Parallel Simulation of Systemc Loosely-Timed Transaction Level Models

Master of Science Thesis

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Overview

Motivation

- This project stems from the work of Björn Runåker:
  speeding up the simulation of 5G radio base stations.
- A **coarse-grained** approach was adopted:
  multiple instantiations of SystemC's simulation engine.
- But motivated a **finer-grained** approach:
  parallelism within a single instance?

Problem Statement

- The verdict is categorical:
  SystemC's Reference Simulation Environment must be **bypassed**.

- Transaction Level Modeling in SystemC:
  breaks the separation of concerns between execution and communication.

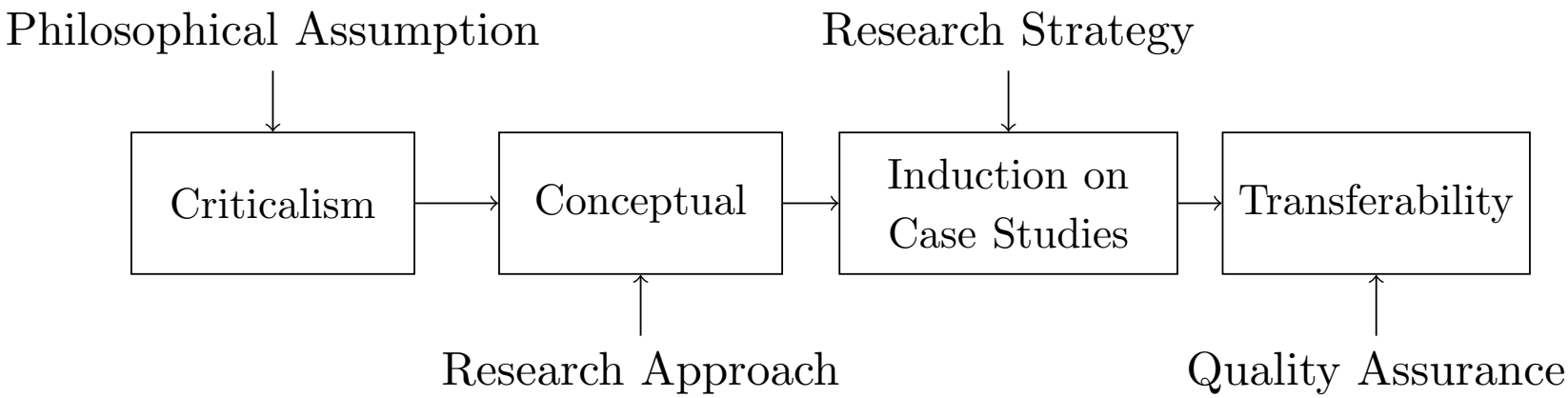
- **Address the question:**
  can we transform a SystemC TLM 2.0 LT model simulation into a parallel application?

Purpose

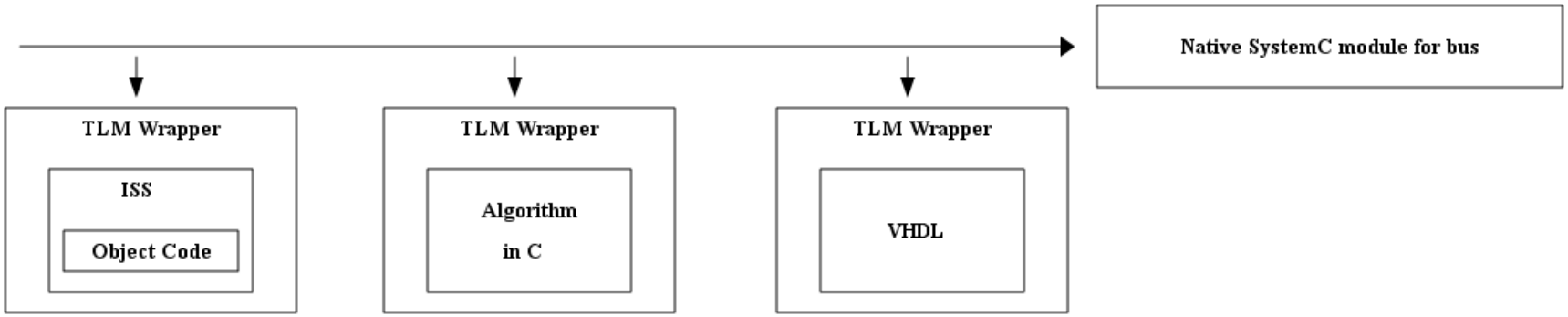
- SystemC TLM 2.0 used to construct **Virtual Platforms**:
  enabling hardware/software co-simulation.

- From SystemC Evolution Day 2016:
  "SystemC must embrace true parallelism
  otherwise it will go down the same path as the dinosaurs"

