

Cortex-R8 SystemC Cycle Model

Version 10.0

User Guide

arm

Cortex-R8 SystemC Cycle Model

User Guide

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Preface

This preface introduces the *Cortex-R8 SystemC Cycle Model User Guide*.

It contains the following:

- [About this book on page 7](#).

About this book

This guide describes how to integrate the Cortex®-R8 SystemC Cycle Model into a SystemC design and simulation environment.

Using this book

This book is organized into the following chapters:

Chapter 1 Introduction

This section introduces the Arm Cortex®-R8 SystemC Cycle Model.

Chapter 2 Using SystemC Cycle Models

This section describes how to work with Arm SystemC Cycle Models, including connecting ports, working with the API, and incorporating models in your design.

Chapter 3 Working with SystemC CPAKs

This section introduces SystemC CPAKs, describes how to modify the CPAK test bench, and explains how to add a model to the CPAK.

Chapter 4 Debugging SystemC Cycle Models with DS-5

This section describes how to connect the Arm Development Studio 5 (DS-5) Debugger with Arm Cortex-R8 SystemC Cycle Models in a CPAK system.

Chapter 5 SystemC Export API function reference

This section describes the functions of the SystemC eXport (SCX) API that are supported by SystemC Cycle Models. Each description of a class or function includes the C++ declaration and the use constraints.

Appendix A Migrating from previous SystemC Cycle Model versions

This section contains instructions specific to upgrading from a previous verison of SystemC Cycle Models to version 10.0.

Glossary

The Arm® Glossary is a list of terms used in Arm documentation, together with definitions for those terms. The Arm Glossary does not contain terms that are industry standard unless the Arm meaning differs from the generally accepted meaning.

See the [Arm® Glossary](#) for more information.

Typographic conventions

italic

Introduces special terminology, denotes cross-references, and citations.

bold

Highlights interface elements, such as menu names. Denotes signal names. Also used for terms in descriptive lists, where appropriate.

`monospace`

Denotes text that you can enter at the keyboard, such as commands, file and program names, and source code.

monospace

Denotes a permitted abbreviation for a command or option. You can enter the underlined text instead of the full command or option name.

`monospace italic`

Denotes arguments to monospace text where the argument is to be replaced by a specific value.

`monospace bold`

Denotes language keywords when used outside example code.

<and>

Encloses replaceable terms for assembler syntax where they appear in code or code fragments.
For example:

```
MRC p15, 0, <Rd>, <CRn>, <CRm>, <Opcode_2>
```

SMALL CAPITALS

Used in body text for a few terms that have specific technical meanings, that are defined in the *Arm® Glossary*. For example, IMPLEMENTATION DEFINED, IMPLEMENTATION SPECIFIC, UNKNOWN, and UNPREDICTABLE.

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Chapter 1

Introduction

This section introduces the Arm Cortex®-R8 SystemC Cycle Model.

Arm SystemC Cycle Models are compiled directly from RTL code. The SystemC model wrapper is provided in source form, which enables you to compile for any SystemC 2.3.1-compliant simulator. You can use SystemC Cycle Models within an Arm Performance Analysis Kit (CPAK) or integrate them directly into any IEEE 1666-compliant SystemC environment.

It contains the following sections:

- [*1.1 Functionality of the SystemC Cycle Model* on page 1-10.](#)
- [*1.2 Prerequisites to using SystemC Cycle Models* on page 1-11.](#)
- [*1.3 Supported platforms, compilers, and simulators* on page 1-12.](#)
- [*1.4 Package contents* on page 1-13.](#)

1.1 Functionality of the SystemC Cycle Model

The Arm Cortex-R8 SystemC Cycle Model simulates the Cortex-R8 MPCore processor.

Supported functionality

This section summarizes the functionality of the Cycle Model compared to that of the hardware and describes the performance and accuracy of the Cycle Model. The Cycle Model supports:

- Configurations of up to four CPUs.
- Configurable number of interrupts (0 to 480 in increments of 32).
- Single or dual AXI master port.
- Access to Tightly Couple Memory (TCM) via slave port.
- Variable ICache and DCache sizes.
- Variable ITCM and DTCM sizes.
- Accelerator Coherency Port (ACP) and ACP bridge with configurable ID size.
- 12, 16, 20, or 24 Memory Protection Unit (MPU) regions.
- Floating Point Unit (FPU).
- ETM interface, including register slice between the processor and ETM interface.
- Fast Peripheral Port (FPP).
- Addition of one latency cycle to ITCM data read.
- Clock gating.

Unsupported hardware features

The following features of the Cortex-R8 hardware are not implemented in this release of the Cortex-R8 Cycle Model:

- Semihosting.
- Split-lock mode.
- Error Correcting Code (ECC) on RAM blocks and buses.
- Memory Built-In Self Test (MBIST) interface.
- Memory Reconstruction Port (MRP).
- Use of Synopsys DesignWare library blocks rather than the Arm equivalents.
- Configurable size for Branch Target Address Cache (BTAC). The default is 512.
- Configurable size of the PREDictor (PRED) RAM. The default is 4096.
- Support for additional signals to control power (required for UPF).

Additional features for Cycle Model usability

To enhance usability, the following features have been added to the Cycle Model, which do not exist in the Cortex-R8 hardware:

- Waveform dumping, including dumping of TCM memories. See [2.4 Dumping waveforms on page 2-18](#).
- Support for viewing register values. See [4.2.1 Supported registers on page 4-37](#) for a list of the registers exposed on the Cycle Model.
- Support for debug view of internal and external memory contents. See [4.2.2 Supported memory views on page 4-38](#) for information.
- Support for debug view of disassembly data. See your debugger documentation for information about accessing disassembly data.

1.2 Prerequisites to using SystemC Cycle Models

Review the following prerequisites to using Arm SystemC Cycle Models:

- Cycle Model SystemC Runtime. The Cycle Model SystemC Runtime installer includes:
 - Fast Models Runtime. This is required for functions related to setting parameters and debugging.
 - Cycle Model Studio Runtime. This is required for simulation and recompilation.

See the *Cycle Model SystemC Runtime Installation Guide* (101146) for more information.

- You must have a SystemC environment configured. See the *Cycle Model SystemC Runtime Installation Guide* (101146) for more information.
- CPAKs may have additional prerequisites. If you are running an Arm CPAK, see [3.1 Introduction to Arm® CPAKs on page 3-27](#).

Arm recommends familiarity with the Fast Models SystemC Export feature with Multiple Instantiation (MI) support. SystemC Cycle Models support a subset of the SystemC eXport (SCX) API functions (these are provided by Fast Models Exported Virtual Subsystems (EVSSs)). See the *Fast Models User Guide* (100965) for more information.

————— **Note** —————

If you are updating from a previous version of Arm SystemC Cycle Models, see [A.1 Migrating from previous versions on page Appx-A-64](#) for important migration tasks.

1.3 **Supported platforms, compilers, and simulators**

This section describes the requirements for running SystemC Cycle Models.

This section contains the following subsections:

- [1.3.1 Supported platforms](#) on page 1-12.
- [1.3.2 Supported compilers](#) on page 1-12.
- [1.3.3 Supported simulators](#) on page 1-12.

1.3.1 **Supported platforms**

Arm SystemC Cycle Models are supported on Red Hat Enterprise Linux version 6.6 (64-bit) and above.

1.3.2 **Supported compilers**

The SystemC Cycle Models have been tested on Linux with GCC 4.8.3 and GCC 6.4.0.

The SystemC Cycle Models include C++11 code, therefore the GCC you are using must support this.

1.3.3 **Supported simulators**

Arm SystemC Cycle Models can be compiled for any SystemC 2.3.1-compliant simulator.

1.4 Package contents

Each SystemC Cycle Model contains the following files:

componentResetModule.h

Reset module used to drive the SystemC pin-level wrapper for the Reset sequence of the IP.

component.xmlAnswers

Shows the configuration of the Cycle Model as built on Arm IP Exchange.

libcomponent.icm.so

RTL-based core of the Cycle Model. When you compile the system executable, this must be included.

libcomponent.h

Base function header exposed by the core Cycle Model. This is required to access functions in the core Cycle Model.

libcomponent.systemc.cpp and libcomponent.systemc.h

Pin-level SystemC wrapping header for the core Cycle Model. Compile this to generate a signal-level, linked SystemC model.

libcomponent_icm.h

Header file for `libcomponent.icm.so`, which is the RTL-based core of the Cycle Model.

loadTCMUtil/*

Set of files that support direct loading of the TCM.

Makefile

Compiles the pin-level model into the shared libraries included with the installation.

component_tarmac.h

Cycle Model parameter definition to generate Tarmac traces.

component_params.cfg

Cycle Model-specific parameter definitions.

component_pmu.h

Cycle Model hardware profiling implementation to generate profiling events.

component.tlm.cpp and component.tlm.h

TLM wrappers.

univent_tarmac.cpp

Tarmac interface implementation. Hook into the pin level Cycle Model to generate Tarmac traces.

univent_tarmac.h

Tarmac interface header which can be hooked into the pin level Cycle Model to generate Tarmac traces.

univentUtil/*

Contains model-specific Tarmac libraries which are needed to compile the `univent_tarmac.cpp` and `univent_tarmac.h` into the model.

Chapter 2

Using SystemC Cycle Models

This section describes how to work with Arm SystemC Cycle Models, including connecting ports, working with the API, and incorporating models in your design.

It contains the following sections:

- [2.1 Connecting model ports on page 2-15](#).
- [2.2 Resetting the SystemC Cycle Model on page 2-16](#).
- [2.3 Setting model parameters on page 2-17](#).
- [2.4 Dumping waveforms on page 2-18](#).
- [2.5 Loading TCMs on page 2-19](#).
- [2.6 Configuring PMU events on page 2-20](#).
- [2.7 Configuring TARMAC trace on page 2-23](#).
- [2.8 Working with the SCX framework on page 2-24](#).
- [2.9 Using a SystemC model in your own design on page 2-25](#).

2.1 Connecting model ports

All pins must be bound to a signal.

For a list of the pins on the Cortex-R8 SystemC Cycle Model, refer to the model header file `Libmodel.Systemc.h`, or the `CM_IPXACT_model.xml` file.

Certain pins are tied and cannot be modified. For a list of tied pins, see [2.1.1 Tied pins on page 2-15](#).

Refer to the SystemC documentation for information about native SystemC binding commands (`sc_in`, `sc_signal`, etc.).

This section contains the following subsection:

- [2.1.1 Tied pins on page 2-15](#).

2.1.1 Tied pins

When making changes to the model pins, be aware that certain pins are tied high or low, and can not be modified.

For a complete list of the pins on the Cortex-R8 SystemC Cycle Model, refer to the model header file `Libmodel.Systemc.h`, or the `CM_IPXACT_model.xml` file. This list includes all pins, including those listed below, which are tied and cannot be modified:

- `DBGEN` (high)
- `DFTRAMHOLD` (low)
- `DFTRAMCLKENABLE` (low)
- `DFTSE` (low)
- `DFTTESTMODE` (low)
- `NIDEN` (high)

2.2 Resetting the SystemC Cycle Model

A default reset sequence is provided in source form in `componentResetModule.h`.

If necessary, you can modify this file as needed to work with your system, then recompile the model after making your changes.

Ensure that the reset module is connected to the model.

Refer to the Technical Reference Manual for your IP for details about its reset sequence.

2.3 Setting model parameters

This section describes how to see a list of the parameters on the Cortex-R8 SystemC Cycle Model, and how to set them.

Initialization parameters

You can change initialization-time (Init) parameters either on the command line prior to simulation, or in the test bench (`system_test.cpp`) prior to the start of simulation (`sc_start`). Ensure that you recompile for the change to take effect. See [3.3 Working with Cycle Models and CPAKs on page 3-30](#) for instructions.

Run-time parameters

For run-time parameters, change the parameter value on the command line and restart the simulation.

