Pythonized SystemC
A non-intrusive scripting approach

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Introduction

- MINRES focuses on VP and architectural modeling
  - Providing support in various forms
- Development often in parallel with HW development
  - what if scenarios are important for architecture decisions
  - Platform definition is not fixed
- VP based embedded software development for large systems requires the use of partial and subsystems to get reasonable simulation speed and runtime
- Flexibility in Reconfiguration is key for efficient model development

Addressing Flexibility

- Complex configurations system
  - Reading and interpreting a configuration file
  - Done in several tools by parsing XML or JSON files
- Code generation
  - Based on some configuration input generated glue logic
- Scripting languages as frontend
  - There are tools which provide such solutions
  - Allows integration of different functionality
  - Limited by scripting API

Scripting Solutions for SystemC

- There are several existing integration into scripting languages
- As part of commercial tools based on TCL/TK, Python
- Open-source solutions
  - SoCRockets Universal Scripting Interface (USI)
  - GreenSoCs GreenScript
  - SystemPy
  - Kosim

SystemC and Python

- We opted for an interpretation "frontend" based on Python
- Python is well-known and existing libraries can be reused
- Besides support for structural construction, simulation control and dynamic model parametrization can be supported
- Existing Python integrations require preparation work
  - Definitions of API into libraries which have been compiled
  - Quite often modification of the libraries to fulfill requirements implied by the interpreter
- Therefore there are no integrations for SCV or CCI available

PySysC

- CERN developed several tools for the analysis of LHC generated data
  - CINT: home-grown Python bindings piggy-backed on C++ reflection for serialization and interactivity
  - CLING: C++ interpreter (https://root.cern/cling)
  - PyPy/CPPYY: Cling-based Python-C++ bindings
- Cppyy can be leveraged for any library
- This is the basis for the PySysC module

PySysC Advantages

- No preparation of libraries to be integrated
- No need to have the sources of the code, even 3rd party binary only libraries can be used
- Allows introspection of the interfaces and thus dynamic generation
- If Python is not sufficient JIT allows to compile on-the-fly generated C++ code

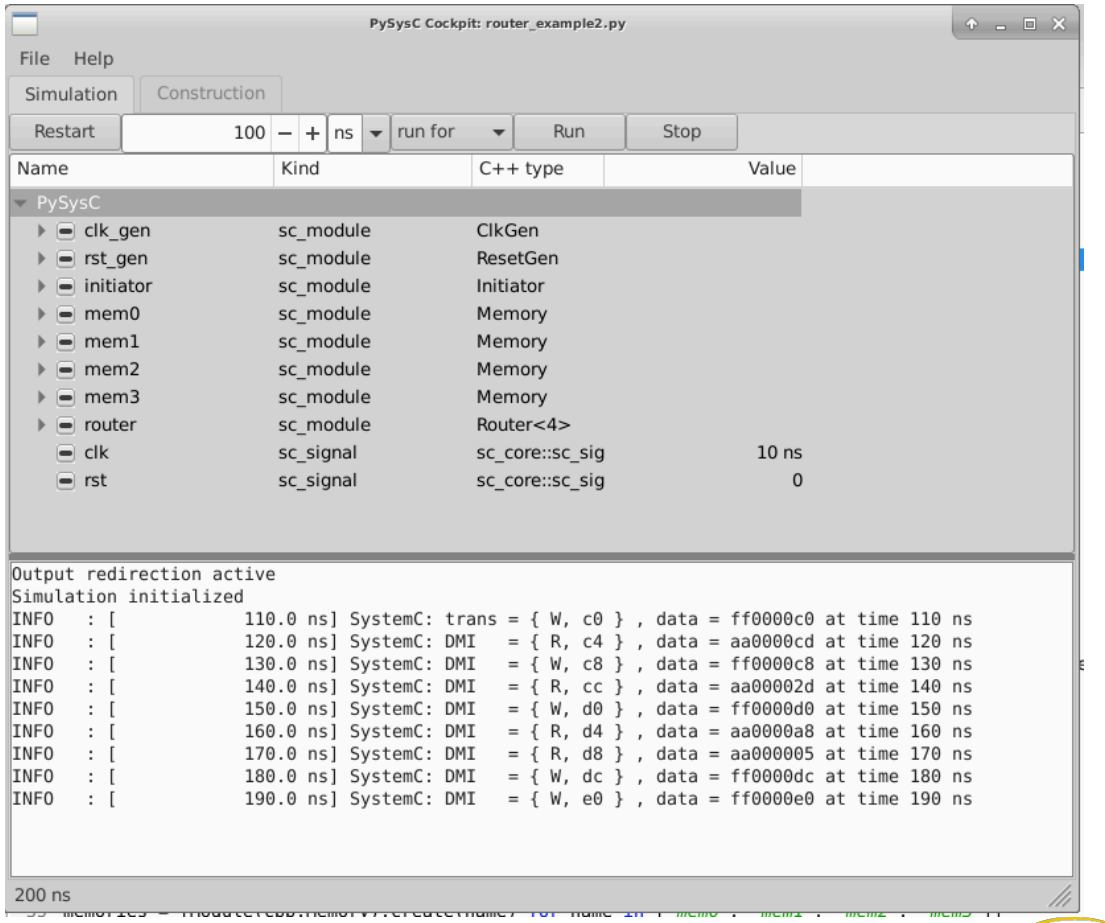
PySysC Example

1. Instantiation of a module
2. Instantiation of a templated module
3. Named signal connection
4. TLM2.0 socket connection
5. Simulation run

```
from cppyy import gbl as cpp
from cppyy.gbl import sc_core
from pysysc.structural import Connection, Signal, Module, Simulation
# loading required libraries
...
# instantiating modules
clk_gen = Module(cpp.ClkGen).create("clk_gen")                    ## (1)
initiator = Module(cpp.Initiator).create("initiator")
memories = [Module(cpp.Memory).create(name)
                for name in ["mem0", "mem1", "mem2", "mem3"]]
router = Module(cpp.Router[4]).create("router")                   ## (2)
# creating connections
clk = Signal("clk")
        .src(clk_gen.clk_o)
        .sink(initiator.clk_i)
        .sink(router.clk_i)                                       ## (3)
[clk.sink(m.clk_i) for m in memories]
Connection()
        .src(initiator.socket)
        .sink(router.target_socket)                               ## (4)
[Connection()
        .src(router.initiator_socket.at(idx))
        .sink(m.socket)
        for idx,m in enumerate(memories)]
# run simulation
sc_core.sc_start()                                                ## (5)
```

Advantages of Python Usage

- Due to broad availability of Python integrations plenty of libraries can be used and combined
  - Computational models using numpy/scipy etc.
  - UIs and cockpits using GTK, wxWidgets or Qt



Evaluation and Results

- Table 1 compares a simple design in SystemC and PySysC in terms of runtime and LoC
- Table 2 uses a RISC-V based VP in different scenarios using plain SystemC and PySysC based structural description.

Scenario	SystemC		PySysC
	build	run	
hello world	15s	8,7s	12,6s
dhrystone	15s	120s	122s

Table 2

	SystemC	PySysC
Time	0.1s	2.9s
LOC	40	22

Table 1

Outlook

- PySysC is available as module via git
  - The Python module: https://git.minres.com/VP/PySysC
  - The examples: https://git.minres.com/VP/PySysC-SC
- Development is work in progress
- Will be used as a basic building block of the BMBF funded project "RAVEN: Acceleration of Virtual Hardware/Software Development Platforms by Reconfigurable Logic'

Questions

Finalize slide set with questions slide

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