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Hardware/Software Co-Verification Using Specman and SystemC with TLM Ports

by

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Overview

- Introduction
- Generic Embedded SoC Testbench Architecture
- Existing Co-verification Methods
- Specman to SystemC TLM Software Bridge
  - Overview
  - TLM port and data structure
  - Specman to C software function calls
  - C to Specman system methods calls
- Advantage and Benefits
- Challenges and Future Development
- Q & A

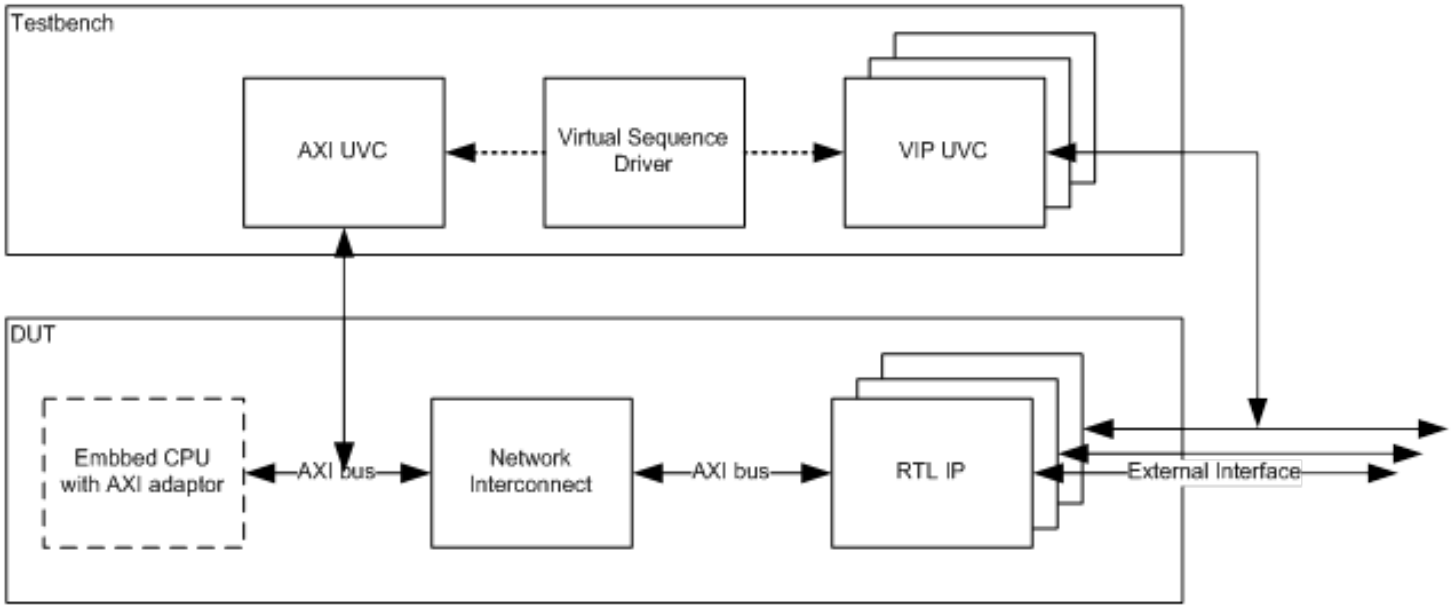
Introduction

- Co-verification benefits
  - Gives software engineer early access to the hardware
  - Provides additional testing for the hardware design
  - Provides better visibility in debugging software and hardware interaction

- Provides an integrated hardware and software solution
- Shortens the overall project schedule

