Efficient Simulation Model for Hybrid Bond Graphs

Edited and presented by
Christopher Beers
ISIS, Vanderbilt University
Introduction

- **Simulation of hybrid systems must combine two models of computation**
- Hybrid Bond Graphs (HBGs) combine
  - Continuous bond graph (BG) models with
  - Switching junctions controlled by FSM
to provide a topological framework that supports run-time model reconfiguration
- However, no computational model associated with HBGs

**Question:** How does one systematically derive simulation models from HBGs?

- **Approach:** Use causal structure implied by BG to derive block diagram models for simulation (SCAP algorithm)
# HBG Overview

- **BG to Block Diagram Computational Model**
  - Constituent element blocks + algebraic relations at junctions

- **Determining Bond (DB)**
  - One per junction, derived from causality at junction
  - Determines algebraic relations

- **HBG Complexities**
  - Junction switches (on and off) may cause causality changes at runtime, thus block diagram may change
  - Only changes in DBs will change algebraic relations at junction
  - These changes can propagate
Approaches

- Pre-generate block diagrams for all modes
  - $2^n$ possible configurations
- Generate block diagrams from scratch after every mode change
  - Can be computationally expensive at switches
- Smarter approach: derive new block diagram incrementally from old
  - Start with block diagram in initial mode
  - Look for changes in DBs
    - Update block diagram at changes

"Efficient Simulation Model for Hybrid Bond Graphs," C. Beers
Efficient Simulation Model

- Causality update triggered by change in discrete state
  - Start at junctions which switch
  - If they cause changes in adjacent junction DBs then
    - update DB's algebraic constraints
  - Continue till no DB change or all junctions visited
- For efficiency, junctions implemented as S-functions; use global variables (cf. Ptolemy's director function)
Questions?