Available parameters

The following table describes the parameters supported by the model. This information is also available:

- In the `component_params.cfg` file included in your model installation.
- By entering `./system_test --list-params` in the `Systems` directory of the CPAK.

See the *Cortex®-R8 Technical Reference Manual* (100400) for additional information about supported parameter values.

See [4.5 CADI RemoteConnection parameters on page 4-47](#) for additional parameters related to configuring CADI debug connections. These options do not appear in the `component_params.cfg` file.

2.4 Dumping waveforms

This section describes how to configure waveform dumping.

To enable and disable waveform dumping using parameter values within the system executable code, set the following parameters.

————— Note —————

Setting `WAVEFORM_TIMEUNIT` and `WAVEFORM_TYPE` is optional; set them only if you want to change the default settings. If you are changing them, call `WAVEFORMS_ENABLED` after setting `WAVEFORM_TIMEUNIT` and `WAVEFORM_TYPE`.

Table 2-1 Waveform parameters

Parameter	Available settings	Default setting
<code>WAVEFORM_TIMEUNIT</code>	Units defined by <code>sc_time_unit()</code> : <code>SC_FS</code> , <code>SC_PS</code> , <code>SC_NS</code> , <code>SC_US</code> , <code>SC_MS</code> , <code>SC_SEC</code>	<code>SC_PS</code>
<code>WAVEFORM_TYPE</code>	<code>FSDB</code> , <code>VCD</code>	<code>VCD</code>
<code>WAVEFORMS_ENABLED</code>	<code>true</code> , <code>false</code>	<code>false</code>

For example:

```
scx::scx_set_parameter("sc-module-name.WAVEFORM_TIMEUNIT",sc_core::SC_NS);
scx::scx_set_parameter("sc-module-name.WAVEFORMS_TYPE","FSDB");
scx::scx_set_parameter("sc-module-name.WAVEFORMS_ENABLED",true);
```

sc-module-name is the name given to the model when it is instantiated in the system executable.

2.5 Loading TCMs

You can load the DTCMS and ITCMS memories by enabling the related parameters within the system executable.

Set the following parameters:

———— **Note** ————

The names of the data files to be loaded are defined by the data file parameters (CPUx_*_DAT_FILE). If you want to customize the default values for the CPUx_*_DAT_FILE parameters, make these changes before setting LOAD_DTCMS and LOAD_ITCMS.

Table 2-2 TCM parameters

Parameter	Available settings	Default setting
LOAD_DTCMS	true, false	false
LOAD_ITCMS	true, false	false

See [2.3 Setting model parameters](#) on page 2-17 for the default filenames.

See also the files CortexR8_dtcm.h and CortexR8_itcm.h for more information.

2.6 Configuring PMU events

SystemC Cycle Model Performance Monitoring Unit (PMU) events are stored in C++ variables.

By default, calculations of PMU events are disabled in the SystemC Cycle Model. You can enable PMU events by setting a parameter value in the system executable code. Use the following parameters:

Table 2-3 PMU parameters

Parameter	Available settings	Default setting
PMU_ENABLED	true, false	false

For example:

```
scx::scx_set_parameter("sc-module-name.PMU_ENABLED",true);
```

sc-module-name is the name given to the model when it is instantiated in the system executable.

For information about C++ variable names for PMU events, refer to the file `component_pmu.h` located in the CPAK directory `MODELS/component/gcc483/SystemC`.

This section contains the following subsection:

- [2.6.1 Supported hardware profiling events on page 2-20](#).

2.6.1 Supported hardware profiling events

The hardware profiling events supported by the Cortex-R8 SystemC Cycle Model are described in this section.

Table 2-4 Instruction stream

Event name	Description
0x00_SW_INCREMENT	Software Increment
0x08_INST_ARCHITECTURALLY_EXECUTED	Instructions architecturally executed
0x09_EXC_TAKEN	Exception taken
0x0A_EXC_RETURN	Exception return architecturally executed
0x0B_CID_WRITE	Counts the number of instructions architecturally executed writing into the ContextID Register
0x06_DATA_READ	Data read architecturally executed
0x07_DATA_WRITE	Data write architecturally executed

Table 2-5 Pipeline stream

Event name	Description
0x0C_SW_PC_CHANGE	Software change of the PC
0x0D_BR_IMMED	Immediate branch architecturally executed
0x0E_BR_RETURN	Procedure return (other than exception returns) architecturally executed

Table 2-5 Pipeline stream (continued)

Event name	Description
0x0F_UNALIGNED	Unaligned load-store
0x10_BR_MIS_PRED	Mispredicted or not predicted branch speculatively executed
0x12_BR_PRED	Predictable branch speculatively executed
0x80_STREX_PASS	Exclusive instruction speculatively executed - STREX pass
0x81_STREX_FAIL	Exclusive instruction speculatively executed - STREX fail

Table 2-6 I-Cache stream

Event name	Description
0x01_I_CACHE_MISS	Instruction cache miss
0x14_I_CACHE_ACCESS	Level 1 instruction cache access

Table 2-7 D-Cache stream

Event name	Description
0x03_D_CACHE_MISS	Data cache miss
0x04_D_CACHE_ACCESS	Data read or write operation that causes a cache access at (at least) the lowest level of data or unified cache

Table 2-8 Cycle stream

Event name	Description
0x11_CPU_CYCLES	Cycle
0x50_NUM_CYCLES_IRQs_INTERRUPTED	Number of cycles IRQs are interrupted
0x51_NUM_CYCLES_FIQs_INTERRUPTED	Number of cycles FIQs are interrupted

Table 2-9 Microarchitecture stream

Event name	Description
0x90_DMB_STALL	DMB stall
0x91_ITCM_ACCESS	ITCM access
0x92_DTCM_ACCESS	DTCM access
0x93_DATA_EVICTION	Data eviction
0x94_SCU_COHERENCY	SCU coherency operation (CCB request)
0x95_ICACHE_STALL	Instruction cache dependent stall
0x96_DCACHE_STALL	Data cache dependent stall

Table 2-9 Microarchitecture stream (continued)

Event name	Description
0x97_NOCACHE_NOPERIPH_STALL	Non-cacheable, no peripheral-dependent stall
0x98_NOCACHE_PERIPH_STALL	Non-cacheable, peripheral-dependent stall
0x99_DCACHE_HI_PRIO_STALL	Data cache high priority dependent stall
0x9A_FPP_ACCESS	Access to AXI fast peripheral port (reads and writes)

2.7 Configuring TARMAC trace

This section describes how to enable and disable TARMAC trace.

By default, TARMAC trace is disabled, and TARMAC buffers log file data. You can enable TARMAC tracing by setting parameter values in the system executable code, and specify the number of instructions after which to flush the log file.

————— Note —————

If you are setting TARMAC_LOGFILE_NAME, call TARMAC_ENABLED after setting TARMAC_LOGFILE_NAME.

Table 2-10 TARMAC trace parameters

Parameter	Description	Available settings	Default setting
TARMAC_LOGFILE_NAME	Sets TARMAC log file name. For multiple cores or clusters, use the @CPUID@ string in the name to specify where to place the CPU identification number.	string	""
TARMAC_ENABLED	Enables or disables TARMAC logging.	true, false	false
TARMAC_FLUSH	Flushes the Tarmac log file data after the specified number of instructions.	integer	0

For example, for a Cortex-R8 design with two cores and one cluster:

```
scx::scx_set_parameter("r8.TARMAC_LOGFILE_NAME","tarmac.r8.@CPUID@.log");
scx::scx_set_parameter("r8.TARMAC_LOGFILE_ENABLED",true);
```

This creates the files `tarmac.r8.0.log` and `tarmac.r8.1.log`.

2.8 Working with the SCX framework

Arm SystemC Cycle Models implement the SystemC Export (SCX) API provided by Fast Models Exported Virtual Subsystems (EVSSs).

SCX API overview

You can configure the parameters and other settings for your SystemC model using either native SystemC signals or using the SCX API. The SCX API is fully described in the *Fast Models User Guide* (100965), section 7.6 (SystemC Export API).

Arm recommends not mixing parameter sets through the SCX framework and parameter sets through native SystemC signal writes, as this can produce unexpected results. For example, the following case describes what would happen in a case where both are used in succession in a system:

```
scx::scx_set_parameter("CortexR8.ACLKENST",1); //Statement 1  
CortexR8.ACLKENST.write(0); //Statement 2
```

Due to intrinsic SystemC properties, the value ultimately assigned to ACLKENST depends on the previous value of the pin:

- If ACLKENST had an initial value of 0, the `write(0)` is ignored because that was the previous value, and ACLKENST is assigned a value of 1. Because of the SystemC property of `write`, if the previous value was 0, `setParameter` takes precedence.
- If ACLKENST had a value of 1, then the `write` takes precedence and the value is set to 0.

See [Chapter 5 SystemC Export API function reference](#) on page 5-50 for details about the functions supported by SystemC Cycle Models.

2.9 Using a SystemC model in your own design

This section describes how to integrate a SystemC model into IEEE-compliant SystemC environments, including required header files and libraries, SCX library instantiation, and other ordering requirements within the code.

Runtime-related include directories, libraries, and sources to build the SystemC Cycle Model system on Linux

To include the required directories, libraries, and sources, do the following:

- Include the common makefile at `$(CM_SYSC_HOME)/makefiles/cm_sysc_common.mak`.
- Add the `CM_SYSC_CXXFLAGS` flag to the compile line.
- Add the following flags to the link line:

```
CM_SYSC_LDFLAGS  
CM_SYSC_MODELS  
FM_LIB
```

`CM_SYSC_HOME` differs based on whether you are using a CPAK system or a standalone Arm Cycle Model:

- For CPAKs: `CM_SYSC_HOME=CPAK_RELEASE_PACKAGE/MODELS/SystemCMisc/$CM_PLATFORM`
- For standalone Cycle Models, you must also download the SystemC Cycle Models Runtime package from Arm IP Exchange (see [1.2 Prerequisites to using SystemC Cycle Models on page 1-11](#)). In this case:

```
CM_SYSC_HOME=PATH_TO_UNZIPPED_CM_SYSC_RUNTIME_RELEASE_PACKAGE
```

Model-related build wrapper sources and library requirements

To compile the SystemC model wrapper into your design, the following build wrapper sources are required:

- `MODELS/component_name/gcc483/SystemC/*.cpp`

Library requirements are:

- `MODELS/component_name/gcc483/SystemC/lib/libcomponent_name.icm.so`

Libraries to run the virtual platform on Linux

The virtual platform might require specific libraries in addition to those required by the SystemC Cycle Model system:

- `MODELS/component_name/gcc483/SystemC/lib/libmodel_name.icm.so`
- `MODELS/component_name/gcc483/SystemC/lib/libicm_runtime.so`
- `MODEL_DIR/$(CM_PLATFORM)/SystemC/univentUtil/lib/model_name_tarmac_dpi.so` - For TARMAC Trace functionality, you must link against this .so file.
- `libprotobuf.so` - This open-source library might be required by `model_name_tarmac_dpi.so`.
- `libcarbon5.so` - This file may already be present as it is provided with the Cycle Model Studio runtime.

Adding a SystemC Cycle Model to your virtual platform

Adding the SystemC Cycle Model to your design requires modifications to the CPAK test bench. See [3.3 Working with Cycle Models and CPAKs on page 3-30](#) for information about these modifications.

Additional include directories and libraries to build the SystemC Cycle Model on Linux

The SystemC Cycle Model system requires the following additional `include` directories and libraries:

Required `include` directories:

- `MODELS/component_name/gccversion/SystemC`

Chapter 3

Working with SystemC CPAKs

This section introduces SystemC CPAKs, describes how to modify the CPAK test bench, and explains how to add a model to the CPAK.

It contains the following sections:

- [*3.1 Introduction to Arm® CPAKs* on page 3-27](#).
- [*3.2 Getting started with CPAKs* on page 3-28](#).
- [*3.3 Working with Cycle Models and CPAKs* on page 3-30](#).
- [*3.4 Building and running CPAK simulations* on page 3-34](#).

