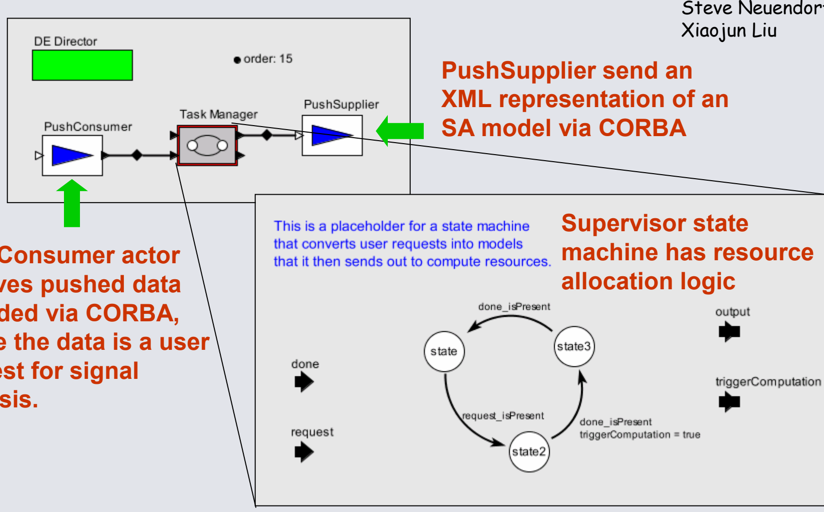
**PushSupplier send an XML representation of an SA model via CORBA**

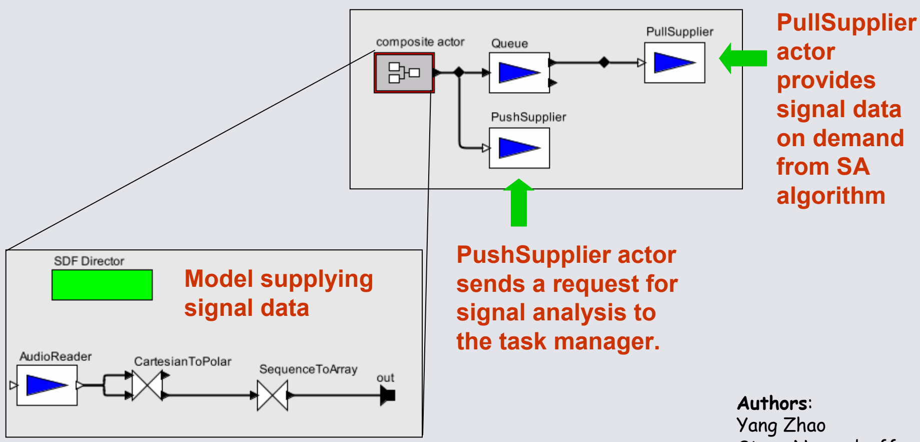



**Supervisor state machine has resource allocation logic**

**PushConsumer actor receives pushed data provided via CORBA, where the data is a user request for signal analysis.**

# Supervisory Structure
# Experimental User Model

**User model:**





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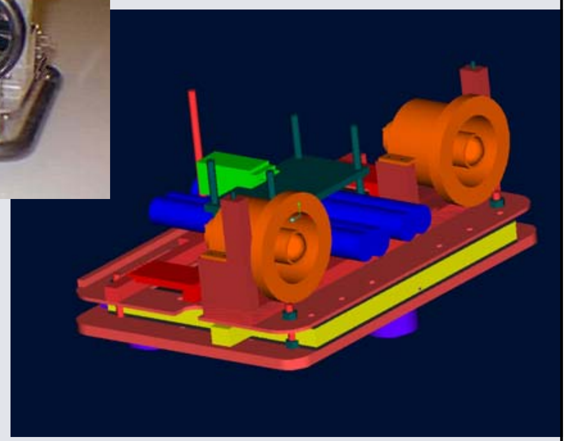
# To Do

- Handle failures of mobile model
  - use "model error handler" mechanism in Ptolemy II
- Secure execution of mobile model
  - all Java code executed is locally defined
  - mark actors and directors that convey no authority
  - set MobileModel security level to restrict actors
- Encrypted communication of models & data
  - currently XML plain text
- Authenticated access to MobileModels
  - consider using "capability" mechanisms
  - use peer-to-peer technology to "discover" capabilities.

