

Behavioral Primitives Analysis

An Approach for Selecting Models of Computation

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Introduction

- The problem : Choosing Models of Computation
 - Motivation
- Our approach
- Methodology
- Preliminary results
- Ongoing and future work

Motivation

- Previous work at our group
 - ATM Switch
 - E1 Signalization
- ATM
 - simulation : SDF + DDF
 - synthesis : VHDL + CGC
- E1
 - simulation : SDF + DE
 - synthesis : SDF

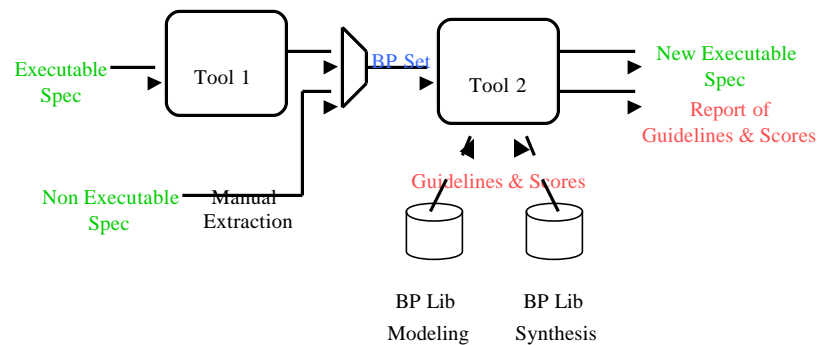
Motivation (2)

- Both designs contained much control flow
- Heavy use of SDF, why?
 - Some data flow
 - Too many models
 - Designers with little background
- Correct specifications where obtained, but ...

Concept

- “Behavioral Primitive” (BP)
 - basic behavior employed by a designer when capturing a subset of the system
 - analogy to a basis from linear algebra
 - BP actually a “pseudo-basis”

What we Need



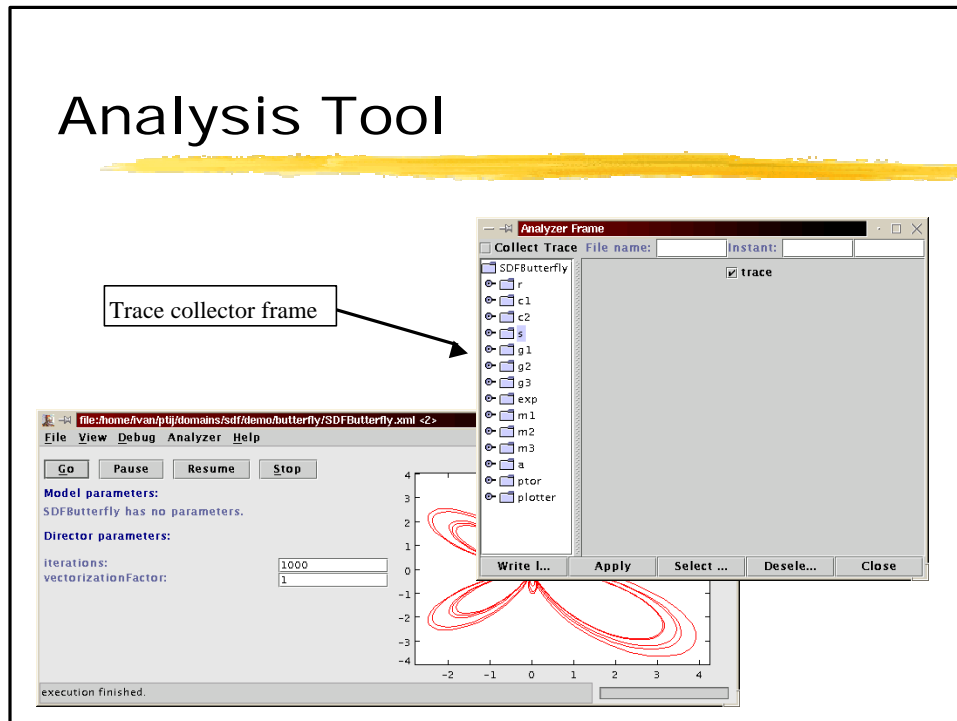
Our Work

- Methodology
 - Capture a BP using one or more toy benchmarks under different MoCs
 - Analyze the results of the execution
- Analysis result: a matrix where each position is the rank for the respective pair (BP, MoC)
 - need for good ranking metrics

