

Cortex-R8 SystemC Cycle Model

Version 11.2

User Guide

The logo for Arm, consisting of the lowercase letters 'arm' in a bold, sans-serif font.

Cortex-R8 SystemC Cycle Model

User Guide

Copyright © 2018–2021 Arm Limited or its affiliates. All rights reserved.

Release Information

Document History

Issue	Date	Confidentiality	Change
1000-00	29 August 2018	Non-Confidential	First release
1100-00	31 May 2019	Non-Confidential	Release 11.0
1102-00	15 March 2020	Non-Confidential	Release 11.2
1102-01	01 May 2021	Non-Confidential	Documentation update

Non-Confidential Proprietary Notice

This document is protected by copyright and other related rights and the practice or implementation of the information contained in this document may be protected by one or more patents or pending patent applications. No part of this document may be reproduced in any form by any means without the express prior written permission of Arm. **No license, express or implied, by estoppel or otherwise to any intellectual property rights is granted by this document unless specifically stated.**

Your access to the information in this document is conditional upon your acceptance that you will not use or permit others to use the information for the purposes of determining whether implementations infringe any third party patents.

THIS DOCUMENT IS PROVIDED “AS IS”. ARM PROVIDES NO REPRESENTATIONS AND NO WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, SATISFACTORY QUALITY, NON-INFRINGEMENT OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE DOCUMENT. For the avoidance of doubt, Arm makes no representation with respect to, and has undertaken no analysis to identify or understand the scope and content of, third party patents, copyrights, trade secrets, or other rights.

This document may include technical inaccuracies or typographical errors.

TO THE EXTENT NOT PROHIBITED BY LAW, IN NO EVENT WILL ARM BE LIABLE FOR ANY DAMAGES, INCLUDING WITHOUT LIMITATION ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, PUNITIVE, OR CONSEQUENTIAL DAMAGES, HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY, ARISING OUT OF ANY USE OF THIS DOCUMENT, EVEN IF ARM HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

This document consists solely of commercial items. You shall be responsible for ensuring that any use, duplication or disclosure of this document complies fully with any relevant export laws and regulations to assure that this document or any portion thereof is not exported, directly or indirectly, in violation of such export laws. Use of the word “partner” in reference to Arm’s customers is not intended to create or refer to any partnership relationship with any other company. Arm may make changes to this document at any time and without notice.

If any of the provisions contained in these terms conflict with any of the provisions of any click through or signed written agreement covering this document with Arm, then the click through or signed written agreement prevails over and supersedes the conflicting provisions of these terms. This document may be translated into other languages for convenience, and you agree that if there is any conflict between the English version of this document and any translation, the terms of the English version of the Agreement shall prevail.

The Arm corporate logo and words marked with ® or ™ are registered trademarks or trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere. All rights reserved. Other brands and names mentioned in this document may be the trademarks of their respective owners. Please follow Arm’s trademark usage guidelines at <https://www.arm.com/company/policies/trademarks>.

Copyright © 2018–2021 Arm Limited (or its affiliates). All rights reserved.

Arm Limited. Company 02557590 registered in England.

110 Fulbourn Road, Cambridge, England CB1 9NJ.

(LES-PRE-20349)

Confidentiality Status

This document is Non-Confidential. The right to use, copy and disclose this document may be subject to license restrictions in accordance with the terms of the agreement entered into by Arm and the party that Arm delivered this document to.

Unrestricted Access is an Arm internal classification.

Product Status

The information in this document is Final, that is for a developed product.

Web Address

developer.arm.com

Progressive terminology commitment

Arm values inclusive communities. Arm recognizes that we and our industry have used terms that can be offensive. Arm strives to lead the industry and create change.

We believe that this document contains no offensive terms. If you find offensive terms in this document, please contact terms@arm.com.

Contents

Cortex-R8 SystemC Cycle Model User Guide

Preface

About this book 7

Chapter 1

Cycle Model functionality and operating requirements

1.1 *Functionality of the SystemC Cycle Model* 1-10
1.2 *Prerequisites to using SystemC Cycle Models* 1-11
1.3 *Supported platforms, compilers, and simulators* 1-12
1.4 *Package contents* 1-13

Chapter 2

Integrating models into your environment

2.1 *Extracting build options using the Cycle Models Configuration Tool* 2-16
2.2 *Adding custom options to the Makefile* 2-22

Chapter 3

Using SystemC Cycle Models

3.1 *Connecting model ports* 3-24
3.2 *Resetting the SystemC Cycle Model* 3-26
3.3 *Setting model parameters* 3-27
3.4 *Dumping waveforms* 3-28
3.5 *Loading DTCM and ITCM* 3-29
3.6 *Configuring PMU events* 3-30
3.7 *Configuring Tarmac trace* 3-33
3.8 *Working with the SCX framework* 3-34