3.1 Introduction to Arm® CPAKs

Arm provides Performance Analysis Kits (CPAKs) that contain SystemC models, which demonstrate how a working system is constructed. You can use an Arm CPAK as a starting point to develop and fine-tune your custom system.

You can copy and migrate a SystemC Cycle Model that is part of a CPAK and build it into your own custom system. Alternatively, you can modify an Arm CPAK system by adding your own SystemC model classes to the Arm CPAK.

- If you want to include a different or additional SystemC Cycle Model in the CPAK, you need to modify the CPAK testbench and corresponding build system to include, instantiate, and connect the model. See [3.3 Working with Cycle Models and CPAKs on page 3-30](#) for details.
- If you want to run a CPAK without altering the system, you need to configure the parameters that generate the performance data you are interested in and run the simulation. See [Chapter 2 Using SystemC Cycle Models on page 2-14](#) for details.

Visit Arm IP Exchange (<http://armipexchange.com/cpaks>) to download a SystemC CPAK.

Prerequisites

Arm CPAKs require the Cycle Model Studio runtime. Visit the Arm IP Exchange Support area (<http://armipexchange.com/websupport/support.aspx>) to download the Cycle Model Studio runtime.

3.2 Getting started with CPAKS

In this section, a Cortex-R8 SystemC CPAK is used to show the basics of working with Arm CPAKS.

CPAK components

The Cortex-R8 CPAK (R8_SysC) includes the Cortex-R8 core, and a bus, UART, and memory (not all Cortex-R8 CPAKS follow this format). The CPAK test bench, `Systems/system_test.cpp`, defines the default CPAK configuration in `sc_main()`. See the following diagram for a graphical representation of its main components, port bindings, and memory map.

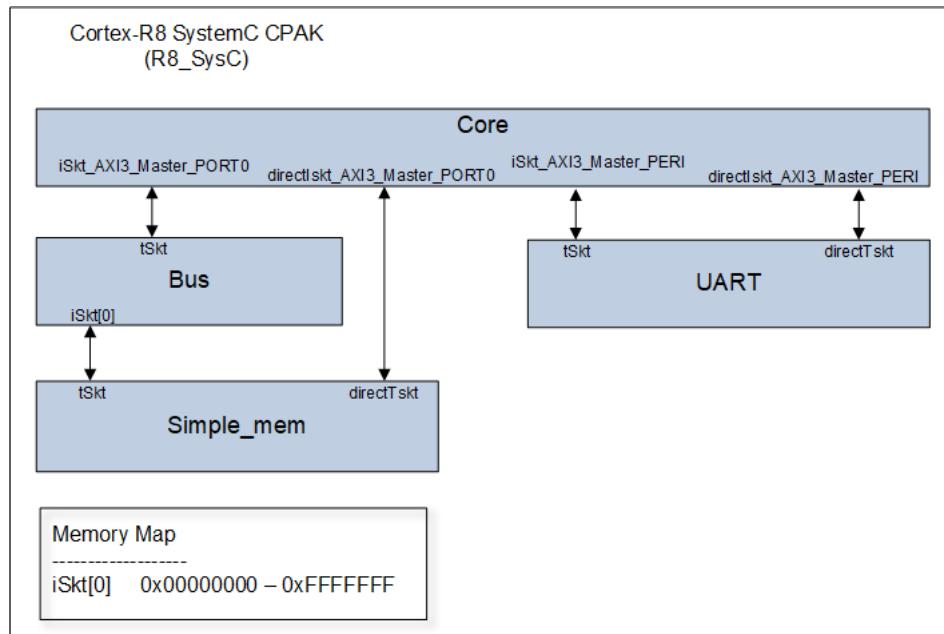


Figure 3-1 Cortex-R8 SystemC CPAK

CPAK directory structure

The following figure describes the general CPAK directory structure and summarizes its contents.

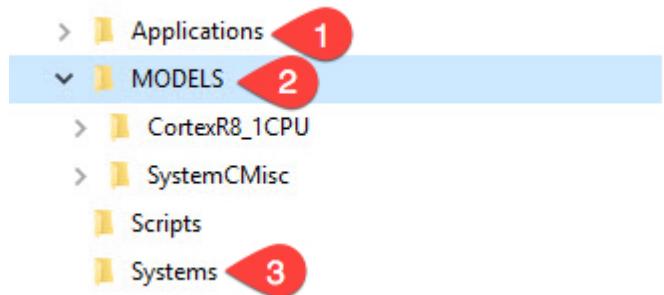


Figure 3-2 Cortex-R8 SystemC CPAK directory structure

1. The `Applications` directory contains source code, build files, and executable images for example applications that execute on the processor.
2. The `MODELS` directory contains model libraries and SystemC wrapper source code for all the models used to build a system.
3. The `Systems` directory contains top-level design files used to connect models. The `system_test.cpp` file contains the `sc_main` function.

Testing CPAK operation

After you download a CPAK from Arm IP Exchange (<http://armipexchange.com/cpaks>):

1. Untar the .tgz file:

```
tar xzvf R8-SysC-V10.0.0-CMS10.0.0.tgz
```

2. Open and review the README.txt file located at the top of the CPAK directory structure. CPAK readme files include instructions for setting up the environment, test applications that are available with the CPAK, requirements and dependencies, and other IP-specific instructions.
3. As described in the README.txt file, perform make and makeclean to create the system_test executable.
4. After you have verified that your environment meets the specified requirements, cd to the Systems directory and run the example test bench system_test. The test bench starts the simulation, and loads and runs the application specified by system_test.cpp. By default, system_test.cpp runs the hello_world application located in the Applications directory:

```
$ ./system_test
SystemC 2.3.1-Accellera --- Jun 18 2015 09:17:13
Copyright (c) 1996-2014 by all Contributors,
ALL RIGHTS RESERVED

Loading: ../Applications/hello_world/armcc/elf/test.elf
[plover_tarmac] Detected capture module at 'PLOVERINTEGRATION.u_plover.u_noram0' (enabled)
[plover_tarmac] Sending stream to 'plover_tarmac_decode -f
tarmac.PLOVERINTEGRATION_u_plover_u_noram0.log'
[plover_tarmac] Detected capture module at 'PLOVERINTEGRATION.u_plover.u_noram2' (enabled)
[plover_tarmac] Sending stream to 'plover_tarmac_decode -f
tarmac.PLOVERINTEGRATION_u_plover_u_noram2.log'
[plover_tarmac] Detected capture module at 'PLOVERINTEGRATION.u_plover.u_noram3' (enabled)
[plover_tarmac] Sending stream to 'plover_tarmac_decode -f
tarmac.PLOVERINTEGRATION_u_plover_u_noram3.log'
[plover_tarmac] Detected capture module at
'PLOVERINTEGRATION.u_plover.u_noram1_wrapper.u_noram1' (enabled)
[plover_tarmac] Sending stream to 'plover_tarmac_decode -f
tarmac.PLOVERINTEGRATION_u_plover_u_noram1_wrapper_u_noram1.log'
Starting Simulation
<01><ff><01><ff><01><ff><01><ff><01><ff>Hello World!
My name is Plover
I wish you a great day
** TEST PASSED OK **
<04>0x04 End Of Simulation message received by TrickBox
.
.
.
```

Next steps

This section provides suggested next steps you can take to learn about general CPAK capabilities and usage.

Table 3-1 Getting started with CPAKs next steps

Task	Reference section
Try single-stepping with a debugger.	Chapter 4 Debugging SystemC Cycle Models with DS-5 on page 4-35 and DS-5 documentation.
Print out waveforms.	2.4 Dumping waveforms on page 2-18
Run a different application.	3.3.1 Application loading on page 3-30 and the CPAK README.txt file.
Modify a component.	3.3 Working with Cycle Models and CPAKs on page 3-30

3.3 Working with Cycle Models and CPAKS

To make changes to the CPAK system, alter the CPAK test bench.

Each CPAK has its own test bench called `system_test.cpp`, which is located in the `Systems` directory of your CPAK. This test bench:

- Instantiates the models
- Defines the connections between models
- Initializes model parameters
- Provides simulation controls (start, stop, run, specific number of cycles, etc.)

After altering the test bench as described in the following sections, recompile the system. Models are recompiled automatically as part of the system-level recompile.

This section contains the following subsections:

- [3.3.1 Application loading on page 3-30](#).
- [3.3.2 Modifying the test bench for pin-level models on page 3-30](#).
- [3.3.3 Modifying the test bench for TLM models on page 3-32](#).

3.3.1 Application loading

Pin-level CPAKs and TLM-based CPAKs handle application loading differently.

Pin-level CPAK application loading

For Cortex-R8 CPAKs implemented through pin-level connections, the application to be loaded is specified by the `.hex` file located in the `Systems` directory. The application is loaded into the CPAK upon initialization of the BP140 memory. See the `README.txt` file for more information on changing the application.

TLM-based CPAK application loading

For Cortex-R8 CPAKs implemented through TLM connections, the application is specified as a command line argument and parsed during the call of the SCX `scx_parse_and_configure()` function.

3.3.2 Modifying the test bench for pin-level models

This section describes the areas of the CPAK test bench you might want to change.

————— Note —————

See [3.3.1 Application loading on page 3-30](#) for information about how pin-level CPAKs handle application loading.

Required includes

The test bench contains the SystemC wrapper files for any models in the system, the corresponding reset module file for each model (for pin-level models only), and `includes` required by the Fast Models runtime. Ensure you add these files for any new models added to your system. Here is an example of the `includes` section of a CPAK test bench:

```
// Include the systemc wrapper files for the models
#include "libCortexR8.systemc.h"           // CortexR8 CPU
#include "libNIC400.systemc.h"              // NIC400 Interconnect
#include "libBP140.systemc.h"                // BP140 Memory
#include "libBP140_TrickBox.systemc.h"       // BP140_TrickBox UART

// Include the reset modules for the above models (pin-level models only)
#include "CortexR8ResetModule.h"
#include "NIC400ResetModule.h"
#include "BP140ResetModule.h"
#include "BP140_TrickBoxResetModule.h"
#include "../perf_common.h"
```

```
#include <iostream>
#include <time.h>

// These includes are need by the SCX FastModel Runtime
#include <scx/scx.h>
#include <scx/scx_signal_sizer.h>
#include <scx_simcontroller.cpp>
#include <scx_scheduler_mapping.cpp>
#include <scx_report_handler.cpp>
```

Initialization of the simulation environment and model instantiation

The `sc_main()` section of the test bench must first initialize the SCX simulation environment. It must state clocking specifications, then instantiate all IP and reset models (for pin-level models only) for any models included in the system. For example:

```
int sc_main(int argc, char *argv[])
{
    // Debug initialization
    scx::scx_initialize("R8-SysC-Debug");

    // If you want to see messages about 'port not bound' change SC_DO_NOTHING to SC_DISPLAY.
    // If you want it to abort on a 'port not bound' error comment out the line below.
    sc_report_handler::set_actions(SC_ID_COMPLETE_BINDING_, SC_ERROR, SC_DO_NOTHING);

    // Clock Object
    sc_clock clk("clk", 1, SC_NS, 0.5);

    // Instantiate IP
    CortexR8 core("cortexR8");
    NIC400 nic400("NIC400");
    BP140 bp140("BP140");
    BP140_TrickBox bp140_trickbox("BP140_TrickBox");
    ARM::Models::Cycle::ModelCortexR8::CortexR8ResetModule core_reset("core_reset");
    ARM::Models::Cycle::ModelNIC400::NIC400ResetModule nic400_reset("nic400_reset");
    ARM::Models::Cycle::ModelBP140::BP140ResetModule bp140_reset("bp140_reset");
    ARM::Models::Cycle::ModelBP140_TrickBox::BP140_TrickBoxResetModule
    bp140_trickbox_reset("bp140_trickbox_reset");
```

Signal bindings

The test bench specifies all signal bindings, including those for reset modules.