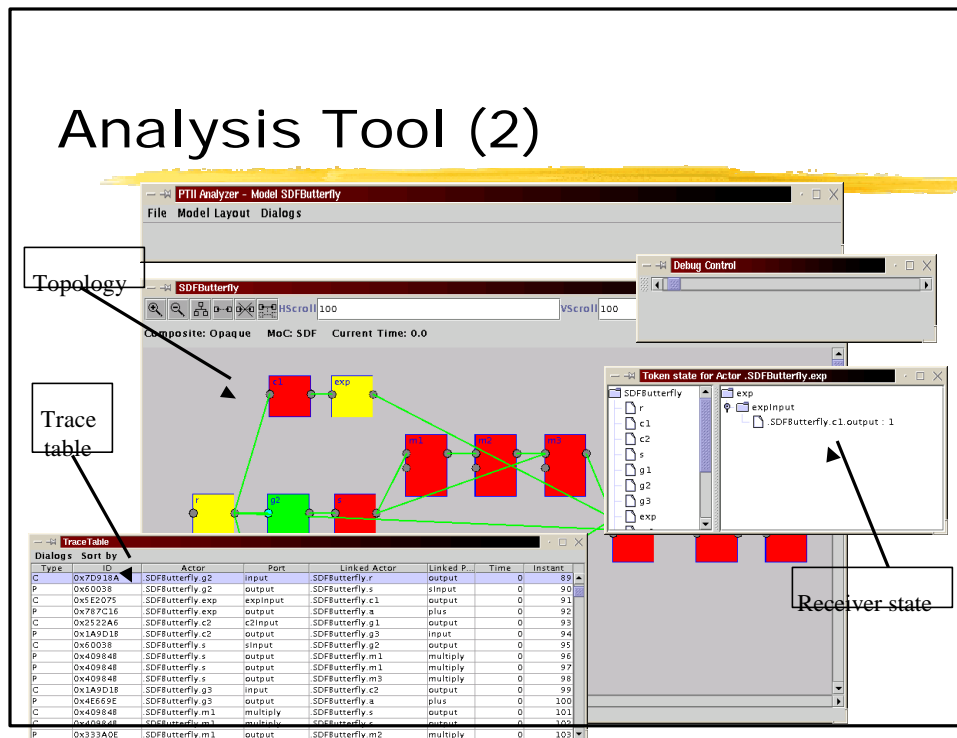
Our Work (2)

- We developed a prototype of a tool to aid the analysis of a specification execution
 - record token exchange and actor's state
 - debugging and profiling capabilities
- It can be used for
 - providing insight into the use of a MoC
 - evaluating different execution policies of a MoC
 - finding errors in a specification
 - optimizing specifications