Chapter 4

Debugging SystemC Cycle Models with Arm® Development Studio

4.1	Restrictions and limitations	4-36
4.2	Prerequisites to debugging	4-37
4.3	Supported debug features	4-38
4.4	Enabling Development Studio for use with SystemC Cycle Models	4-40
4.5	CADI RemoteConnection parameters	4-45
4.6	Multicore debugging	4-46
4.7	Changing the timeout setting	4-47

Chapter 5

SystemC Export API function reference

5.1	scx::scx_initialize	5-49
5.2	scx::scx_load_application	5-50
5.3	scx::scx_set_parameter	5-51
5.4	scx::scx_get_parameter	5-52
5.5	scx::scx_get_parameter_list	5-53
5.6	scx::scx_cpulimit	5-54
5.7	scx::scx_timelimit	5-55
5.8	scx::scx_parse_and_configure	5-56
5.9	scx::scx_print_statistics	5-60

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 Cycle Model functionality and operating requirements

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

Chapter 2 Integrating models into your environment

This section describes using the Cycle Models Configuration Tool to extract required build options from Arm models, and how to specify custom build options.

Chapter 3 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 4 Debugging SystemC Cycle Models with Arm® Development Studio

This section describes how to connect the Arm Development Studio Debugger to Arm SystemC Cycle Models in a Cycle Model reference platform.

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.

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.

Feedback

Feedback on this product

If you have any comments or suggestions about this product, contact your supplier and give:

- The product name.
- The product revision or version.
- An explanation with as much information as you can provide. Include symptoms and diagnostic procedures if appropriate.

Feedback on content

If you have comments on content then send an e-mail to errata@arm.com. Give:

- The title *Cortex-R8 SystemC Cycle Model User Guide*.
- The number 101391_1102_01_en.
- If applicable, the page number(s) to which your comments refer.
- A concise explanation of your comments.

Arm also welcomes general suggestions for additions and improvements.

————— **Note** —————

Arm tests the PDF only in Adobe Acrobat and Acrobat Reader, and cannot guarantee the quality of the represented document when used with any other PDF reader.

Other information

- [Arm® Developer](#).
- [Arm® Documentation](#).
- [Technical Support](#).
- [Arm® Glossary](#).

Chapter 1

Cycle Model functionality and operating requirements

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 IEEE 1666-compliant simulator. You can use SystemC Cycle Models within an Arm Cycle Model reference platform, 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 [3.4 Dumping waveforms on page 3-28](#).
- Support for viewing register values. See [4.3.1 Supported registers on page 4-38](#) to learn about registers exposed on the Cycle Model.
- Support for debug view of internal and external memory contents. See [4.3.2 Supported memory views on page 4-39](#) 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 prerequisites in this section for using Arm SystemC Cycle Models.

Details about the following prerequisites can be found in the [Cycle Model SystemC Runtime Installation Guide](#) (101146):

- Supported Cycle Model SystemC Runtime must be installed in your environment.
- Supported GCC version must be installed in your environment.
- Supported Cycle Model Studio Runtime is required for simulation and recompilation. This is installed as part of the SystemC Runtime.
- Configured SystemC environment.

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 (EVSS)). See the [Fast Models User Guide](#) (100965) for more information.

Prerequisites for Cycle Model reference platform environments

All models in a Cycle Model reference platform must be the same release (for example, all v10.x or all v11.x). Mixing different versions within a reference platform is not supported, and results in incorrect Cycle Model behavior, incorrect Tarmac results, or other issues.

Reference platforms may have additional prerequisites. See the [Cycle Model Reference Platform Getting Started Guide](#) (101497).

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 to run on Red Hat Enterprise Linux versions 6.6 (64-bit) and 7 (64-bit).

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 files described in this section.

In a Cycle Model reference platform, these files are located in the root directory *reference_platform/*MODELS/component/*gccversion/SystemC*.

For models downloaded from Arm IP Exchange (<https://ipx.arm.com/>), these files and directories are located in the root directory *gccversion/SystemC*.

Note

Package content and filenames may differ slightly from model to model.

.data/

Contains the XML data file for the model. The XML data file is readable by the Cycle Model Configuration Tool (*cm_config*), and provides required build and link data when you run *make*.

icm/

Contains header files for Cycle Model APIs.

lib/

Contains *libcomponent.icm.so*, the RTL-based core of the Cycle Model. When you compile the system executable, this must be included.

univentUtil/ (Models that support Tarmac only)

Contains files required for Tarmac tracing.

CM_busdefs.tar

Cycle Model IPXACT bus definition bundle.