# Another Application: Controlling the Caltech Ducted Fan Vehicle

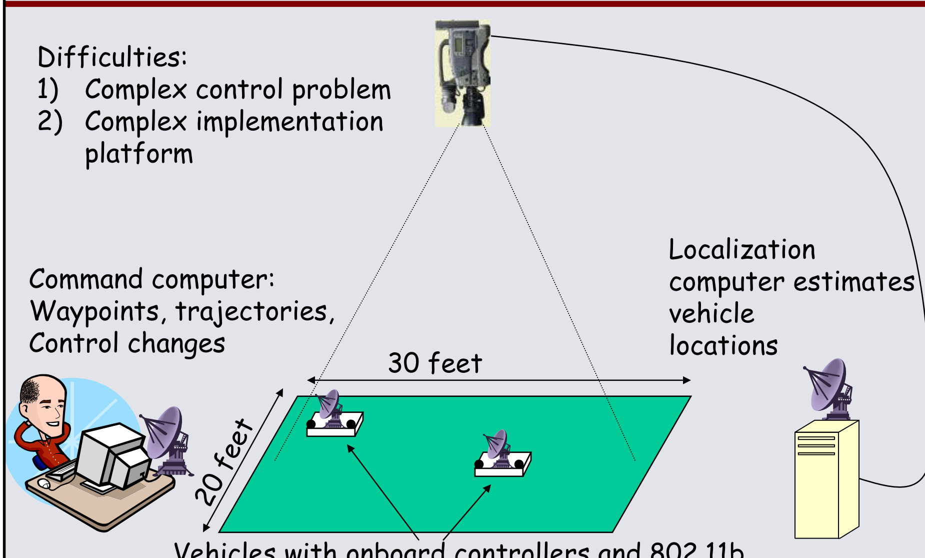
This effort is applying Mobies technology to the SEC program





# Caltech Vehicles

Difficulties:
1) Complex control problem
2) Complex implementation platform



# A Detailed Heterogenous Model

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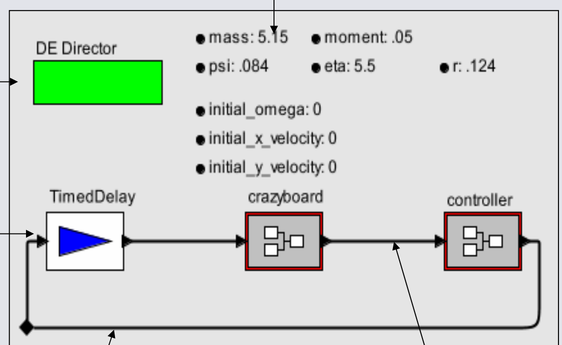
Measured Physical Parameters

Discrete Event model convenient for events that do not occur at the same time.



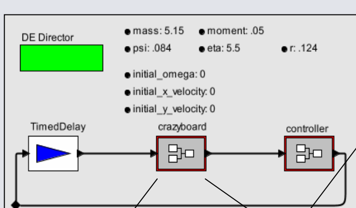

Model of computation and communication delay.

Array of 3 Bytes:
{85, *Left*, *Right*}
Sent immediately after controller computes value

Array of 50 Bytes:
{ *TimeStamp, ID, X, Y, Angle*}
60 times a second



# A Detailed Heterogenous Model




Continuous time model of vehicle dynamics

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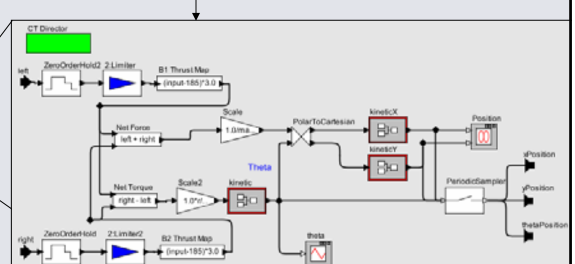