Qualitative Research Methodology



The Role of SystemC TLM 2.0

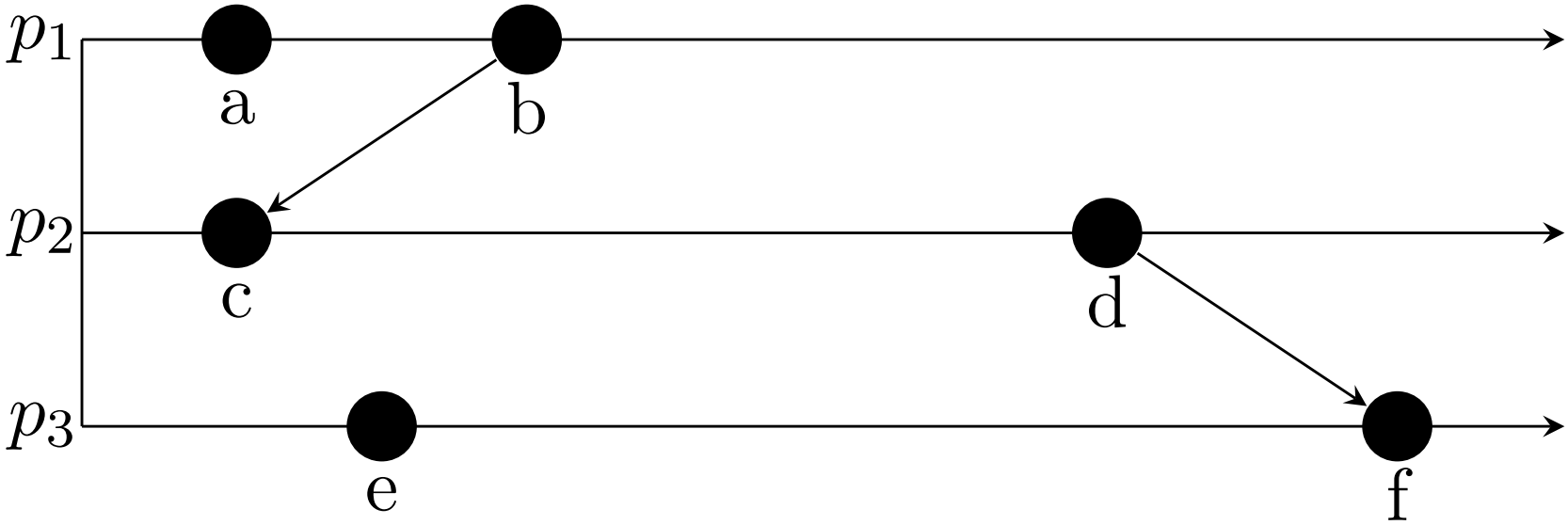


Enabling the reuse of IP components in a ”plug and play” fashion.

The DE Model of Computation

- Provides the **operational semantics** of:
  Electronic System-Level Design Languages.
- A model is a system of:
  processes that **execute** and **communicate**
- Logic Time vs Real Time:
  logic time is also relativistic.

The DE Manifold



Execution:

$$b = f(a) \implies a \propto b \implies a \sqsubset b$$

Communication:

$$c = g(b) \implies b \propto c \implies b \sqsubset c$$

SystemC's DES

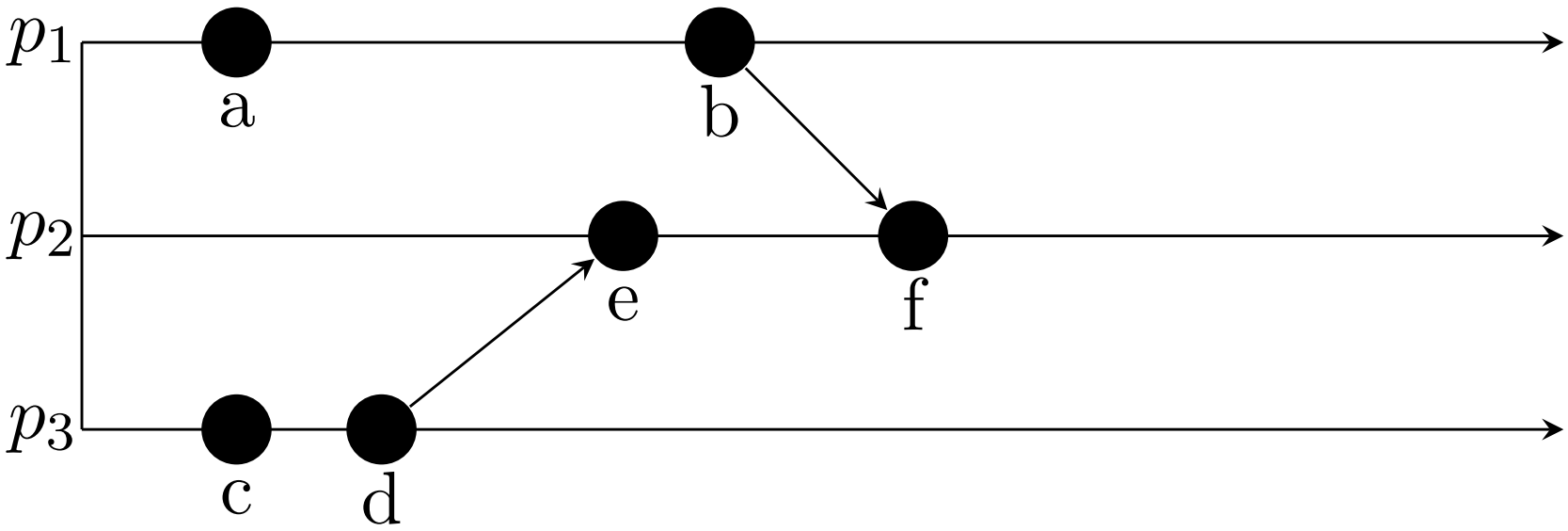
- A realization of the DE MoC:
  is a **Discrete Event Simulator (DES)**.
- SystemC's DES:
  uses **coroutines** to emulate space dimensionality.
- Enforces a global perspective on logic time:
  since space is emulated.

Parallel DES

- A Parallel DES preserves spatial decomposition:
  processes must keep their own perspective of logic time.

- Communication is **Synchronization**:
  a global perspective of logic time is realized
  through communication.

Causality Hazard



Event e might occur earlier in real time than f.

Event e may causally affect event f.

How can p_2 determine when it is safe to advance its logic time perspective?

The End