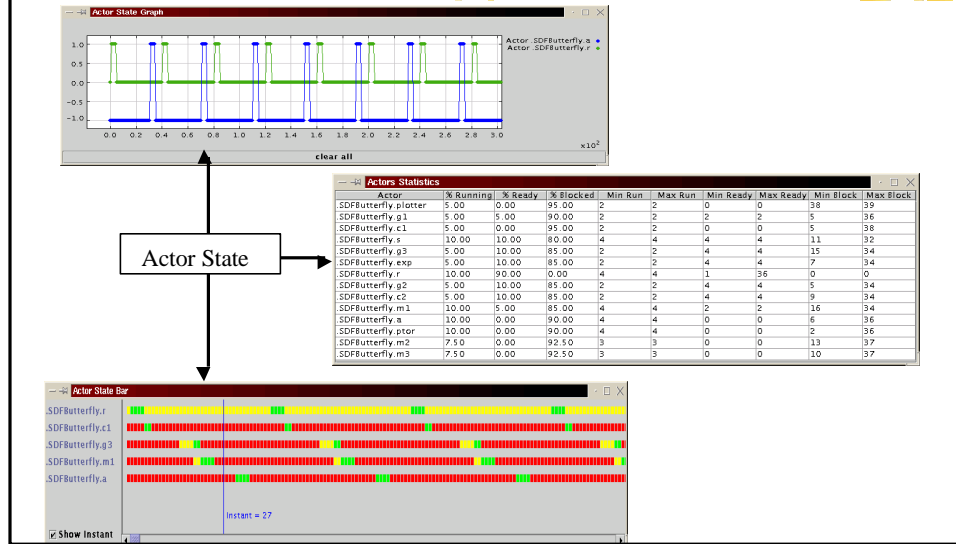
Analysis Tool



Analysis Tool (2)



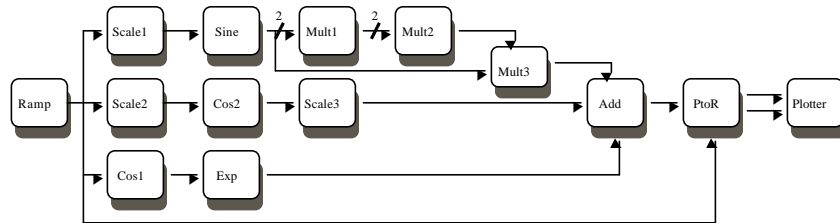
Analysis Tool (3)



Behavioral Primitives

- Basic Block - butterfly curve
- Conditional Execution - line slope
- Fixed Length Iteration - matrix multiplication
- Synchronism (data) - DCT
- Resource Sharing - dining philosophers
- Concurrency (data) - trapezoidal rule
- Preemption - ABRO
- Recursion - Fibonacci
- others

Basic Block



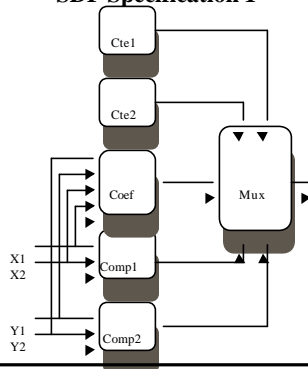
- Specification
 - domain polymorphic actors
- Execution
 - trivial schedule for all MoCs
 - deadlock situation with CSP

Conditional Execution

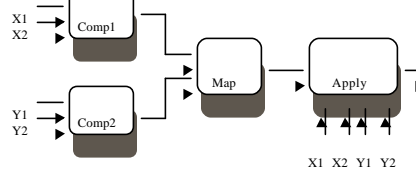
- Specification
 - SDF: problem with actors always being fired

```
double coeff(int x1, int y1, int x2, int y2) {
    if(x1 == x2) {           // Cond1
        return 1.0;         // Cte1
    } else
    if(y1 == y2) {           // Cond2
        return 0.0;         // Cte2
    }
    else {
        return (double) (y1 - y2)/(x1 - x2); // Coef
    }
}
```

SDF Specification 1



SDF Specification 2

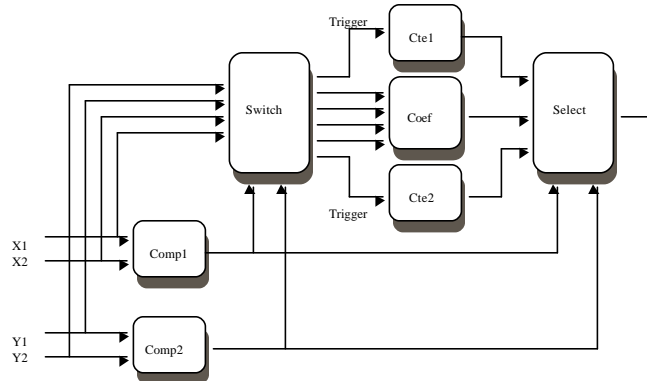


Conditional Execution (2)