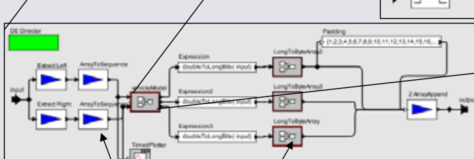


Fan Thrust Map

Data formatting

# A Detailed Heterogenous Model

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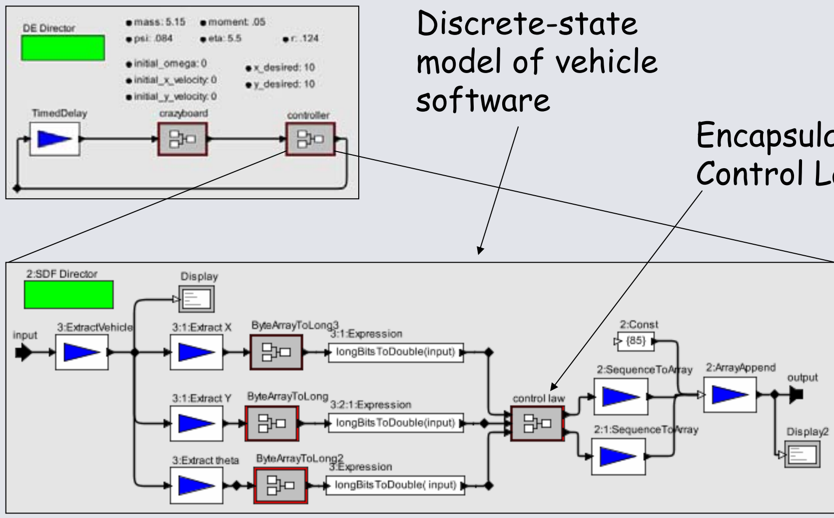
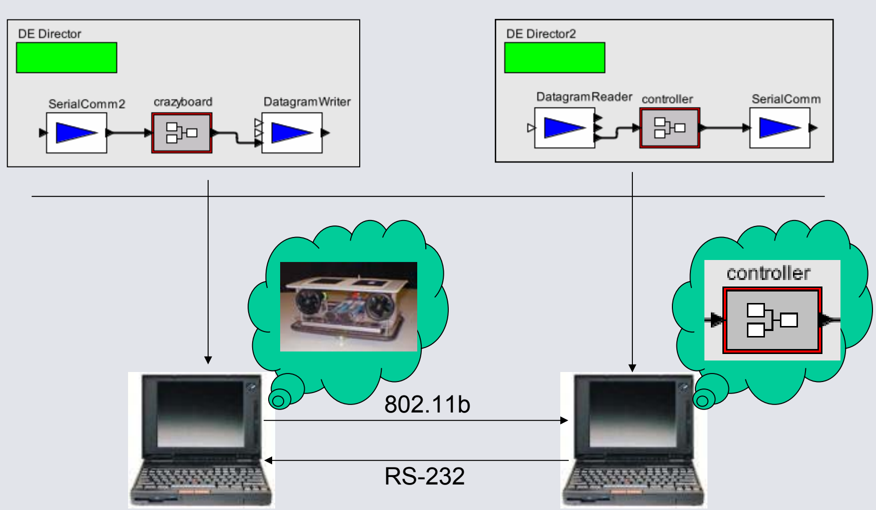
Discrete-state model of vehicle software

Encapsulated Control Law





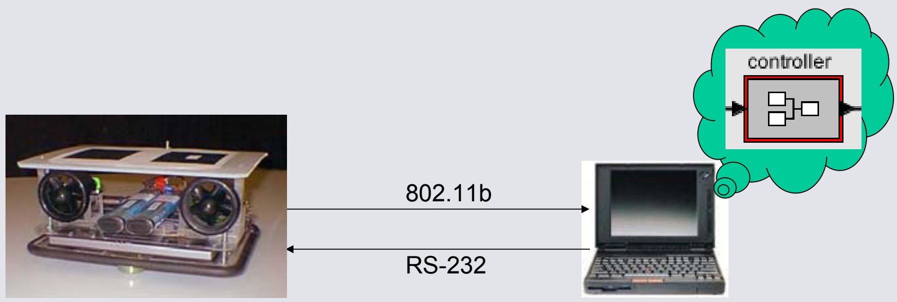

# Towards Implementation



# Hardware-in-the-loop

Replace hardware-true simulation model with actual vehicle.

Allows validation of continuous dynamics model, and hardware/software interface.

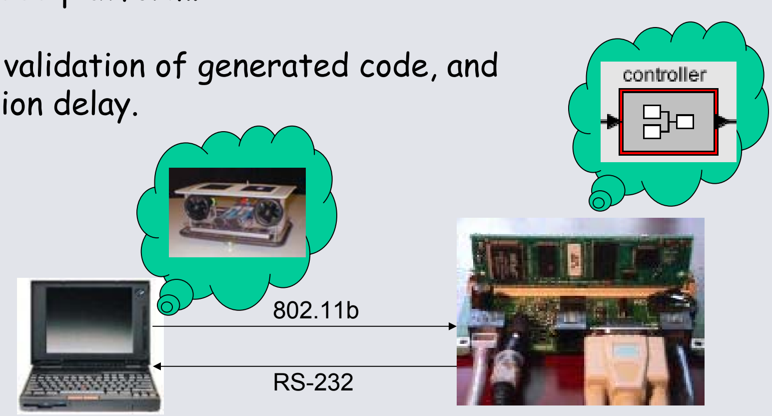





# Simulation-in-the-loop

Code generation of the controller onto an embedded platform.

Allows validation of generated code, and execution delay.




Embedded Java Platform

## System Implementation

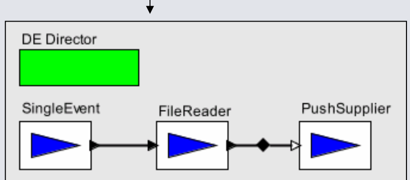
The generated code forms the final system implementation.


Embedded Java Platform

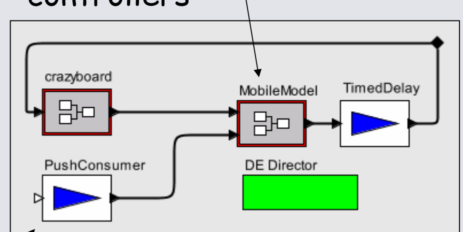


## Controller Updates

Simplified model of base station




Mobile model allows substitution of different controllers




Controller component transmitted over publish/subscribe network

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