Java, Threads, and Ptolemy

A New Direction for Ptolemy

Ptolemy Miniconference

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Why Java?

- Because Java is
  - Portable
  - Distributable (Applets)
  - Cleaner than C++
  - Threaded
  - Buzzword Compliant
- Itcl complements Java
  - Java is low-level
  - Itcl is high-level & scripted

Building on the Ptolemy Experience

- Separate Domains (current)
  - Strict Information Hiding
  - Hierarchical Nesting of Models of Computation
  - Simulation vs Code Generation
- Integrated Domains (future)
  - More seamless Programming Model
  - More seamless User Interface
  - Potential for Better Synthesis
  - Modularized Programming Environment
  - Deployable, Modular Design Tools

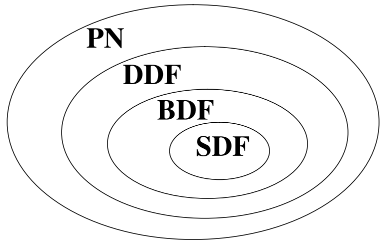
Integrated Domains

- We have learned a lot
  - Domains have helped
  - We can exploit what we have learned
- Models of Computation
  - Kahn Process Network (PN)
  - Dynamic Data Flow (DDF)
  - Boolean Data Flow (BDF)
  - Synchronous Data Flow (SDF)
  - Finite State Machine (FSM)

Increasing specialization: More efficient execution

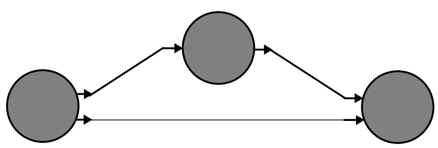
Control

Models of Compuation to be Integrated



- **PN: Sequential processes**
  - **communication via FIFO channels**
  - **blocking read when channel is empty**
- **DDF: Run time firing of actors, mutable graph**
- **BDF: Compile time analysis => firing sequence**
- **SDF: Periodic firing sequence**

Implementing PN in Java



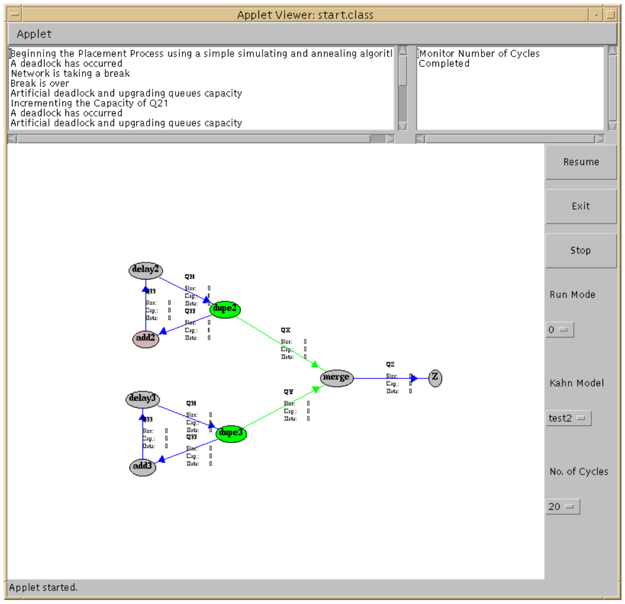
Icon	Object	Implementation
Circle	Process	Thread
Connecting Line	FIFO Channel - Unbounded - Blocking Read	List - Expandable - Wait & Notify

PN vs Java Threads

- **Threads are low-level & non-determinate**
- **PN is high-level & determinate**
- **Use Java Threads to implement higher level concurrence model**

Prototype PN in Java

Student Project for EE290N, Fall ‘96



- **Participants**
  - **Peggy Laramie**
  - **Marlene Wan**
  - **Dick Stevens**
- **Define Processes**
- **Connect Processes**
- **Run**

Technical Issues

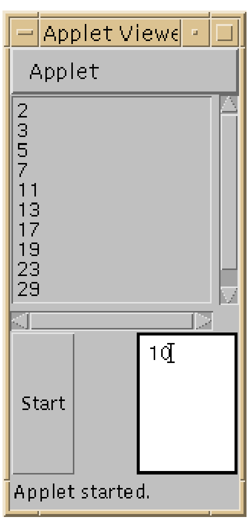
- **Will a PN eventually halt?**
  - **In SDF - Decidable in finite time**
  - **In general - Undecidable**
- **If not, will it execute in bounded memory?**
  - **In SDF - Decidable**
  - **In general- Undecidable**
  - **Tom Parks: Execute in bounded memory if possible**

Executing a PN in Bounded Memory

Tom Parks' Algorithm

- Set a capacity on each channel
- Block write when channel is full
- Repeat
  - Run until deadlock occurs
  - If never deadlocks, then problem solved
  - If deadlock and no blocking writes, then PN halts
  - Among channels that block writes, select one with lowest capacity
  - Increase capacity of selected channel
- Infinite time to decide
  - Whether PN halts
  - Whether PN executes forever in bounded memory

Applet to Generate Primes



- Sieve of Eratosthenes
- Mutable Graph
  - Processes to generate 2, 3, 4, ...
  - Process to filter multiples of 2
  - Dynamically add process for each new prime
- Run from within Tycho using the Tcl/Java interface

Status

- **Project: Prototype demonstration**
  - **Process Networks: Blocking Reads**
  - **Implemented in Java**
  - **Execute in Bounded Memory when possible**
- **Tycho/Java Environment**
  - **Applet to generate primes**
- **Currently Building Java Kernel**

Summary

- **Java implementation for Ptolemy**
  - **Portable, Distributable, Multi-Threaded**
  - **Build on past experience**
  - **Use same Itcl interface**
  - **Merge simulation, code generation**
  - **Merge hierarchical models of computation**
- **Approach**
  - **Generic Kernel to support multiple domains**
  - **Start with PN domain, PN model**
  - **Add more specialized models DDF, BDF, SDF**
  - **Add other models DE, VHDL, SR, ...**