CM_IPXACT_component.xml

Cycle Model IPXACT description.

cm_sysc_utils.h

SystemC utilities header file.

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.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.

component_icm.h

Header file for *libcomponent.icm.so*, located in *lib/*.

Makefile

Compiles the Cycle Model into the shared libraries included with the installation.

component_params.cfg

Cycle Model-specific parameter definitions.

component_pmu.h (Models that support PMU only)

Cycle Model hardware profiling implementation to generate profiling events.

component_tarmac.h (Models that support Tarmac trace only)

Cycle Model Tarmac trace implementation.

component.tlm.cpp and ***component.tlm.h***

TLM wrappers. Present only in TLM-based models.

TCM-related files

Models that support TCMs may have additional header files related to TCM loading and waveform dumping, if supported.

Chapter 2

Integrating models into your environment

This section describes using the Cycle Models Configuration Tool to extract required build options from Arm models, and how to specify custom build options.

It contains the following sections:

- [2.1 Extracting build options using the Cycle Models Configuration Tool](#) on page 2-16.
- [2.2 Adding custom options to the Makefile](#) on page 2-22.

2.1 Extracting build options using the Cycle Models Configuration Tool

To integrate an Arm model into your build flow, use the Cycle Models Configuration Tool to extract its build options.

The Cycle Models Configuration Tool is a command-line utility included with the SystemC Cycle Model Runtime. It provides a standard interface to the Cycle Model SystemC Runtime and Model packages.

The Cycle Models Configuration Tool simplifies integration of models into your systems, build flow, or custom `Makefile` by extracting the required build and link options for all Arm Cycle Model components in the model or reference platform.

The Cycle Models Configuration Tool also flags incompatibilities between individual model requirements within a system. For example, if you add a new model to an existing system, the Cycle Models Configuration Tool determines the version of the SystemC Cycle Model Runtime that satisfies the version requirements of all of the models.

You can run the Cycle Models Configuration Tool at the command line or as part of the build flow.

Restrictions and limitations

The following restrictions and limitations apply to the Cycle Models Configuration Tool:

- For use on 64-bit Linux platforms only.
- Tested on GCC 4.8.3 and GCC 6.4.0.
- The Cycle Models Configuration Tool uses the directory it is run from as the default `searchpath`; use the `--searchpath` option to specify a different location to search.
- Backward compatibility is limited to Version 11.0 (and later) models. These models contain the data files required by the Cycle Models Configuration Tool.
- Models built on IP Exchange contain the data files required by the Cycle Models Configuration Tool. If you are working in a reference platform environment with models that were not built on IP Exchange, you must explicitly make the build options available to the `Makefile`. Your reference platform will not build successfully without the required build options for all components. See the [Cycle Model Reference Platform Getting Started Guide](#) for more information.

This section contains the following subsections:

- [2.1.1 Cycle Models Configuration Tool command syntax on page 2-16.](#)
- [2.1.2 Cycle Models Configuration Tool examples on page 2-20.](#)

2.1.1 Cycle Models Configuration Tool command syntax

Extracts compiler, link, and source data and dependencies for specified components.

Syntax

```
cm_config [-h] [--verbosity [{debug,error,info,warning}]] [--version]
[--list] [--list-req] [--use-tool USE-TOOL]
[--searchpath SEARCHPATH [SEARCHPATH ...]]
[--model MODEL [MODEL ...]] [--ignore IGNORE [IGNORE ...]]
[--compile [{defines,flags,includes}]] [--sources]
[--link [{dirs,dirs_rt,flags,libs}]]
[--model-type [{pin,tlm}]] [--use-env USE-ENV [USE-ENV ...]]
[--use-arm]
```

Arguments

--compile [{defines, flags, includes}]

Optional.

Outputs compile options for the specified component or components. By default, defines, flags, and includes are output. Optionally, you can specify one or more of the following options to output only the related data:

- defines
- flags
- includes

This example outputs define, flag, and link data:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath ./ --model cms --compile
```

This example outputs define and flag data only:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath ./ --model cms --compile defines --  
compile flags
```

-h, --help

Optional.

Shows command help and exits.

Example:

```
$ cm_config --help
```

--ignore [{cms, cm_sysc, SystemC, model}]

Optional.

Directs the Cycle Models Configuration Tool to ignore the specified data when returning compiler, build, or link information. Use a space delimiter when specifying one or more of the following options:

- cms ignores data related to the Cycle Model Studio Runtime
- cm_sysc ignores data related to the SystemC Cycle Model Runtime
- SystemC ignores data related to the SystemC environment
- component ignores model- or component-related data. Use the --list argument for the exact component name.