- Declare bindings using an `sc_signal` call in the test bench file. The signal must be the same type and width as the two ports being connected. If the ports are the same type but different widths, use `scx_signal_sizer` instead of `sc_signal`. For example:

```
scx::scx_signal_sizer<sc_uint<13>, sc_uint<16> >ARIDsignal1;
core.ARIDM0.bind(ARIDsignal1);
nic400.arid_s_axi_64.bind(ARIDsignal1);
```

- Signals must be bound to both ports. For example:

```
sc_signal(bool) signal1;
Inst1.port1.bind(signal1);
sc_signal(bool) signal2;
Inst2.port1.bind(signal2);
```

Clock bindings

All models must be bound to the system clock; for example:

```
// Bind all the models to the system (cpu) clock
core.CLKIN.bind(cpu_clk);
mem.ACLK.bind(cpu_clk);
bus.mainclk.bind(cpu_clk);
uart.ACLK.bind(cpu_clk);
core_reset.clk.bind(cpu_clk);
bus_reset.clk.bind(cpu_clk);
bp140_reset.clk.bind(cpu_clk);
bp140_trickbox_reset.clk.bind(cpu_clk);
```

Functions to generate performance data

The following example shows the use of SCX API functions to specify PMU and Tarmac output. See [Chapter 2 Using SystemC Cycle Models](#) on page 2-14 for more information:

```
// Enable PMU and TARMAC for the CortexR8
scx::scx_set_parameter("cortexr8_core.PMU_ENABLED",true);
scx::scx_set_parameter("cortexr8_core.TARMAC_ENABLED",true);
```

Parsing of command line arguments

The test bench calls the SCX `scx_parse_and_configure()` function to parse any command line arguments used by the SCX runtime:

```
scx::scx_parse_and_configure(argc, argv);
```

Simulation call

To simulate the system, the test bench calls `sc_start()`:

```
sc_start();
```

Specify all includes, initializations, bindings, functions, and command line options before `sc_start()`.

3.3.3

Modifying the test bench for TLM models

`sc_main` has the same basic flow for both pin-level and TLM models. One difference is that the TLM models are connected using TLM sockets rather than pins. This section describes the TLM-specific instructions.

————— Note —————

See the file `libcomponent.tlm.h` in your installation directory for socket names.

————— Note —————

See [3.3.1 Application loading](#) on page 3-30 for information about how TLM-based CPAKS handle application loading.

Required includes

The SystemC pin-level models are wrapped with TLM functionality. The test bench includes the SystemC wrapper files for any models included in the system, and `includes` required by the Fast Models runtime. Ensure you add these files for any new models added to your system. Here is an example of the `includes` section of a CPAK test bench:

```
// Include the systemc wrapper files for the models
#include "models/SimpleMem.h"
#include "models/SimpleFlash.h"
#include "models/SimpleFlashImp.h"
#include "models/RAMBlock.h"
#include "models/SimpleBus.h"
#include "models/BasicUART.h"
#include "models/Elfloader.h"
#include "libCORTEXR8.tlm.h"                                // Cortex-R8
                                                       CPU
#include <tlm_utils/simple_initiator_socket.h>
#include "../perf_common.h"

#include <iostream>

// These includes are need by the SCX FastModel Runtime
#include <scx/scx.h>
#include <scx_simcontroller.cpp>
#include <scx_scheduler_mapping.cpp>
```

```
#include <scx_report_handler.cpp>
```

Initialization of the simulation environment and model instantiation

The `sc_main()` section of the test bench must first initialize the SCX simulation environment. It states clocking specifications, then instantiates any models included in the system. Ensure you instantiate any new models added to your system. For example:

```
int sc_main(int argc, char *argv[])
{
    // Debug initialization
    scx::scx_initialize("R8-SysC");

    // If you want to see messages about 'port not bound' change SC_DO_NOTHING to SC_DISPLAY.
    // If you want it to abort on a 'port not bound' error comment out the line below.
    sc_report_handler::set_actions(SC_ID_COMPLETE_BINDING_, SC_ERROR, SC_DO_NOTHING);

    // Clock Object
    sc_clock cpu_clk("clk", 1, SC_NS, 0.5);

    ARM::Models::Cycle::ModelCortexR8::CortexR8Imp core("CortexR8");

    // Main Memory
    ARM::Models::RAMBlock ram_block;
    ARM::Models::SimpleMemConfig simple_mem_params;
    simple_mem_params.delay = 1;
    simple_mem_params.ram_block = &ram_block;
    simple_mem_params.busWidthBits = 64;

    ARM::Models::SimpleMem simple_mem("RAM", simple_mem_params);
    ARM::Models::BasicUART uart("UART", std::cout, "UART: ");

    // BUS & its Mappings
    ARM::Models::SimpleBus bus("Interconnect", 1, 1, 64);
    bus.addMap(0, 0, 0xFFFFFFFF); // Main Memory
```

Port bindings

The test bench specifies all TLM port bindings. Signal bindings required for the system are also specified in this area. Specify any additional TLM port bindings and signal bindings in this area:

```
// Core Main Memory Port Bindings
core.iSkt_AXI3_Master_PORT0->bind(bus.tSkt);
core.directIskt_AXI3_Master_PORT0.bind(simple_mem.directTskt);

// Core Low Latency Peripheral Port Bindings
core.iSkt_AXI3_Master_PERI->bind(uart.tSkt);
core.directIskt_AXI3_Master_PERI.bind(uart.directTskt);

// Bus iSkt[0] connected to Main Memory
bus.iSkt[0]->bind(simple_mem.tSkt);

// Clock
core.clk(cpu_clk);
simple_mem.clock.bind(cpu_clk);
uart.clock.bind(cpu_clk);
bus.clock.bind(cpu_clk);
```

For information about signal bindings, clock bindings, performance data generation, command line arguments, and simulation calls, use the instructions in [3.3.2 Modifying the test bench for pin-level models on page 3-30](#).

3.4 Building and running CPAK simulations

CPAKs include Makefiles for building its applications, models, and systems..

This section describes the available CPAK build, run, and simulation options. The instructions in this section are for Arm SystemC CPAK systems only.

CPAKs come with sample applications and application build scripts; these are located in the *CPAK_Name/Applications* directory.

The top-level CPAK Makefile is the command script for your build infrastructure. The Makefile includes the following available targets:

make all

Builds the system.

make system

Takes the CPAK test bench (*system_test.cpp*) and the library files, and generates the *system_test* binary. For more information about the test bench, see [3.3 Working with Cycle Models and CPAKs on page 3-30](#).

make app-setup [APP=path]

where *path* is the path to the compiled application (.elf) file. This option sets up the particular application the system uses during simulation.

make run [APP=path] [RUNLOG=file_name]

where *path* is the path to the compiled application (.elf) file and *file_name* is the name of the file for log output. This option runs the simulation. If APP is not specified, it runs the default application or the one that was last set up using app-setup.

make clean

Removes all the binaries and object files.

make help

Prints all available targets.

Chapter 4

Debugging SystemC Cycle Models with DS-5

This section describes how to connect the Arm Development Studio 5 (DS-5) Debugger with Arm Cortex-R8 SystemC Cycle Models in a CPAK system.

It contains the following sections:

- [*4.1 Prerequisites to debugging* on page 4-36.](#)
- [*4.2 Supported debug features* on page 4-37.](#)
- [*4.3 Restrictions and limitations* on page 4-39.](#)
- [*4.4 Enabling DS-5 for use with SystemC Cycle Models* on page 4-40.](#)
- [*4.5 CADI RemoteConnection parameters* on page 4-47.](#)
- [*4.6 Multicore debugging* on page 4-48.](#)
- [*4.7 Changing the timeout setting* on page 4-49.](#)

4.1 Prerequisites to debugging

Arm DS-5 Development Studio is required before you begin. The instructions in this chapter have been verified using DS-5 Version 5.28.1.

————— Note —————

The Windows version of DS-5 is not supported for SystemC Cycle Models. Only the Linux 64-bit version is supported.

- Download and install the Linux 64-bit version of DS-5 Development Studio (Ultimate Edition) from <https://developer.arm.com/products/software-development-tools/ds-5-development-studio/downloads>. In the DS-5 **Arm License Manager** dialog box (accessed from the **Help** menu), specify **Arm DS-5 Ultimate Edition** as the toolkit to use.
- See the *Arm® DS-5 Getting Started Guide* (100950) for DS-5 system requirements and installation instructions.

4.2 Supported debug features

This section describes DS-5 features that are supported on SystemC Cycle Models and debugging features that have been added to SystemC Cycle Models.

————— Note —————

CPUs are modeled as masters that issue debug access downstream to other components. Upstream debug access into CPU models through slave ports is not supported.

DS-5 features

SystemC Cycle Models support the following DS-5 functionality:

- Debugging of multi-core and multi-cluster configurations. You can specify whether you want to debug software running on multiple CPUs, or debug software on one CPU at a time. See the section [4.6 Multicore debugging on page 4-48](#) for more information.
- Debugging of *Symmetric Multi Processing* (SMP) systems.

See the *Arm® DS-5 Debugger User Guide* (100953) for more information about debugging multi-core, multi-cluster, and SMP targets.

Support for memory and register views

The SystemC Cycle Model supports visibility into memory spaces and a subset of the registers. See:

- [4.2.1 Supported registers on page 4-37](#) for information about supported registers.
- [4.2.2 Supported memory views on page 4-38](#) for information about supported memory views.

————— Note —————

Registers and memory spaces are exposed on the model. However, their visibility varies depending on the debugger in use.

This section contains the following subsections:

- [4.2.1 Supported registers on page 4-37](#).
- [4.2.2 Supported memory views on page 4-38](#).

4.2.1 Supported registers

This section describes how to access the register views supported by the Cortex-R8 SystemC Cycle Model.

————— Note —————

Registers are exposed on the model. However, their visibility varies depending on the debugger in use.

The processor is a dual issue out-of-order completion machine. This means that while the processor is running, it does not present a coherent programmer's view state (a *debuggable point*); instructions in the pipeline may be in different execution states.

————— Note —————

Due to the speculative nature of the processor pipeline, values in the registerse are not guaranteed to be accurate. In general, you can write to a register only at a debuggable point. If a value is written at any other point, it might not propagate correctly.

To view a list of the registers that are viewable using a debugger, enter:

```
$ ./system_test --list-reg
```

For a description of these registers, see the Technical Reference Manual for your IP.

4.2.2 Supported memory views

This section describes the memory views exposed by the Cycle Model.

————— **Note** —————

Memory spaces are exposed on the model. However, their visibility varies depending on the debugger in use.

Table 4-1 Memory views

Name	Description
memory	Unified memory view including TCMs, data cache, and downstream master AXI ports.
axi_m0	Downstream master AXI port m0 memory view.
axi_m1	Downstream master AXI port m1 memory view. Presence is configuration-dependent.

4.3 Restrictions and limitations

This section describes the restrictions and limitations for debugging SystemC Cycle Models.

Be aware of the following limitations related to debugging SystemC Cycle Models with DS-5:

- The Windows version of DS-5 is not supported for SystemC Cycle Models. Only the Linux 64-bit version is supported.
- Some multi-cluster systems may support cache coherency. Cycle Models in SystemC CPAKs do not currently show a coherent debug view of memory shared across clusters.
- System reset is not supported through the debugger interface.
- `sc_stop()` function calls are not supported during simulation, because they could result in termination of the debugger connection. A suggested workaround is to use an infinite loop at the end of the software being simulated.
- For certain cores, breakpoints may be missed during debug if they exist within short loops. See [4.6 Multicore debugging on page 4-48](#) for workarounds.

4.4 Enabling DS-5 for use with SystemC Cycle Models

This section describes how to set up DS-5 to debug Cycle Models.