■ Specification

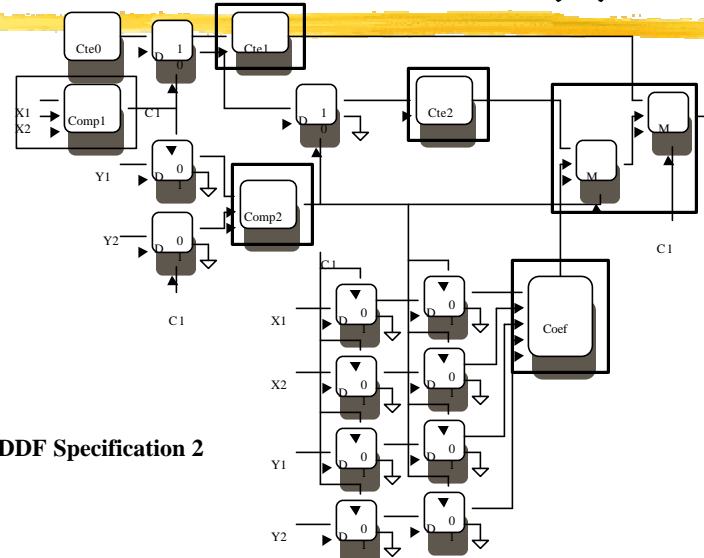
■ DDF

DDF Specification 1



Conditional Execution (3)

DDF Specification 2

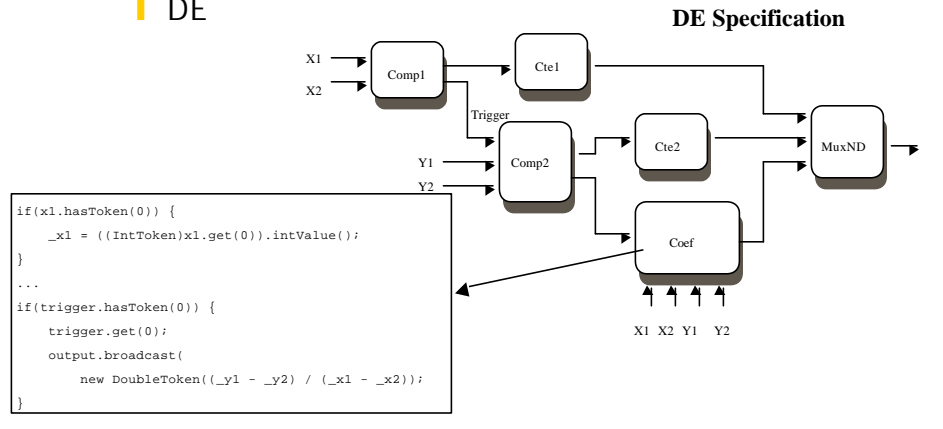


Conditional Execution (4)

- Specification

- CSP and PN: same as DDF

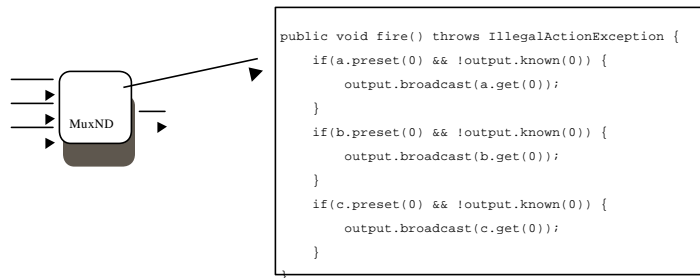
- DE



Conditional Execution (5)

- Specification

- SR : employed a non-monotonic actor



- Execution

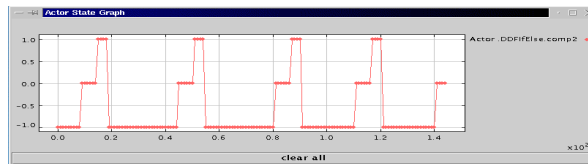
- DDF : second specification more efficient in terms of firings but had longer running time