Generic Embbed SoC Testbench Architecture

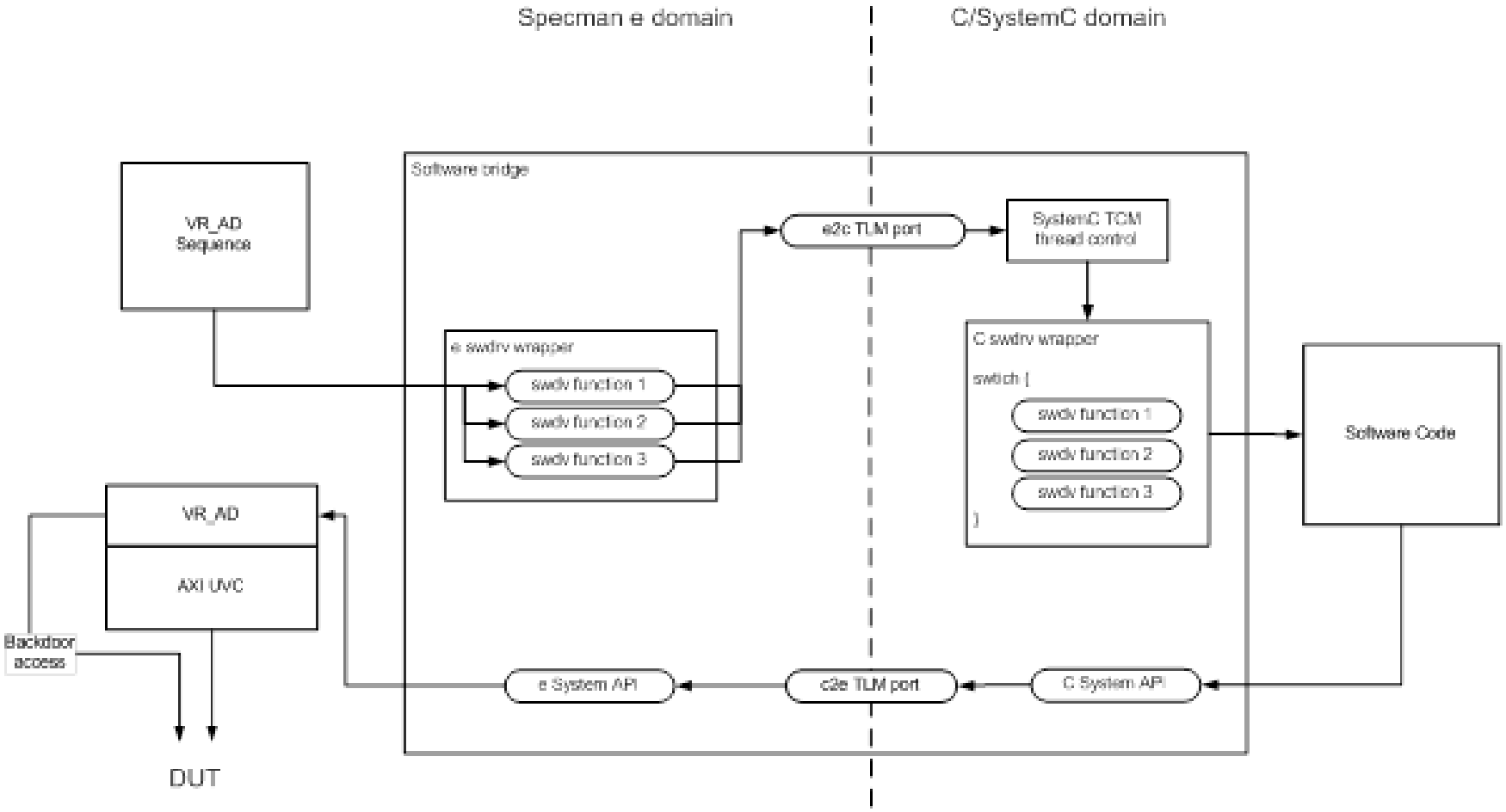
- Specman Testbench with UVM
  - How to call C functions from the testbench?
  - How to initiate AXI transactions from C functions?
  - How to the check the expected behavior of RTL IP?



Existing Co-Verification Methods

- Acceleration/Emulation
  - Very Expensive
  - Hard to reuse existing testbench components
- ISX/ISS
  - Require extra license
  - Slow execution speed
- Socket/CVL
  - Testbench has to relinquish control to the software
  - C code cannot access internal data structure of the testbench

Specman to SystemC TLM Software Bridge



TLM port and data structure

- Sample software function

```
int foo(int arg1, arg2);
```

- TLM port data structure

```
struct func_calls_s {
  func     : func_name;
  arg_ptr  : uint;
};
```

- Function arguments data structure

```
Extend func_name_t : [foo]
struct foo_arg_s {
  arg1          : int;
  arg2          : int;
  return_value  : int;
};
```

- TLM port declaration

```
e2c : out interface_port of tlm_blocking_put_if
      of (func_call_s) is instance;
c2e : in interface_port of tlm_blocking_put_if
      of (func_call_s) is instance;
```

Specman to C software function Call

```
foo(arg1 : int, arg2 : int) : int @sys.any is {
  var foo_arg : foo_arg_s = new with {
    .arg1 = arg1;
    .arg2 = arg2;
  };
  var func_call : func_call_s = new with {
   .func = foo;
   .arg_ptr = foo_arg.get_pointer();
  };
  e2c$.put(func_call);
  return foo_arg.return_value;
};
```

- e Wrapper

- C Wrapper

```
switch (func_call->func)  {
  case SN_ENUM(func_name_t, foo) :
    SN_TYPE(foo_arg_s) arg = (SN_TYPE(foo_arg_s))
           func_call->arg_ptr;
    arg->return_value = foo(arg->arg1,arg->arg2);
  break;
```

C to Specman system methods calls

- Intercept system read/write options in C functions

```
int sys_read(int addr){
  func_call_s func_call;
  SN_TYPE(sys_read_arg_s) sys_read_arg = new;
  sys_read_arg->addr = addr;
  func_call.func = sys_read;
  func_call.arg_ptr = &sys_read_arg;
  c2e->put(func_call);
  return sys_read_arg->return_value;
};
```

- Hook up system functions call to VR_AD sequences in Specman side
- Use Doxygen to auto-generate the wrappers

Advantage and Benefits

- FREE!!!
- Fast execution speed
  - The C code is running on the Linux host
- Easy debug support
  - Simvision SystemC debugger (gdb)
  - Simvision stripe chart
- Scalarable
  - Swap the SystemC with ISX using WHEN subtype
- Coverage for software calls
  - Define coverage item on the argument data structure

Challenges and Future Development

- Pointer errors in C code
  - Simulator and software running in same memory space
  - Segmentation fault can bring down the simulator
- Debug turn around time
  - SystemC code is statically linked into RTL snapshot
  - Enhance the bridge to use dynamically loaded shared library
- System Verilog Support

Q & A

- Question and Answer