This section contains the following subsections:

- [4.4.1 Initial database configuration on page 4-40](#).
- [4.4.2 Starting the simulation and selecting the model for debug on page 4-40](#).
- [4.4.3 Specifying the application to debug on page 4-42](#).

4.4.1 Initial database configuration

This section describes how to set up the initial configuration database.

Create a configuration database as follows:

1. Launch DS-5.
2. From the main menu, select **Window > Perspective > Open Perspective > Other**. The **Open Perspective** dialog box launches.
3. Select **DS-5 Configuration** and click **OK**. The **Open Perspective** dialog box closes.
4. From the DS-5 main menu, select **File > New > Configuration Database**. The **New Configuration Database** dialog box launches.
5. In the **Database Name** field, enter a name for your database.
6. Click **Finish**. The new database appears in the DS-5 Project Explorer.

Start a SystemC Cycle Model simulation to begin debugging (see [4.4.2 Starting the simulation and selecting the model for debug on page 4-40](#)).

4.4.2 Starting the simulation and selecting the model for debug

This section describes starting the simulation and selecting the SystemC model for debug.

After the DS-5 Configuration database has been created (see [4.4.1 Initial database configuration on page 4-40](#)):

1. Start the SystemC simulation with the CADI server enabled:

```
./system_test -s
```

2. Starting from a clean workspace, launch DS-5.
3. In DS-5, right-click on the Configuration Database you created during initial configuration, and select **New > Model Configuration**. The **New Model** dialog box appears.
4. In the **Select the database** panel, select the database in which to create the entry and click **Next**.

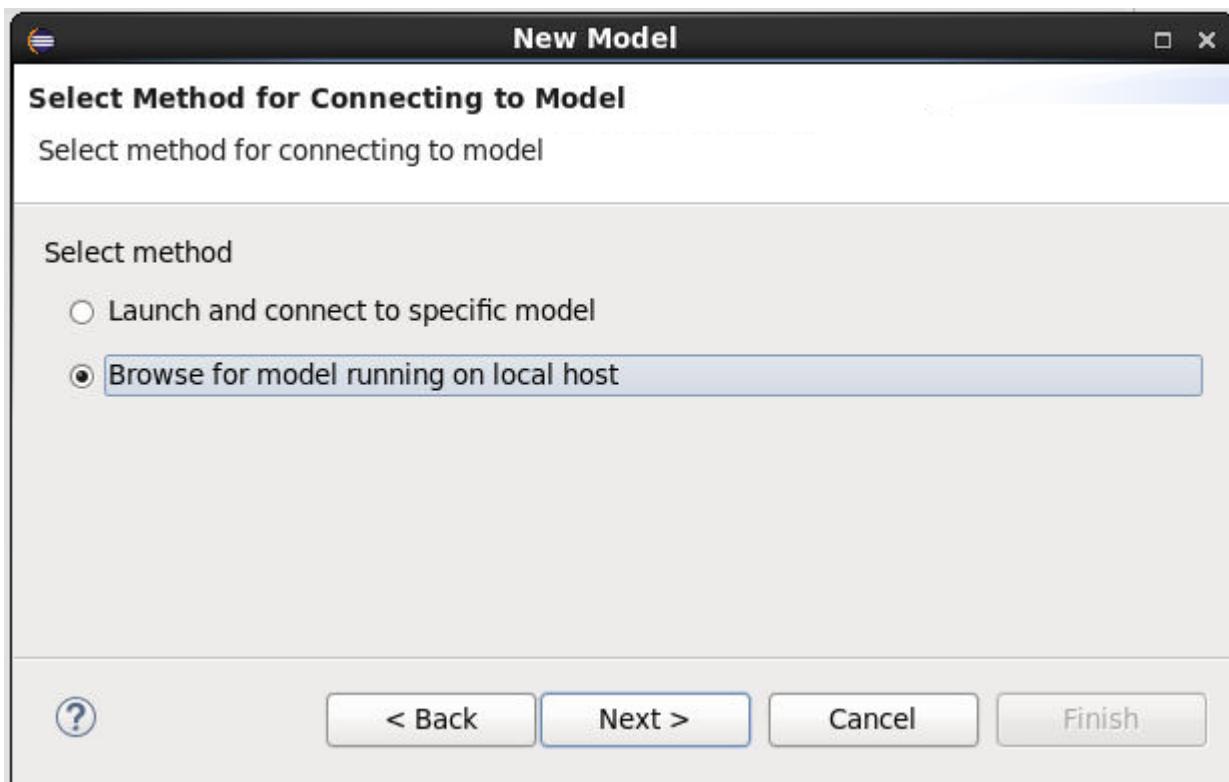


Figure 4-1 Selecting the method of connecting to a model

5. In the **Select Method for Connecting to Model** dialog, select **Browse for model running on local host** and click **Next**.
6. In the **Browse for model running on local host** dialog, click **Browse**.

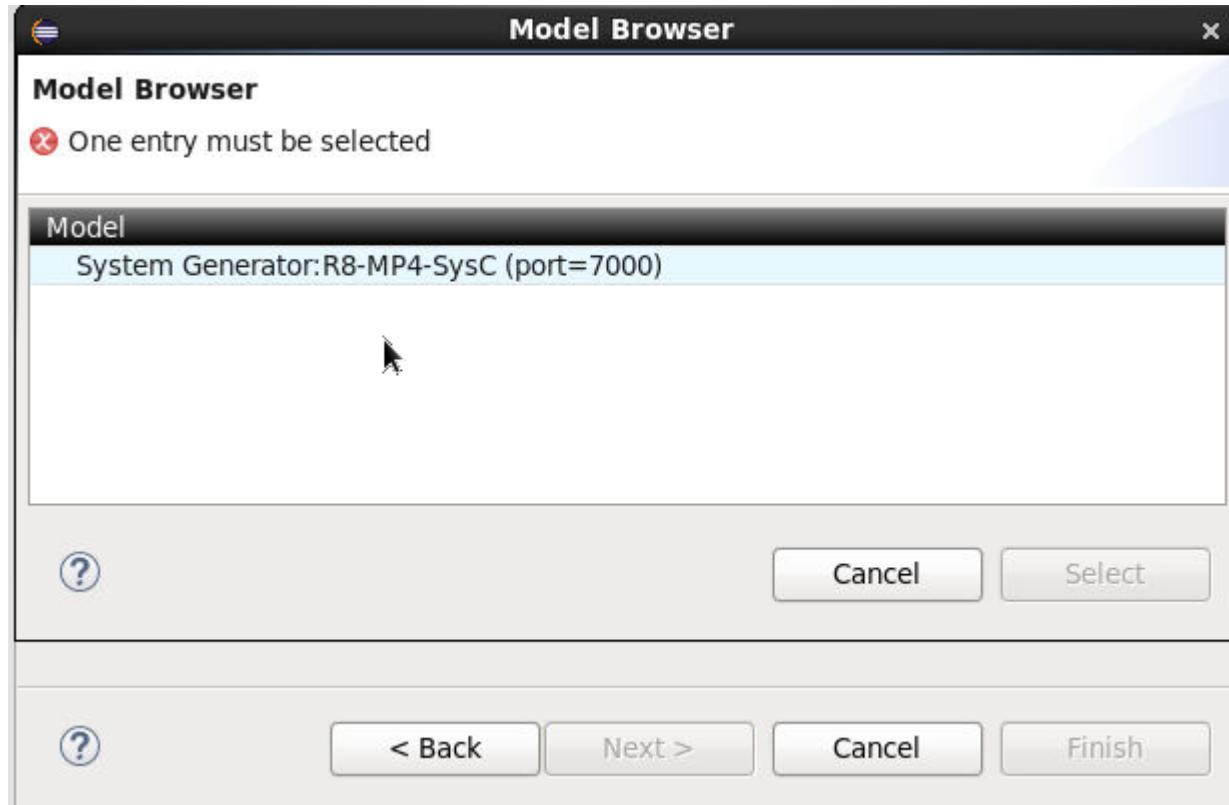


Figure 4-2 Selecting the method of connecting to a model

Result: DS-5 searches for the SystemC simulation sessions running on the host, and displays available simulations in the **Model Browser** dialog box.

7. Select the model for debug and click **Select**.
8. In the **New Model** dialog box, click **Finish**.

Result: DS-5 connects to the selected model and displays the cores available for debug.

4.4.3 Specifying the application to debug

This section describes how to launch a debug session.

1. In the DS-5 user interface, click **Debug**. This launches the **Debug Configurations** dialog box.
2. Under the **Connections** tab, check that the model you want is listed as a target. For example, in the following figure, Cortex-A53_0 is the target:

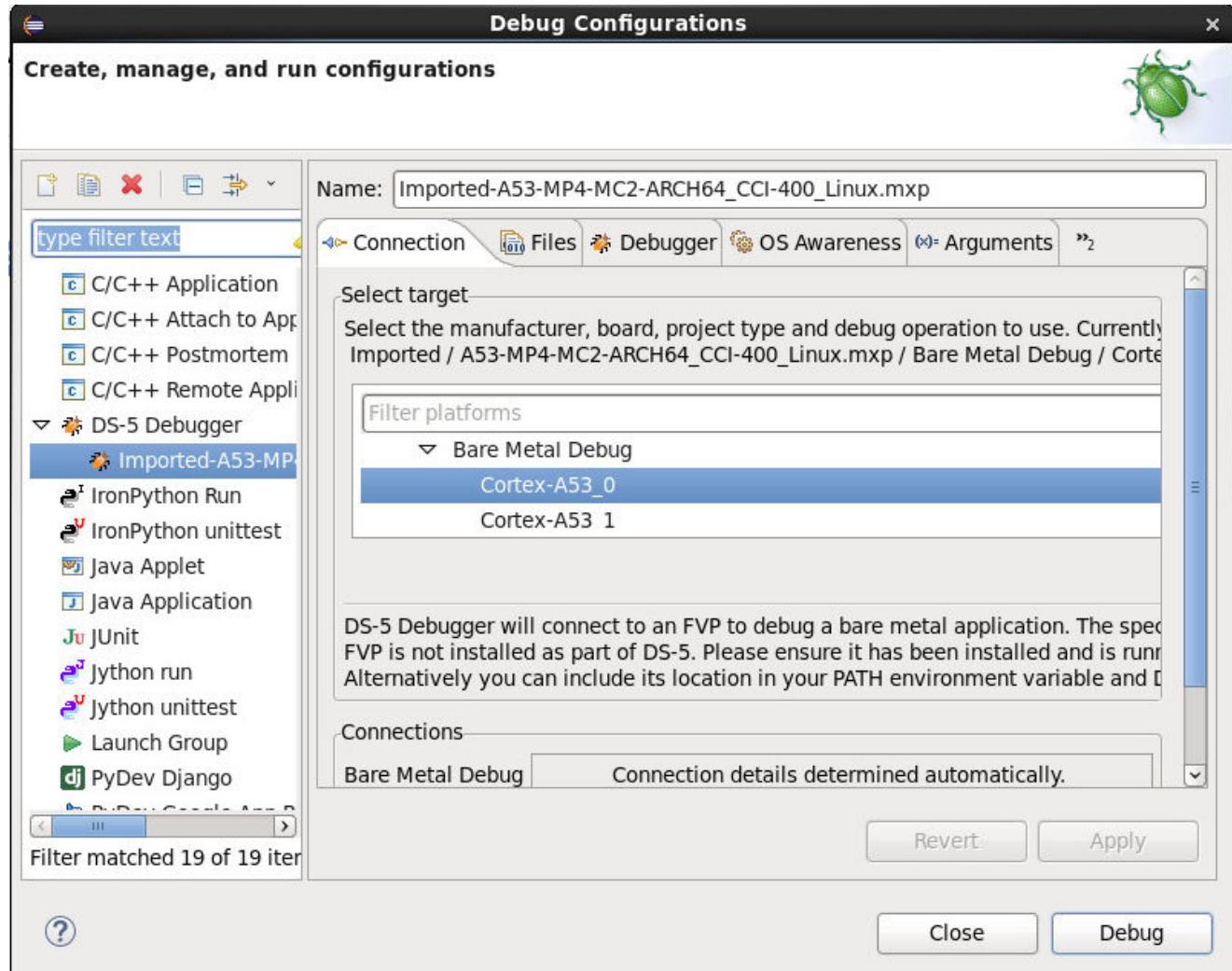


Figure 4-3 Selecting the target

3. Under the **Files** tab, browse to the application you want to run. For example, in the following figure, the application is **a53x4c2-v8-linux.elf**.

