Integrating Statechart Components in Polyglot

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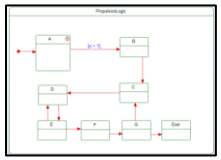
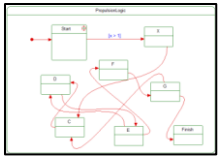
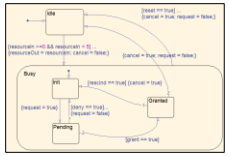
Motivation



UML
Statecharts



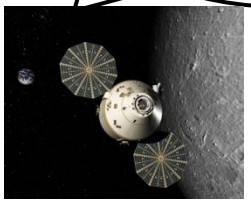
Stateflow
Statecharts



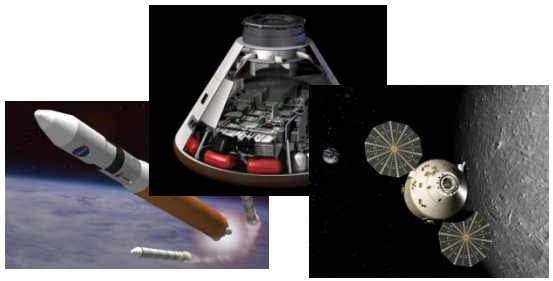
Rhapsody
Statecharts

Ares

Orion



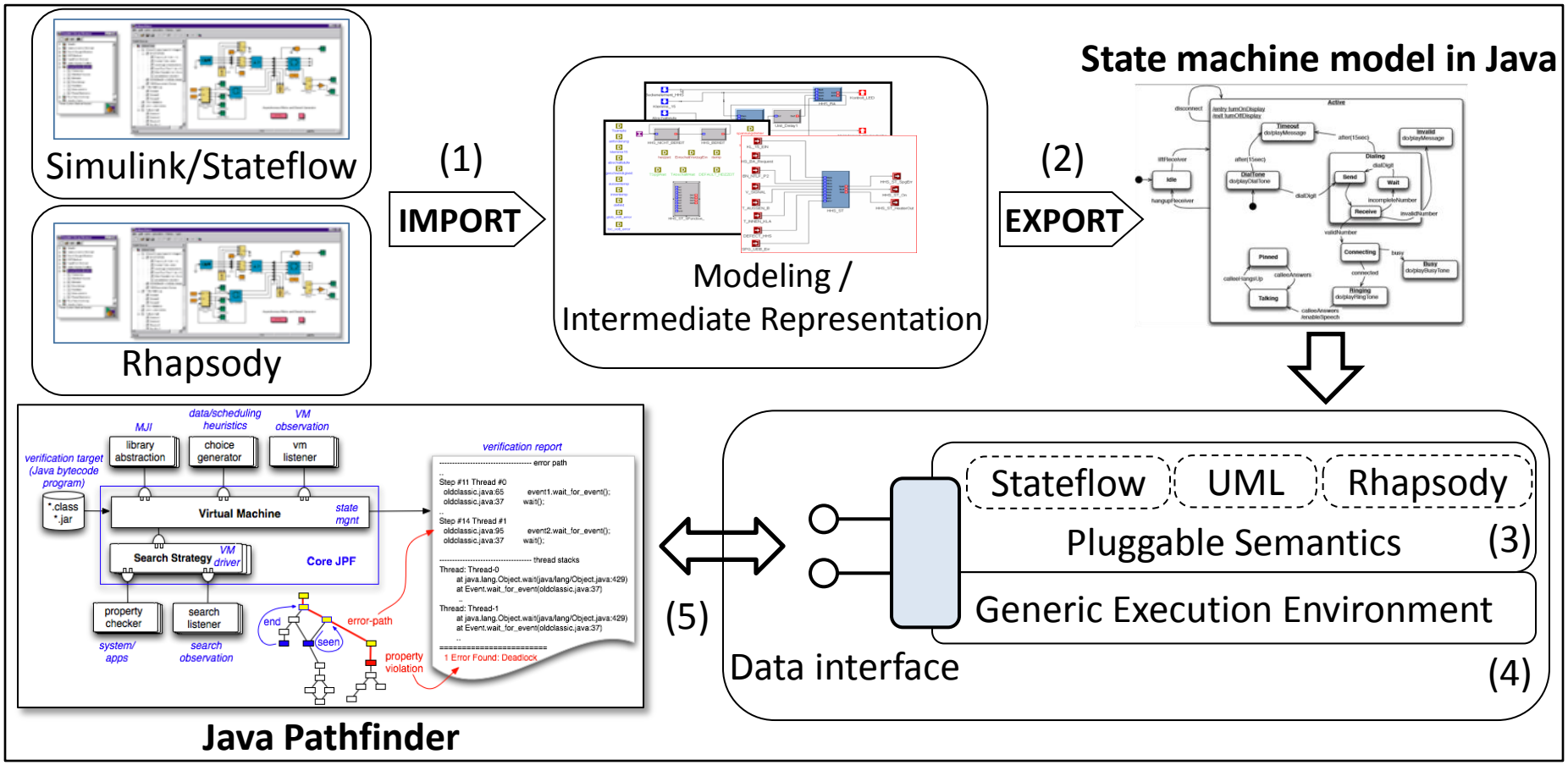
Orion (software framework)



