

Formal and Executable Contracts for Transaction-Level Modeling in SystemC

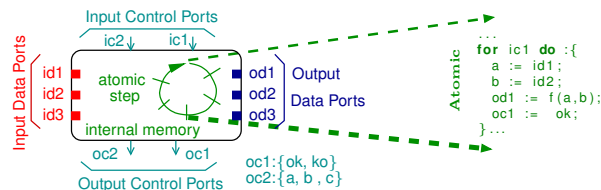
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Context of the Work

A System-on-a-Chip (SoC) consists of a dedicated hardware platform plus the application software running on several processors. Software developers need virtual prototypes (executable models) of the hardware.

42 Component-Based Model [GPCE'07]



42 (inspired by Ptolemy [Ptolemy]) is a component-based approach to the virtual prototyping of embedded systems. 42 distinguishes control and data flows.

Motivations

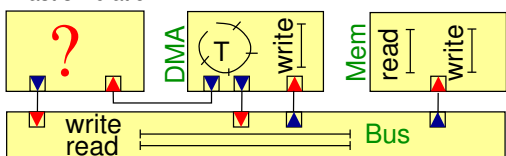
Combining the use of an engineering language with the advantages of a formal component-based model:

- Distinguish between the simulation mechanics and the model semantics
- Propose executable contracts for SystemC-TLM components
- Provide a lightweight simulation for SystemC-TLM
- First steps towards formal verification of synchronization bugs in SystemC-TLM

Transaction Level Modeling with SystemC

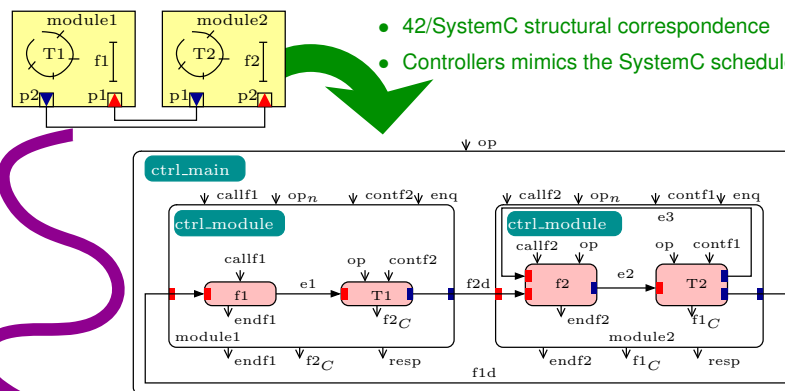
SystemC: a de facto standard for the virtual prototyping of SoCs:

- Early available models
- Component-based
- Fast simulation

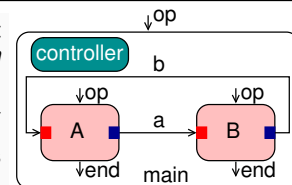


Contributions

- 42/SystemC structural correspondence
- Controllers mimics the SystemC scheduler

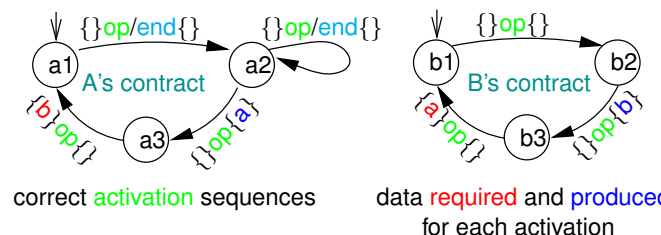


The controller is a small program that defines a MoCC (Model of Computation and Communication). It translates an activation of the component *main* into a sequence of: i) activations of the sub-components (A, B); ii) data exchanges through the wires.

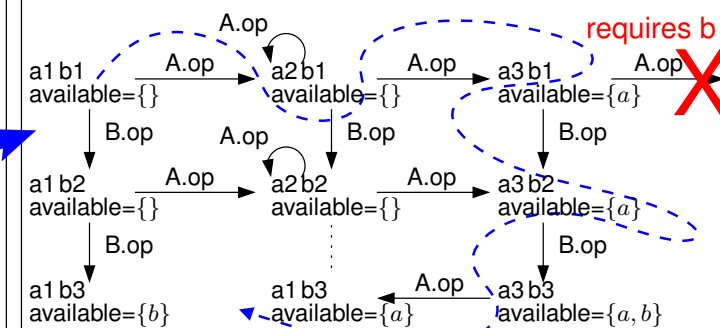


Executable Control Contracts [COORD'09]

control produced for each activation



correct activation sequences data required and produced for each activation



Example execution path

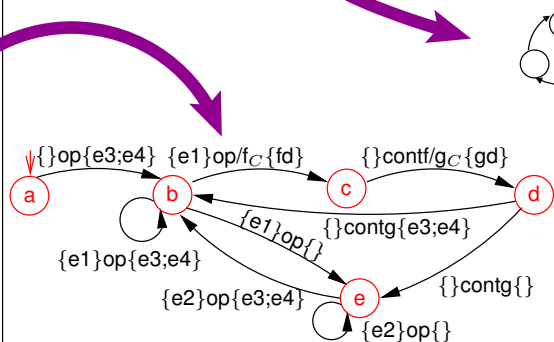
Contract Execution:

- A 42 controller can be an interpreter of the contracts
- It selects randomly a path in the asynchronous product, compatible with data dependencies

Example SystemC Code

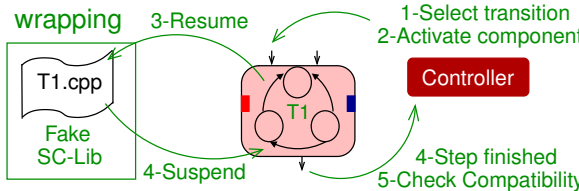
```
@while (true){
  x++;
  e3.notify();
  e4.notify();
  @wait(e1);
  if (x < 42){
    @p.f(x);
    @p.g(x);
  }
  y=x+1;
  while (y < 5){
    y++;
    @wait(e2);
  }
}
```

Automatic extraction of control contracts from SystemC code



- An execution mode for contracts only
- Checking synchronization problems

- Parallel execution of contract and SC-code
- Checking implementation correctness



[GPCE'07] F. Maraninchi and T. Bouhadiba. 42: Programmable models of computation for a component-based approach to heterogeneous embedded systems. In *ACM GPCE*, Salzburg, Austria, Oct. 2007.

[Ptolemy] J. Buck, S. Ha, E. Lee, and D. Messerschmitt. Ptolemy: a framework for simulating and prototyping heterogeneous systems. *International Journal of Computer Simulation*, 4:155–182, April 1994.

[COORD'09] T. Bouhadiba and F. Maraninchi. Contract-based coordination of hardware components for the development of embedded software. In *COORDINATION'09*, Lisbon, Portugal, June 2009.