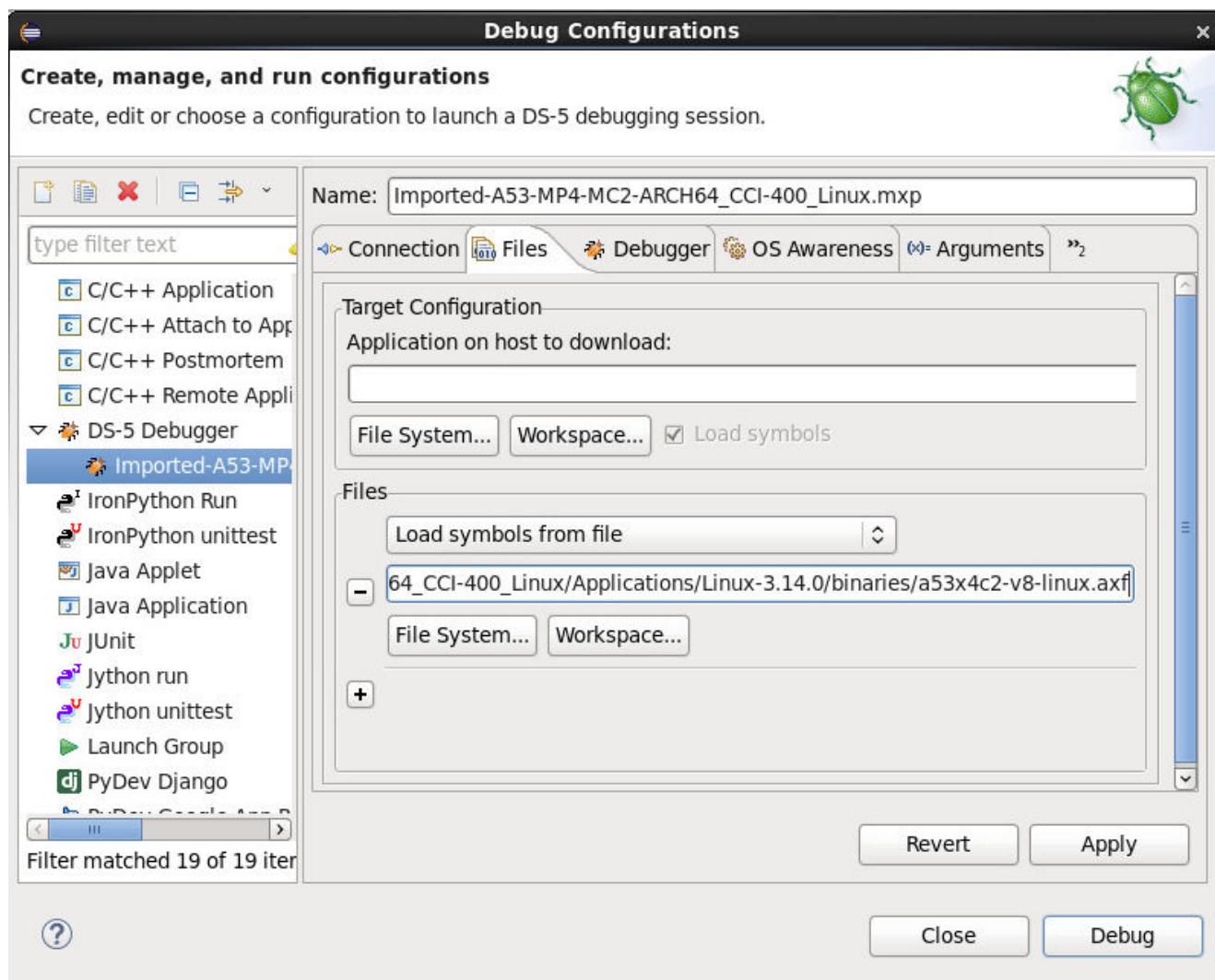


Figure 4-4 Selecting the application

4. Click **Apply**.
5. Under the **Debugger** tab, check that **Connect only** is selected in the **Run control** panel:

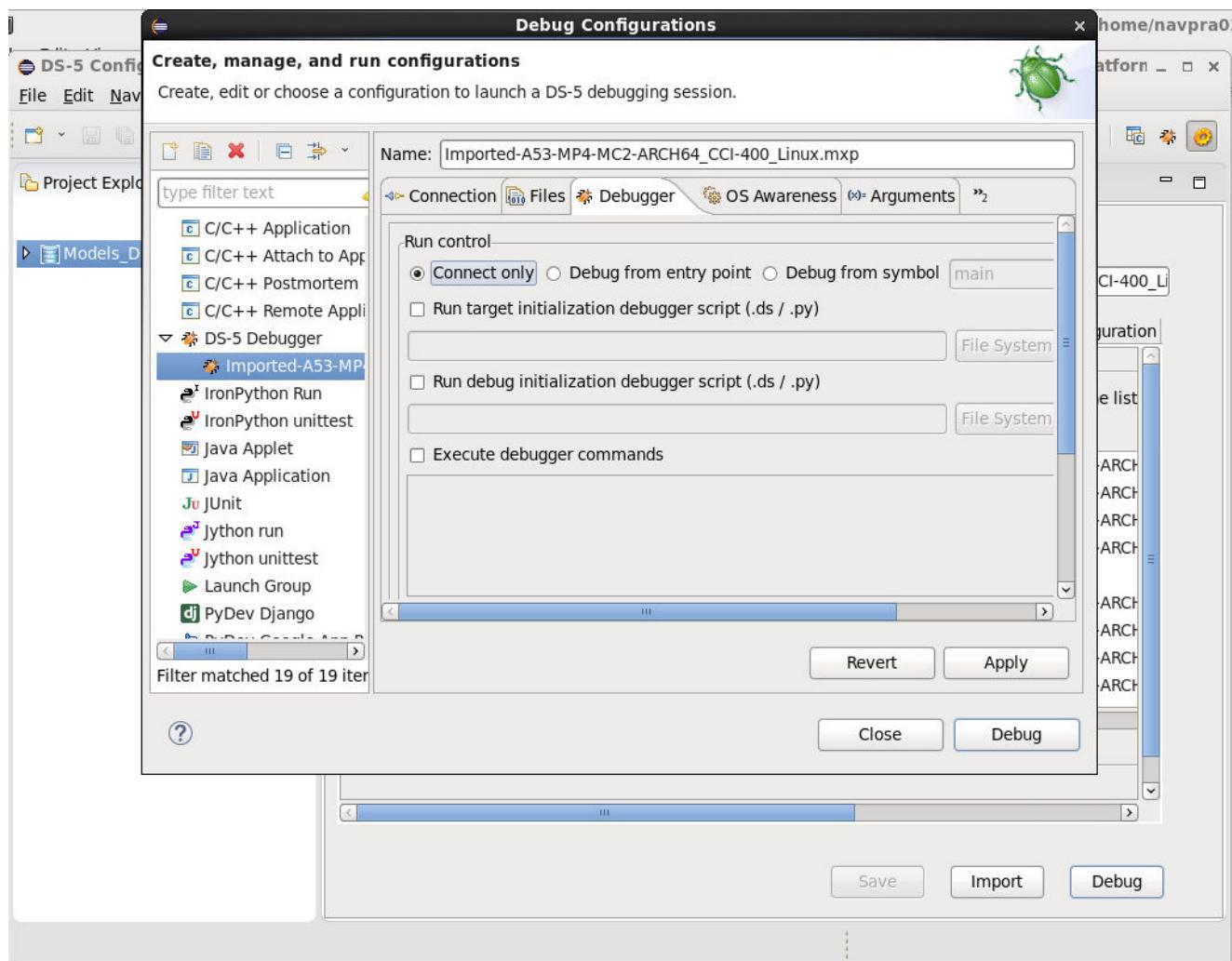


Figure 4-5 Selecting Connect only

6. Apply any changes and return to the **Connection** tab.
7. Select the core to debug:

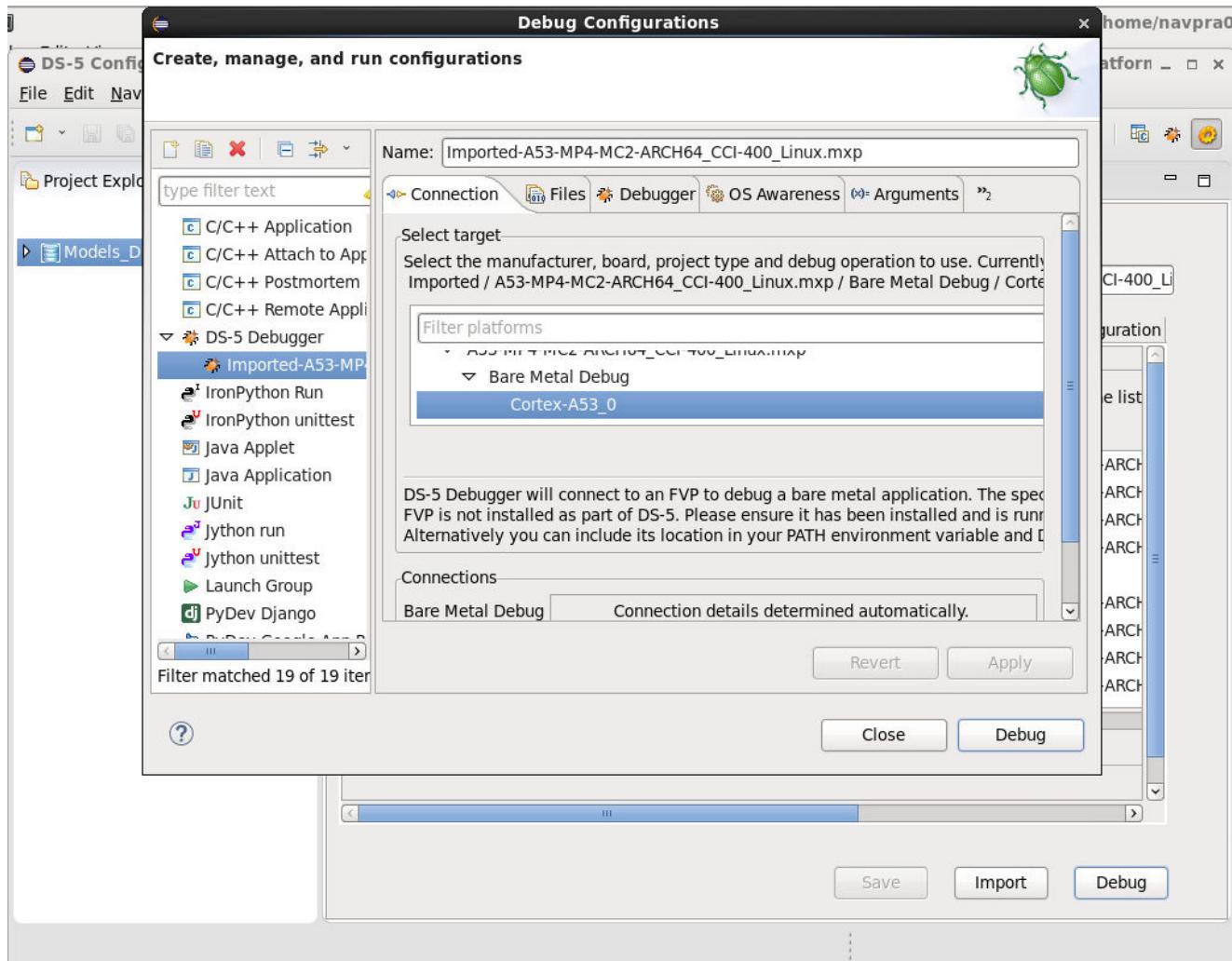


Figure 4-6 Selecting the core to debug

8. Click **Debug**. You are prompted to confirm the change to the debug perspective:

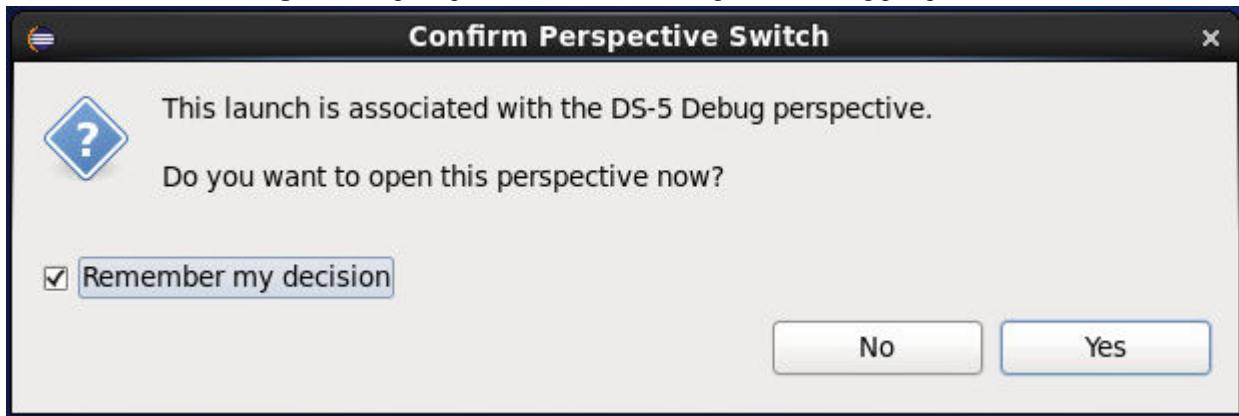


Figure 4-7 Confirming the perspective switch

9. Select **Remember my decision** to prevent subsequent prompts, and click **Yes**.

Result: The connected debug session launches in the DS-5 debug view:

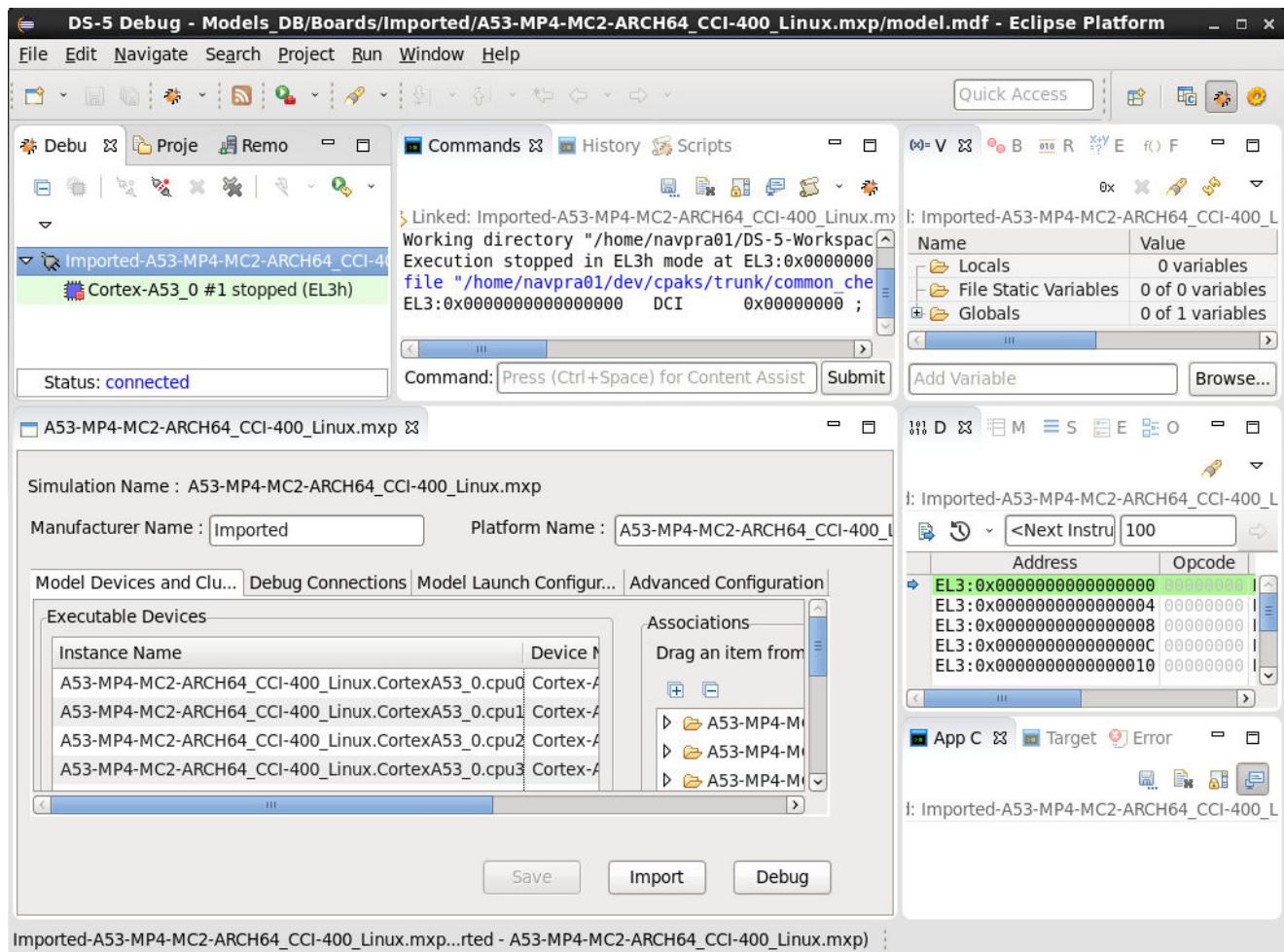


Figure 4-8 Connected debug session

4.5 CADI RemoteConnection parameters

This section describes the parameters for CADI connections.

Each parameter is prefixed with REMOTE_CONNECTION.CADIServer; for example:

REMOTE_CONNECTION.CADIServer.range

— Note —

The default value restricts connections to be from the localhost only. To enable remote connections, specify an IP address to listen to, or specify 0.0.0.0 to listen to all adapters.

Table 4-2 CADIIPCRemoteConnection parameters

Name	Type	Default value	Allowed values	Runtime	Description
enable_remote_cadi	bool	false	true, false	false	Allow connections from remote hosts.
listen_address	string	"127.0.0.1"	""	false	If enable_remote_cadi is set, this parameter is the network address the server listens on.
port	int	0x7b8b	0x1 - 0xffff	false	If enable_remote_cadi is set, this parameter is the TCP port the server listens on.
range	int	0x0	0x0 - 0x64	false	If the requested port is not available, search for the next available port in the range [port:port+range]. Only try the specified port.

See [5.8 scx::scx_parse_and_configure](#) on page 5-58 for information about CADI command-line options used with scx::scx_parse_and_configure().

4.6

Multicore debugging

This section contains information about debugging in SystemC Cycle Model multi-core and multi-cluster environments.

Multi-core, multi-cluster, and single-core debugging modes

For more information about debugging multi-core and multi-cluster targets, see the *Arm® DS-5 Debugger User Guide* (100953).

In SystemC Cycle Model multi-core and multi-cluster environments, you can specify whether to debug software running on multiple CPUs (this is the default), or whether to debug only on one CPU at a time.

To debug one CPU at a time, set the environment variable `CM_SCX_DEBUG_ONE` to 1 before running the simulation. When debugging a single CPU, only the CPU that hits a breakpoint has an accurate debug view. Impact on simulation performance in this mode is minimal, as only one CPU's pipeline is flushed.

To debug multiple CPUs, remove the environment variable `CM_SCX_DEBUG_ONE`.

Note

When debugging multiple CPUs, be aware that the impact on simulation performance is higher than when debugging one CPU at a time, because each of the core models performs additional debug logic to read data from internal pipelines. All CPUs attempt to accurately reflect the debug view, monitoring all CPU simulation stops, halts, single-steps, and breakpoints.

Timeouts and their effect on reliable debug views

This section describes how timeouts may interfere with reaching a debuggable point, and possible workarounds for timeouts. A *debuggable point* is a point in the simulation where the model's internal state can be accurately represented using architectural registers. Cycle Models must be at a valid debuggable point before they can provide a reliable debug view into registers and memory.