Integrated system

Integrated system can't be analyzed at the model level in any of the original environments…

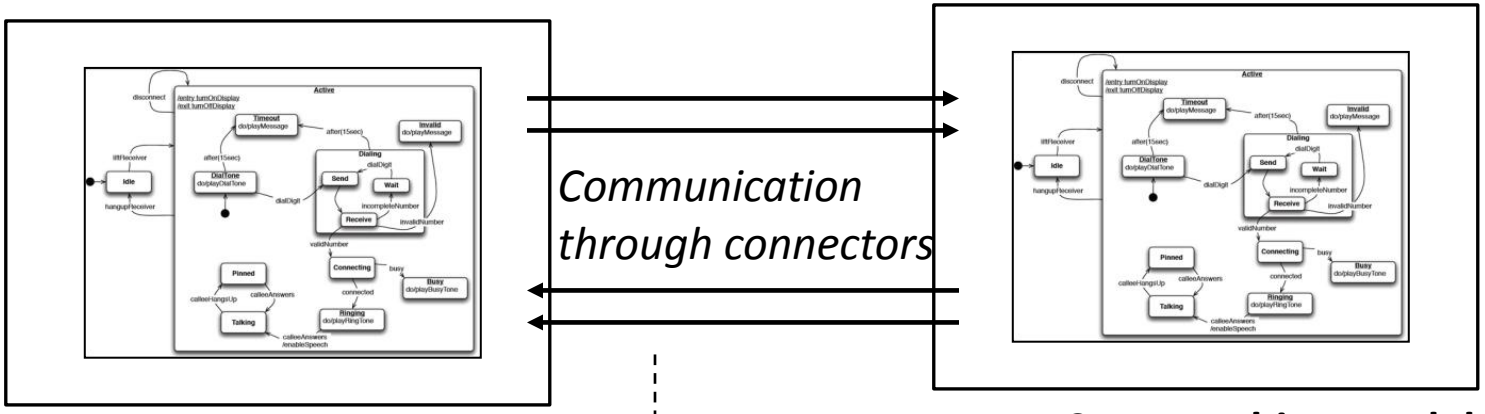
Polyglot: a Statechart Analysis Framework



What about communicating, asynchronous components?

Extension 1: Connectors

- A **connector framework** provides generic communication mechanism.
  - Basic mechanism is FIFO, non-lossy. Library includes lossy and non-FIFO connectors.



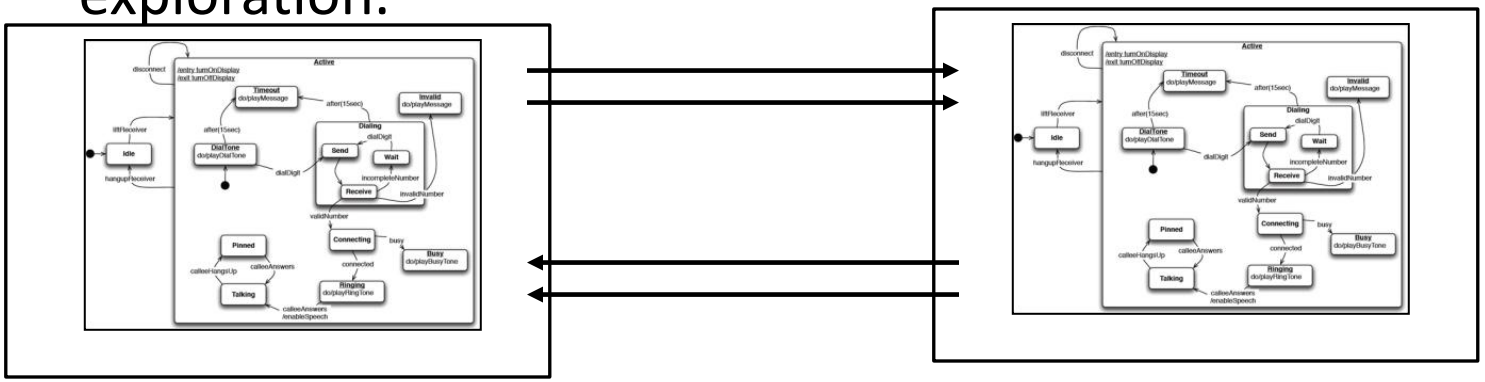
Stateflow model

UML Statemachine model

```
public interface Connector {
  boolean recvFrom(Component to, Component from, Object[]  res);
  boolean sendTo(Component from, Component to, Object arg);
}
```

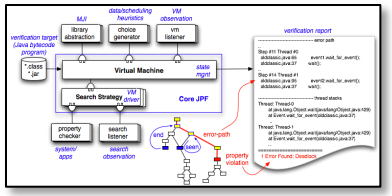
Extension 2: scheduling

- A generic **scheduling framework** sequences component execution and property checking.
  - Basic version is non-deterministic. Integrated with JPF for exploration.