Example:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath MODELS --ignore cms cm_sysc SystemC --  
model CortexR8
```

--link [{dirs, dirs_rt, flags, libs}]

Optional.

Outputs linker data for the specified component or components. Used without an option, returns directories, libraries, and flags. Optionally, specify one or more of the following options:

- dirs
- dirs_rt (returns the unformatted directories for dynamically loaded libraries)
- flags
- libs

This example returns directory, library, and flag data:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath MODELS --model CortexR8 --link
```

This example returns flag and library data only:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath MODELS --model CortexR8 --link flags --  
link libs
```

--list

Optional.

Lists all available components. Optionally, use in combination with the `--searchpath` option to restrict to a particular directory.

Example:

```
$ cm_config --list
```

--list-req

Optional.

Lists all available components and the tools and components each one requires. Optionally, use in combination with the `--searchpath` option to restrict to a particular directory.

Example:

```
$ cm_config --list-req
```

--model MODEL [MODEL ...]

Required unless the `--list` or `--list-req` option is used.

Specifies one or more components to retrieve information for. Optionally, specify a version with a comparison operator; for example: `"COMP_A>3.2.4"` or `"COMP_A > 3.2.4"`. Component names match the C++ class name defined at model build time. Versions must be only numbers and decimals. If greater or less than signs are used, the model name and version must be enclosed by quotations.

Example:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath MyModelsAndRuntimeInstallPath --model  
MyCPUModel MyInterconnectModel --  
link
```

--model-type [{pin, tlm}]

Optional.

Models may be pin-based or TLM-based. By default, the Cycle Models Configuration Tool returns all data regardless of the model type. The `--model-type` argument returns only data related to the specified model type:

- `pin` returns pin-related data plus data common to both model types.
- `tlm` returns TLM-related data plus data common to both model types.

Example:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath MODELS --model CortexR8 --model-type  
tlm --link
```

--searchpath SEARCHPATH [SEARCHPATH ...]

Optional.

Specifies the directories to search for Models or Cycle Model SystemC Runtime components. When not specified, the Cycle Models Configuration Tool searches the directory in which the tool was run.

Example:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath MODELS --model CortexR8 --link
```

--sources

Optional.

Outputs a list of source files.

Example:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath MODELS --model CortexR8 --sources
```

--use-arm

Optional.

Extracts data only for Arm libraries and components. Recommended only when extracting data for custom flows.

————— **Note** —————

Use this option with care. Build failures may result if libraries other than Arm libraries are required to build an executable.

Example:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath ./ --model CortexR8 --link libs --use-arm
```

--use-env <COMPONENT>:<ENV> [<COMPONENT>:<env> ...]

Optional.

Formats data for one or more specified <component>:<env> pairs. For these components, the path data returned is relative to an environment variable that reflects the root of the component. Recommended for advanced users only.

Some examples of component pair options are:

- cms:CARBON_HOME
- SystemC:SYSTEMC_HOME
- cm_sysc:CM_SYSC_HOME
- CortexM0Plus:MY_M0PLUS_HOME

Example:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath ./ --model cms --sources --use-env cms:CARBON_HOME
```

--use-tool GCC:VERSION

Required.

Specifies which compiler and link options to return. Options are:

- gcc:6.4.0
- gcc:4.8.3

Example:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath MODELS --model CortexR8 --sources
```

--verbosity VERBOSITY

Optional.

Specifies the verbosity of Cycle Models Configuration Tool execution feedback. Options are:

- debug
- error (default)
- info
- warning

Example:

```
$ cm_config --use-tool gcc:6.4.0 --searchpath MODELS --verbosity debug --model CortexR8 --link
```

--version

Optional.

Returns the version of the Cycle Models Configuration Tool. Example:

```
$ cm_config --version
```

Related information

[2.1.2 Cycle Models Configuration Tool examples on page 2-20](#)

2.1.2 Cycle Models Configuration Tool examples

The examples in this section assume that the path for the Cycle Models Configuration Tool is part of the PATH environment variable (*install path/ARM/CycleModels/Runtime/cm_sysc/version/bin/*). Add the tool path to the PATH environment variable by sourcing one of the runtime setup scripts in ARM/CycleModels/etc.