If you issue a debugger halt, and one or more CPUs can not reach a debuggable point within the timeout interval, the simulation halt request times out, resulting in a warning similar to the following:

```
Warning: stop at a debug point failed: Simulation suspended before these target(s)
could reach debug point: r8_core.cpu1;r8_core.cpu3;
```

In these cases, the debug view of the affected CPU may show inaccurate values, and register or memory modifications are not allowed.

Scenarios that might cause a timeout include:

- Simulated software uses WFI (wait for interrupts) or WFE (wait for events), and after a single-step or breakpoint hit on a different CPU, the interrupts or events do not occur within the timeout window.
- Breakpoints within loops are not reached (see [4.3 Restrictions and limitations on page 4-39](#)). In these cases, lengthening the loop by adding nops may allow the debugger to hit the breakpoint. For example:

```
end:
  nop
  nop
  nop
  nop
B end
```

Workarounds to avoid timeouts and view the content of such cores include:

- avoid using WFI/WFE in the simulated software
- avoid tight loops such as:

```
self: branch self
```
- Changing the timeout setting (see [4.7 Changing the timeout setting on page 4-49](#))

4.7 Changing the timeout setting

The timeout interval is counted by the simulation host. By default, the timeout interval is set to three seconds.

To change the timeout interval, set the environment variable `CM_SCX_STOP_TIMEOUT_SEC` before starting the simulation. For example, to set the timeout interval to five seconds using Linux bash shell:

```
export CM_SCX_STOP_TIMEOUT_SEC=5
```

The minimum interval allowed for this environment variable is one second.

Chapter 5

SystemC Export API function reference

This section describes the functions of the SystemC eXport (SCX) API that are supported by SystemC Cycle Models. Each description of a class or function includes the C++ declaration and the use constraints.

It contains the following sections:

- [5.1 `scx::scx_initialize` on page 5-51.](#)
- [5.2 `scx::scx_load_application` on page 5-52.](#)
- [5.3 `scx::scx_set_parameter` on page 5-53.](#)
- [5.4 `scx::scx_get_parameter` on page 5-54.](#)
- [5.5 `scx::scx_get_parameter_list` on page 5-55.](#)
- [5.6 `scx::scx_cpulimit` on page 5-56.](#)
- [5.7 `scx::scx_timelimit` on page 5-57.](#)
- [5.8 `scx::scx_parse_and_configure` on page 5-58.](#)
- [5.9 `scx::scx_print_statistics` on page 5-62.](#)

5.1 scx::scx_initialize

This function initializes the simulation.

Initialize the simulation before constructing any exported subsystem.

```
void scx_initialize(const std::string &id,  
                    scx_simcontrol_if *ctrl = scx_get_default_simcontrol());
```

id

an identifier for this simulation.

ctrl

a pointer to the simulation controller implementation. It defaults to the one provided with Arm models.

————— **Note** —————

Arm recommends specifying a unique identifier across all simulations running on the same host.

5.2 scx::scx_load_application

This function loads an application in the memory of an instance.

```
void scx_load_application(const std::string &instance,  
                           const std::string &application);
```

instance

the name of the instance to load into. The parameter **instance** must start with an EVS instance name, or with "*" to load the application into the instance on all EVSs in the platform. To load the same application on all cores of an SMP processor, specify "*" for the core instead of its index, in parameter **instance**.

application

the application to load.