Stateflow model

UML Statemachine model



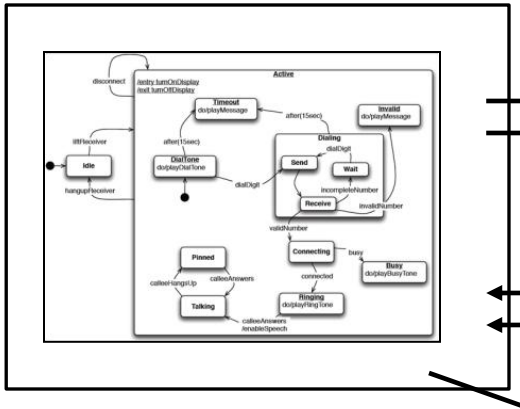
Java Pathfinder

Guides execution

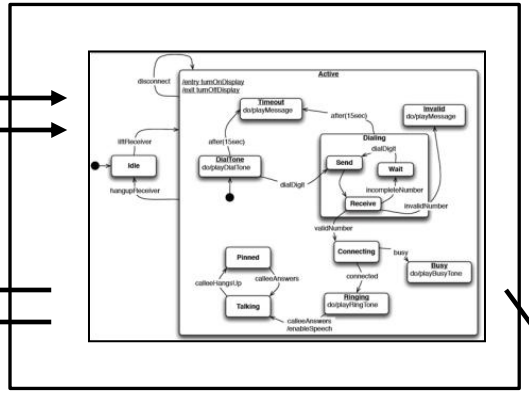
```
class BasicScheduler extends Scheduler {
  public void run {
    // non-deterministically choose component
    // check properties (next)
}
```

Extension 3: properties

- Observer automata used to check properties

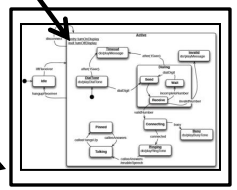


Stateflow model



UML Statemachine model

inputs

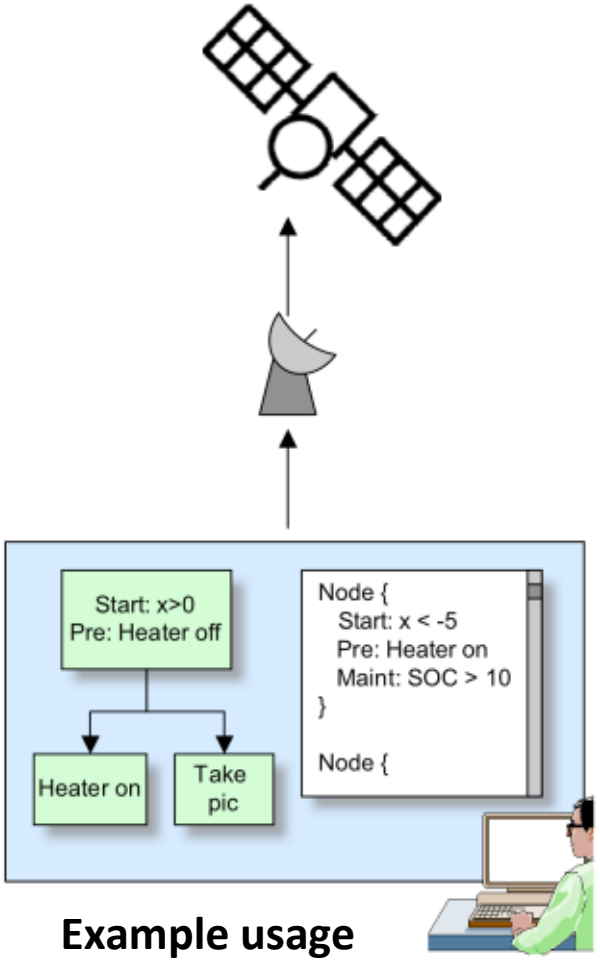


Observer automaton

```
public class Observer {
  void run() {
    // determine state of observed components
    // check property
    // report violation
  } }
```

Plexil integration

- PLan EXecution Interchange Language
- Reactive, synchronous, and deterministic language for commanding and monitoring space systems



Example usage

PLEXIL to Java translation

- Plexil uses implicit state machine nodes and a 3-valued logic (True, False, and Unknown), interacting with the outside world using lookups
- Initially, JPF took over ***13 hours*** to verify a relatively simple plan
  - Choice points for lookups were being created on demand in the middle of a step, causing JPF to capture irrelevant state information
  - By precomputing values between steps, that ***time dropped to just 8 minutes***, with further optimizations possible
- JPF verification uncovered a problem when If(Unknown) occurred, where the Then and Else branches would not start (since the expression was not true or false) causing the plan to become unresponsive
- Regression testing against the reference PLEXIL implementation also revealed a possible infinite loop in a state machine

Ongoing work

- More efficient analysis of Plexil plans
- Efficient symbolic execution of Statecharts in Polyglot
  - Custom symbolic execution engine, multithreading

Questions?