Example use in a simple Makefile

Following is an example in which the compile and link steps are combined. There are two models: MyCPUModel and MyInterconnectModel. Both are in the directory MyModelsAndRuntimeInstallPath. The Cycle Models Configuration Tool is called once to create a list of source files, then a second time to retrieve all of the compile and link options.

```
# Tool name with baseline options. Options that may change are specified here,
# such as compiler version, location of the Models, and the Model Names
CM_CONFIG:=cm_config --use-tool gcc:6.4.0 --searchpath MyModelsAndRuntimeInstallPath --
model MyCPUModel MyInterconnectModel
SRCS:=$(shell $(CM_CONFIG) --sources)

system: $(SRCS)
$(CXX) -o $@ $^ $(shell $(CM_CONFIG) --compile --link)
```

Example use in a complex Makefile

If your build flows separate includes, compiler flags, and linker options, use the arguments to the --compile option to return this data as shown:

```
CM_CONFIG:=cm_config --use-tool gcc:6.4.0 --searchpath MyModelsAndRuntimeInstallPath --
model MyCPUModel MyInterconnectModel
CINCS := $(shell $(CM_CONFIG) --compile includes)
CFLAGS := $(shell $(CM_CONFIG) --compile flags)
LDOPTS := $(shell $(CM_CONFIG) --link)

SRCS := $(shell $(CM_CONFIG) --sources)
OBS := $(patsubst %.cpp,%.o,$(SRCS))

system: system.o $(OBS)
$(CXX) -o $@ $^ $(LDOPTS)

system.o: system.cpp
$(CXX) -c $(CFLAGS) $(CINCS) -o $@ $^

%.o: %.cpp
$(CXX) -c $(CFLAGS) $(CINCS) -o $@ $^
```

Example of retrieving source and link files for different model types

You may want to build a TLM or pin-level version of a SystemC Model.

The following example shows how to return the required file list and link options for a Cortex-R8 Cycle Model. The command directs cm_config to search only in the runtime and model directories.

```
$ cm_config --use-tool gcc:6.4.0 --model CORTEXR8 --sources --link --model-type tlm --ignore
cms cm_sysc

/arm/models/R8_Model/gcc640/SystemC/univent_tarmac.cpp /arm/models/R8_Model/gcc640/SystemC/
libCORTEXR8.systemc.cpp /arm/models/R8_Model/gcc640/SystemC/CORTEXR8ResetImp.cpp /arm/models/
R8_Model/gcc640/SystemC/libCORTEXR8.tlm.cpp -L/arm/models/R8_Model/gcc640/SystemC -L/arm/
models/R8_Model/gcc640/SystemC/lib /arm/models/R8_Model/gcc640/SystemC/univentUtil/lib/
plover_tarmac_dpi.so -lCORTEXR8.icm -licm_runtime -L/arm/models/R8-SysC-V11.0.0-CMS11.0.0-
MK2019.05.31-SOCD9.6.0/ARM/ThirdPartyIP/Accellera/SystemC/2.3.1/lib/Linux64_GCC-6.4 -
lsystemc -lpthread
```

The following example shows how to return the required file list and link options for only the pin-level model:

```
$ cm_config --use-tool gcc:6.4.0 --model CORTEXR8 --sources --link --model-type pin --ignore
cms cm_sysc

/arm/models/R8_Model/gcc640/SystemC/univent_tarmac.cpp /arm/models/R8_Model/gcc640/SystemC/
libCORTEXR8.systemc.cpp -L/arm/models/R8_Model/gcc640/SystemC -L/arm/models/R8_Model/gcc640/
```

```
SystemC/lib /arm/models/R8_Model/gcc640/SystemC/univentUtil/lib/plover_tarmac_dpi.so -  
lCORTXR8.icm -licm_runtime -L/arm/models/R8-SysC-V11.0.0-CMS11.0.0-MK2019.05.31-  
SOCD9.6.0/ARM/ThirdPartyIP/Accellera/SystemC/2.3.1/lib/Linux64_GCC-6.4 -lsystemc -lpthread
```

Example of substituting environment variables for component roots

When extracting build data for integration in custom flows, you may need to substitute environment variables for component roots. In the following example, CORTEXM7_HOME is used as the model root. SYSTEMC_HOME is used for the SystemC root:

```
$ cm_config --use-tool gcc:6.4.0 --model CORTEXR8 --sources --link --model-type pin --ignore  
cms cm_sysc --use-env CORTEXR8:CORTEXR8_HOME SystemC:SYSTEMC_HOME  
  
${CORTEXR8_HOME}/gcc640/SystemC/univent_tarmac.cpp ${CORTEXR8_HOME}/gcc640/SystemC/  
libCORTEXR8.systemc.cpp -L${CORTEXR8_HOME}/gcc640/SystemC -L${CORTEXR8_HOME}/gcc640/SystemC/  
lib ${CORTEXR8_HOME}/gcc640/SystemC/univentUtil/lib/plover_tarmac_dpi.so -lCORTXR8.icm -  
licm_runtime -L${SYSTEMC_HOME}/lib/Linux64_GCC-6.4 -lsystemc -lpthread
```