— **Note** —

The loading of the application happens at `start_of_simulation()` call-back, at the earliest.

5.3 scx::scx_set_parameter

This function sets the value of a parameter in components present in EVSs or in plug-ins.

- `bool scx_set_parameter(const std::string &name, const std::string &value);`
- `template<class T>
bool scx_set_parameter(const std::string &name, T value);`

name

the name of the parameter to change. The parameter `name` must start with an EVS instance name for setting a parameter on this EVS, or with "*" for setting a parameter on all EVSs in the platform, or with a plug-in prefix (defaults to "TRACE") for setting a plug-in parameter.

value

the value of the parameter.

This function returns `true` when the parameter exists, `false` otherwise.

————— **Note** —————

- Changes made to parameters within System Canvas take precedence over changes made with `scx_set_parameter()`.
- You can set parameters during the construction phase, and before the elaboration phase. Calls to `scx_set_parameter()` after the construction phase are ignored.
- You can change run-time parameters after the construction phase with the debug interface.
- Specify plug-ins before calling the platform parameter functions, so that the plug-ins load and their parameters are available. Any plug-in that is specified after the first call to any platform parameter function is ignored.

5.4 scx::scx_get_parameter

This function retrieves the value of a parameter from components present in EVSs or from plug-ins.

- `bool scx_get_parameter(const std::string &name, std::string &value);`
- `template<class T> bool scx_get_parameter(const std::string &name, T &value);`
- `bool scx_get_parameter(const std::string &name, int &value);`
- `bool scx_get_parameter(const std::string &name, unsigned int &value);`
- `bool scx_get_parameter(const std::string &name, long &value);`
- `bool scx_get_parameter(const std::string &name, unsigned long &value);`
- `bool scx_get_parameter(const std::string &name, long long &value);`
- `bool scx_get_parameter(const std::string &name, unsigned long long &value);`
- `std::string scx_get_parameter(const std::string &name);`

`name`

the name of the parameter to retrieve. The parameter `name` must start with an EVS instance name for retrieving an EVS parameter or with a plug-in prefix (defaults to "TRACE") for retrieving a plug-in parameter.

`value`

a reference to the value of the parameter.

The `bool` forms of the function return `true` when the parameter exists, `false` otherwise. The `std::string` form returns the value of the parameter when it exists, empty string ("") otherwise.

— Note —

Specify plug-ins before calling the platform parameter functions, so that the plug-ins load and their parameters are available. Any plug-in that is specified after the first call to any platform parameter function is ignored.

5.5 scx::scx_get_parameter_list

This function retrieves a list of all parameters in all components present in all EVSs and from all plug-ins.

```
std::map<std::string, std::string> scx_get_parameter_list();
```

The parameter names start with an EVS instance name for EVS parameters or with a plug-in prefix (defaults to "TRACE") for plug-in parameters.

————— Note —————

- Specify plug-ins before calling the platform parameter functions, so that the plug-ins load and their parameters are available. Any plug-in that is specified after the first call to any platform parameter function is ignored.
- If `scx_set_parameter()` is called after the simulation elaboration phase, the new value is not set in the model, although it is returned by `scx_get_parameter_list()`.

5.6 scx::scx_cpulimit

Sets the maximum number of CPU (User + System) seconds to run, excluding startup and shutdown.

```
void scx_cpulimit(double t);
```

t

the number of seconds to run. Defaults to unlimited.

5.7 scx::scx_timelimit

Sets the maximum number of seconds to run, excluding startup and shutdown.

```
void scx_timelimit(double t);
```

t

the number of seconds to run. Defaults to unlimited.

5.8 scx::scx_parse_and_configure

This function parses command-line options and configures the simulation accordingly.

```
void scx_parse_and_configure(int argc,
                             char *argv[],
                             const char *trailer = NULL,
                             bool sig_handler = true);
```

argc

the number of command-line options listed with `argv[]`.

argv

command-line options.

trailer

a string that follows the option list when printing help message (`--help` option).

sig_handler

whether to enable signal handler function, `true` to enable (default), `false` to disable.

This function calls `std::exit(EXIT_SUCCESS)` to exit. It calls `std::exit(EXIT_FAILURE)` if there was an error in the parameter specification, or an invalid option was specified, or if the application or plug-in was not found.

Options

The application must pass the values of the options from function `sc_main()` as arguments to this function. The following options are supported:

--application, -a [INST=]FILE

This option specifies the application to load. The application to load must be the first argument on the command line.

————— **Note** —————

Use this option only for CPAKs with TLM models. For CPAKs with pin-level models, specifying `--application` has no effect and results in multiple warnings. The application for CPAKs with pin-level models is determined by the contents of the hex files in the CPAK Systems directory. See the CPAK `README.txt` file for more information.

[INST=]

Specifies the core instance on which to load the application. This field is optional for Symmetric Multiprocessor (SMP) cores.

FILE

Specifies the test case or application to be loaded.

The following example loads `test0.elf` on core 0, and `test1.elf` on core 1:

```
$ ./system_test -a CortexR8_core0=test0.elf -a CortexR8_core1=test1.elf -S -p
```

The following example for SMP cases loads `test.elf` on all cores:

```
$ ./system_test -a test.elf -S -p
```

--cadi-log, -L

This option logs all CADI calls to an XML log file. The simulation generates one XML log file per CPU and outputs them to the CPAK Systems directory with the filename `CADIlog-model_core.cpucpu-process_ID.xml`. A cluster-level XML log file is also generated and output to this location with the filename `CADIlog-model_core-process_ID.xml`

For example:

```
$ ./system_test -L
```

--cadi-server, -S FILE

This option instructs a CADI server to wait for a debugger to connect and receive commands (such as run) before starting the simulation. If -S is not specified, the simulation starts immediately and connection to a CADI client or debugger is not allowed.

FILE

Specifies the test case or application to be loaded.

For example:

```
$ ./system_test test.elf -S
```

--config-file, -f FILE

This option loads model parameters from the specified configuration file.

FILE

Name of the configuration file.

For example:

```
$ ./system_test --config-file R8_config.cfg
```

--cpulimit

Maximum number of CPU (User + System) seconds to run, excluding startup and shutdown. Defaults to unlimited.

--help, -h

This option prints descriptions of available command line options.

— Note —

Arm Models support the full set of options that are printed when you enter --help or -h. Currently, Arm SystemC Cycle Models support a subset of these options. The options supported by this release of SystemC Cycle Models are described in this section.

For example:

```
$ ./system_test --help
```

--list-params, -l

This option prints a list of model parameters to standard output.

For example:

```
$ ./system_test -l
.
.

[plover_tarmac] Sending stream to 'plover_tarmac_decode -f
tarmac_PLOVERINTEGRATION_u_plover_u_noram1_wrapper_u_noram1.log'
Starting Sim
# Parameters:
# instance.parameter=value      #(type, mode) default = 'def value' : description :
[min..max]
#-----
REMOTE_CONNECTION.CADIServer.enable_remote_cadi=0      # (bool , init-time) default =
'0'          : Allow connections from remote hosts
REMOTE_CONNECTION.CADIServer.listen_address=127.0.0.1  # (string, init-time) default =
'127.0.0.1' : Network address the server should listen on if enable_remote_cadi is set
("127.0.0.1" by default)
REMOTE_CONNECTION.CADIServer.port=31627                # (int , init-time) default =
'0x7b8b' : TCP port the server should listen on if enable_remote_cadi is set (31627 by
default)
REMOTE_CONNECTION.CADIServer.range=0                  # (int , init-time) default =
'0x0' : If requested port is not available, search for next available port in range:
[port:port+range] (0 by default, only try specified port)
```

```

cortexr8_core.ACLKENSC=1          # (int , run-time ) default =
'0x1'   : ACLKENSC enable parameter
cortexr8_core.ACLKENST=1          # (int , run-time ) default =
'0x1'   : ACLKENST enable parameter
cortexr8_core.AFVALIDMD0=0        # (int , run-time ) default =
'0x0'   : Default value for AFVALIDMD0
cortexr8_core.AFVALIDMD1=0        # (int , run-time ) default =
'0x0'   : Default value for AFVALIDMD1
cortexr8_core.AFVALIDMD2=0        # (int , run-time ) default =
'0x0'   : Default value for AFVALIDMD2
cortexr8_core.AFVALIDMD3=0        # (int , run-time ) default =
'0x0'   : Default value for AFVALIDMD3
.
.
.

```

--list-reg

This option prints a list of model registers that are supported for viewing with a debugger. See also [4.2.1 Supported registers on page 4-37](#). See the Technical Reference Manual for your IP for register descriptions.

For example:

```
$ ./system_test --list-reg
```

--quiet

Run quiet, suppress informational output.

--parameter, -C [INST.]PARAMETER=VALUE

This option sets the specified model parameter using the format : -C INST.PARAM=VALUE

[INST=]

Specifies the core instance. This field is optional for Symmetric Multiprocessor (SMP) cores.

PARAMETER

Specifies the parameter to set.

VALUE

Specifies the parameter value.

For example:

```
$ ./system_test -C cortexr8_core0.LOAD_DTCMS=true
```

--print-port-number, -p

This option causes the CADI server to print the TCP/IP port it is listening to.

For example:

```

$ ./system_test -S -p
.
.
.
Starting Sim
CADI server started listening to port 7001
Info: R8-MP4-SysC: CADI Debug Server started for ARM Models...

```

--stat

This option prints run statistics on simulation exit.

```
$ ./system_test -S --stat
```

After the simulation ends, statistics such as those shown in the following example are output:

```

--- R8-MP4-SysC statistics: -----
Simulated time                 : 0.000000s
User time                      : 0.028996s

```

```
System time           : 0.002999s
Wall time            : 4.278761s
cortexr8_core.cpu0  : 0.00 KIPS (      0 Inst)
cortexr8_core.cpu1  : 0.00 KIPS (      0 Inst)
cortexr8_core.cpu2  : 0.00 KIPS (      0 Inst)
cortexr8_core.cpu3  : 0.00 KIPS (      0 Inst)
-----
```

-timelimit, -T

Maximum number of seconds to run, excluding startup and shutdown. Defaults to unlimited.

5.9 scx::scx_print_statistics

This function specifies whether to enable printing of simulation statistics at the end of the simulation.

```
void scx_print_statistics(bool print = true);
```

print

true to enable printing of simulation statistics, false otherwise.

— **Note** —

- You cannot enable printing of statistics once simulation starts.
- The statistics include LISA `reset()` behavior run time and application load time. A long simulation run compensates for this.

Appendix A

Migrating from previous SystemC Cycle Model versions

This section contains instructions specific to upgrading from a previous verison of SystemC Cycle Models to version 10.0.

It contains the following section:

- *A.1 Migrating from previous versions* on page Appx-A-64.

A.1 Migrating from previous versions

Perform the actions in this section if you are upgrading to SystemC Cycle Models version 10.0 from a previous version.

Make the following additions to the `LD_LIBRARY_PATH` environment variable:

- Add `MODELS/component_name/gcc483/SystemC/lib`. This addition is required because `MODELS/component_name/gcc483/SystemC/lib/libcomponent.a` has been replaced with `libmodelname.icm.so`.
- Add `runtime install_path/ARM/CycleModels/Runtime/cm_sysc/version/lib/Linux64_GCC-x.y`.

————— Note —————

In this filepath, *version* is the latest Cycle Model SystemC Runtime version (not the model version), and *x.y* is the GCC version.

This addition is required because the installation package includes a new library, `runtime install_path/ARM/CycleModels/Runtime/cm_sysc/version/lib/Linux64_GCC-x.y/libcm_runtime.so`, which you are required to link.

SystemC Cycle Models version 10.0 includes TLM socket name changes; for example, `core.iSkt_M0` has changed to `core.iSkt_ACE5_Master_M0`. See the file `libcomponent.tlm.h` in your installation directory for socket names.