Conditional Execution (6)

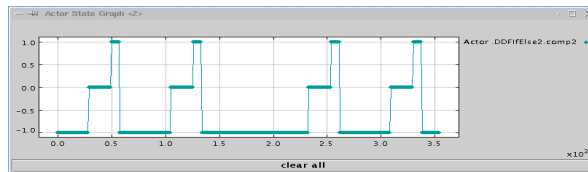
- Execution

- DDF

DDF Specification 1



DDF Specification 2



Execution

CSP : again deadlock due to actor D

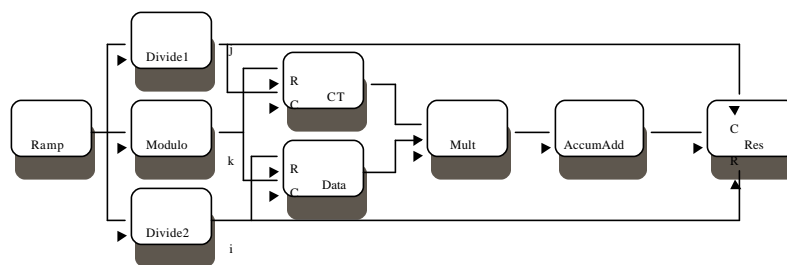
Fixed Length Iteration

- Specification

- Polymorphic

```

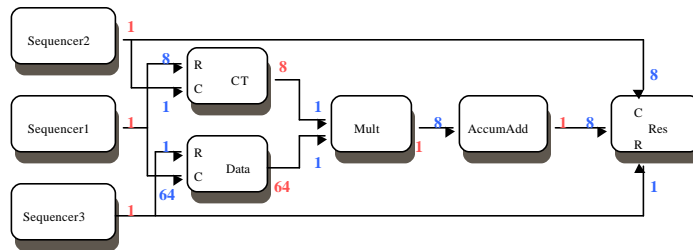
for(int i = 0; i < N; i++) {
    for(int j = 0; j < N; j++) {
        for(int k = 0; k < N; k++) {
            res[i][j] += data[i][k] * cT[k][j];
        }
    }
}
    
```



Fixed length Iteration (2)

- Specification

- SDF : non unitary sample rates



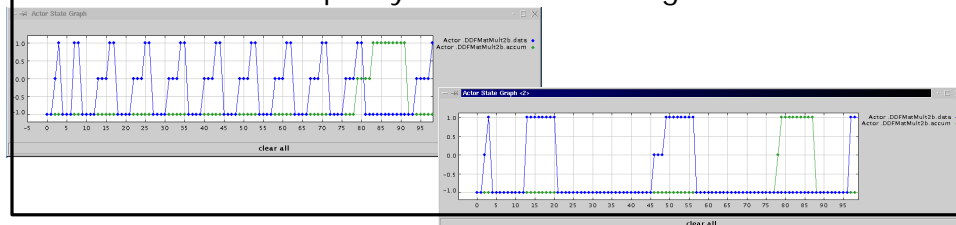
Fixed length Iteration (3)

- Specification

- PN, CSP and DDF : blocking reads
- DE : event driven
- SR : *makeAbsent()* method

- Execution

- SDF : FIFO Capacity x Unnecessary token production
- DDF : FIFO Capacity x Actor Scheduling



Final Remarks

- Our approach : based on the idea of decomposing a specification in a number of primitive behaviors
- Status : we are building the BP libraries
- Tasks : tool, examples with a few TB
- Identification of a set of BP
- Too early to draw relevant conclusions

Future Work

- Near
 - extend the study to other primitives and MoCs
 - give a theoretical basis to the analysis
 - specifications with multiple BP/MoCs
- Far
 - add intelligence to a GUI in order to compose / decompose actors
 - include synthesis metrics
- Hopefully
 - find a strategy to decompose a specification into BP
 - develop a tool that will recognize when to use a MoC