Example of extracting Arm® data

The following example shows using the --use-arm option to retrieve data owned or developed by Arm.

```
$ cm_config --use-tool gcc:6.4.0 --model CORTEXR8 --sources --link --model-type pin --ignore  
cms cm_sysc --searchpath Runtime_v3.0 R8_Model --use-arm  
  
/arm/models/R8_Model/gcc640/SystemC/univent_tarmac.cpp /arm/models/R8_Model/  
gcc640/SystemC/libCORTEXR8.systemc.cpp -L/arm/models/R8_Model/gcc640/SystemC -L/arm/models/  
R8_Model/gcc640/SystemC/lib /arm/models/R8_Model/gcc640/SystemC/univentUtil/lib/  
plover_tarmac_dpi.so -lCORTXR8.icm -licm_runtime
```

2.2 Adding custom options to the Makefile

You may want to further customize your build, including using a different installation of SystemC than the one Arm includes in the runtime. In this case, you can use the information in this section to add build options into the `Makefile` without the need to edit it.

Arm Cycle Models support the flexibility to:

- Add arguments to the Cycle Models Configuration Tool command line. This is useful for adding searchpaths, models, or ignores.
- Specify build variables to add any extra sources and build options you may need, such as compile flags and defines, or link flags, directories, and libraries. The build variables also allow you to use your own version of SystemC.

Build variables

The following build variables exist in the model `Makefile`. In a Cycle Model reference platform environment, they are also present in the reference platform `Systems/Makefile`:

- `CM_CONFIG_ARGS` - Arguments added to the `cm_config` command line.
- `CXXFLAGS` - Compile flags, includes, and defines to be added into the build.
- `LDFLAGS` - Link flags, directories, and libraries to be added into the build.
- `RPATHS` - Runtime `rpaths` to be added into the build.
- `SRCS` - Sources to be added into the build.

The following build variable is present only in the model `Makefile`:

- `SRCS_TLM` - TLM sources to be added into the build.

Example 1: Specifying your own version of SystemC

The following example directs the Cycle Models Configuration Tool not to search for SystemC, and adds in build data for a custom SystemC installation, assuming `SYSTEMC_INC` and `SYSTEMC_LIB` are set to the `includes` and `library` directories:

```
$ make all CM_CONFIG_ARGS='--ignore SystemC' CXXFLAGS='-I$SYSTEMC_INC' LDFLAGS='-L $SYSTEMC_LIB -lsystemc' RPATHS='-Wl,-rpath,$SYSTEMC_LIB'
```

Example 2: Providing another runtime path

The following example provides a different runtime path than the default, allowing the Cycle Models Configuration Tool to pick the latest compatible runtime components:

```
$ make all CM_CONFIG_ARGS='--searchpath path_to_alternative_runtime'
```

Example 3: Adding different debug or optimization parameters

The following example shows specifying alternate debug outputs and optimization parameters:

```
$ make all CXXFLAGS='-g`  
$ make all CXXFLAGS='-ggdb`  
$ make all CXXFLAGS='-O3`
```

Chapter 3

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:

- [3.1 Connecting model ports](#) on page 3-24.
- [3.2 Resetting the SystemC Cycle Model](#) on page 3-26.
- [3.3 Setting model parameters](#) on page 3-27.
- [3.4 Dumping waveforms](#) on page 3-28.
- [3.5 Loading DTCM and ITCM](#) on page 3-29.
- [3.6 Configuring PMU events](#) on page 3-30.
- [3.7 Configuring Tarmac trace](#) on page 3-33.
- [3.8 Working with the SCX framework](#) on page 3-34.

3.1 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 [3.1.1 Tied pins on page 3-24](#).

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

This section contains the following subsections:

- [3.1.1 Tied pins on page 3-24](#).
- [3.1.2 Port binding on page 3-24](#).

3.1.1 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)

3.1.2 Port binding

This section summarizes how port binding and tying are implemented in Cycle Models, and how you can make changes.

By default, all signal ports of the model are bound to their corresponding internal `sc_signal`. This ensures that every signal port is bound, as required by SystemC, and prevents you from having to bind all ports even if they are not being used. These bindings are defined in the `CortexR8ResetImp.cpp` file located in the directory `gccversion/SystemC/` for the model.

The following example shows a portion of the port binding section of a `ResetImp.cpp` file:

```
// bind all the non-TLM ports to their corresponding signals
void CortexR8Imp::bind_nontlm_ports_to_signals()
{
#ifdef CM_SYSC_DONT_BIND_NONTLM_PORTS
    CLKEN.bind(CLKENsignal);
    FCLKEN.bind(FCLKENsignal);
    HCLKEN.bind(HCLKENsignal);
    CLK1EN.bind(CLK1ENsignal);
    .
    .
    .

```

If you need to tie these signals to a specific value or bind them to an external `sc_signal`, then the internal binding needs to be removed.

Procedure

To change the default port binding in the context of an Arm Cycle Model reference platform:

1. In the `CortexR8ResetImp.cpp` file, inside the `bind_nontlm_ports_to_signals()` function, remove the binding by commenting out the line for the port.
2. In the reference platform `Systems/system_test.cpp` testbench file, the unbound port can be either:

- Driven directly from `sc_main`; e.g., `sc_signal.write(1)`.
 - Bound to another `sc_modules` port; e.g., `another_sc_module.port.bind(cycle_model.port)`. You can create a new `sc_module` in a separate `.cpp` file, or include it in the existing `Systems/system_test.cpp` file.
3. Recompile the reference platform using `Systems/Makefile`. This recompiles the Cycle Model and the platform.

3.2 Resetting the SystemC Cycle Model

A default reset sequence is provided in source form in the model directory `gccversion/SystemC/`.

If necessary, you can modify this file as needed to work with your system:

- For pin-level models, the file is `CortexR8ResetModule.h`
- For TLM models, the file is `CortexR8ResetImp.cpp`

After modifications, recompile the model. For pin-level models, ensure that the reset module is connected to the model (this step is not necessary for TLM models).

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

3.3 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.

Run-time parameters

For run-time parameters, change the parameter value on the command line using `-C INST.PARAM=VALUE` or `--parameter INST.PARAM=VALUE`.

The following example restarts the simulation, specifying the `hello_world` application with waveform dumping enabled:

```
./system_test -a ../Applications/hello_world/armcc/elf/test.elf -C  
CortexR8.WAVEFORMS_ENABLED=true
```

Available parameters

To list the parameters supported by the model:

- In a Cycle Model reference platform environment, enter `./system_test --list-params` in the `Systems` directory.
- View the file `CortexR8_params.cfg` located in the directory `MODELS/CortexR8_xCPU/gccversion/SystemC`.

Related information

- `CortexR8_params.cfg` located in the directory `MODELS/CortexR8_xCPU/gccversion/SystemC`. This file contains a complete list of the parameters supported by the model, and their supported values.
- [4.5 CADI RemoteConnection parameters on page 4-45](#) describes parameters related to configuring CADI debug connections. Debug parameters do not appear in the `CortexR8_params.cfg` file.
- The Technical Reference Manual for your IP includes additional information about supported parameter values.

3.4 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`.

By default, waveform files are sent to the reference platform `Systems` directory with the default filename `arm_cm_CPU.fsdb` or `arm_cm_CPU.vcd`.

Table 3-1 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.

Following is an example of setting waveform values on the command line:

```
./system_test -a ../Applications/hello_world/armcc/elf/test.elf -C
CortexR8.WAVEFORM_TYPE=FSDB -C CortexR8.WAVEFORMS_ENABLED=true
```

Related information

- [3.3 Setting model parameters on page 3-27](#)

3.5 Loading DTCM and ITCM

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

Data files

————— **Note** —————

By default, the system loads data files with predefined names. Before enabling TCM memories, create the required `.dat` files and name them accordingly.

The data files are named as follows:

- `CortexR8_cpux_{D/I}TCM.dat` (for example, `CortexR8_cpu0_ITCM.dat`)

If you do not want to use the predefined `.dat` file names, you can create `.dat` files with different names, and load them on the command line when you run the simulation. Call the upper-case parameter defined in the associated `.h` file (for example, `CPU0_ITCM_DAT_FILE`).

For more information, review the following files, located in `MODELS/CortexR8_xCPU/gccversion/SystemC`:

- `CortexR8_itcm.h`
- `CortexR8_dtcM.h`

These files contain the default parameter names for the data files to be loaded.

Related parameters

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 3-2 TCM parameters

Parameter	Available settings	Default setting
<code>LOAD_DTCMS</code>	true, false	false
<code>LOAD_ITCMS</code>	true, false	false

See the files `CortexR8_dtcM.h` and `CortexR8_itcm.h` for more information.

Example of enabling TCM load on the command line

Following is an example of enabling DTCM memory load on the command line:

```
./system_test -a ../Applications/hello_world/armcc/elf/test.elf -C CortexR8.LOAD_DTCMS=true
```

Related information

- [3.3 Setting model parameters on page 3-27](#)

3.6 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 3-3 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 reference platform directory `MODELS/component/gccversion/SystemC`.

This section contains the following subsection:

- [3.6.1 Supported hardware profiling events on page 3-30.](#)

3.6.1 Supported hardware profiling events

The Cortex-R8 SystemC Cycle Model supports PMU visibility.

Table 3-4 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 3-5 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
0x0F_UNALIGNED	Unaligned load-store

Table 3-5 Pipeline stream (continued)

Event name	Description
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 3-6 I-Cache stream

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

Table 3-7 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 3-8 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 3-9 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
0x97_NOCACHE_NOPERIPH_STALL	Non-cacheable, no peripheral-dependent stall

Table 3-9 Microarchitecture stream (continued)

Event name	Description
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)

3.7 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 3-10 Tarmac trace parameters

Parameter	Description	Available settings	Default setting
TARMAC_LOGFILE_NAME	Sets Tarmac log file name. This parameter should not be set in a multi-cluster environment; use the alternate instructions below.	<i>string</i>	""
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

Enabling Tarmac trace in multicore environments

In multicore environments, use the @CPUID@ designation to name the Tarmac files. For example, for a Cortex-R8 design with two cores and one cluster:

```
scx::scx_set_parameter("cr8.TARMAC_LOGFILE_NAME", "tarmac.cr8.@CPUID@.log");
scx::scx_set_parameter("cr8.TARMAC_LOGFILE_ENABLED", true);
```

This creates the files tarmac.cr8.0.log and tarmac.cr8.1.log.

Enabling Tarmac trace in multicluster environments

For multiple clusters, use the default Tarmac log file name (*cr8.aff2.aff1.cpuid.log*) rather than setting a different name with the TARMAC_LOGFILE_NAME parameter. Set the affinity values using the model parameters CLUSTERIDAFF1 and CLUSTERIDAFF2.

3.8 Working with the SCX framework

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

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 5-48](#) for details about the functions supported by SystemC Cycle Models.

Chapter 4

Debugging SystemC Cycle Models with Arm® Development Studio

This section describes how to connect the Arm Development Studio Debugger to Arm SystemC Cycle Models in a Cycle Model reference platform.

It contains the following sections:

- [4.1 Restrictions and limitations](#) on page 4-36.
- [4.2 Prerequisites to debugging](#) on page 4-37.
- [4.3 Supported debug features](#) on page 4-38.
- [4.4 Enabling Development Studio for use with SystemC Cycle Models](#) on page 4-40.
- [4.5 CADI RemoteConnection parameters](#) on page 4-45.
- [4.6 Multicore debugging](#) on page 4-46.
- [4.7 Changing the timeout setting](#) on page 4-47.

4.1 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 Arm Development Studio:

- The Windows version of Arm Development Studio 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 4-46](#) for workarounds.

4.2 Prerequisites to debugging

Arm Development Studio is required before you begin. The instructions in this chapter have been verified using Arm Development Studio Version 2018.0.

Linux version of Development Studio

————— **Note** —————

The Windows version of Arm Development Studio is not supported for SystemC Cycle Models. Only the Linux 64-bit version is supported.

Download and install the Linux 64-bit version of Arm Development Studio from <https://developer.arm.com/tools-and-software/embedded/arm-development-studio/downloads>.

Specify Active Product

Licensed version of Arm Development Studio Gold Edition. Open the Arm License Manager to confirm.

Related information

- See the *Arm® Development Studio Getting Started Guide* (101469) for system requirements, installation instructions, and licensing information.

4.3 Supported debug features

This section describes Arm Development Studio 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.

Arm® Development Studio features

SystemC Cycle Models support the following Arm Development Studio 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 4-46](#) for more information.
- Debugging of *Symmetric Multi Processing* (SMP) systems.

See the *Arm® Development Studio Debugger User Guide* (101470) 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:

- [4.3.1 Supported registers on page 4-38](#) for information about supported registers.
- [4.3.2 Supported memory views on page 4-39](#) 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:

- [4.3.1 Supported registers on page 4-38](#).
- [4.3.2 Supported memory views on page 4-39](#).

4.3.1 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. Memory mapped registers are not viewable using Arm Development Studio.

While the processor model 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

Values in the registers are not guaranteed to be accurate unless the model is at a debuggable point.

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

```
$ ./system_test --list-regs
```

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

4.3.2 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.

4.4 Enabling Development Studio for use with SystemC Cycle Models

This section describes how to set up Arm Development Studio to debug Cycle Models.

Note

The examples in this section apply to all Arm CPU models that support debugging. The process of enabling Arm Development Studio is the same for all Arm CPU models.

This section contains the following subsection:

- [4.4.1 Connect Development Studio to the model on page 4-40.](#)

4.4.1 Connect Development Studio to the model

Start the simulation and select the SystemC model for debug.

Procedure

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

```
./system_test -S
```

2. Launch Arm Development Studio.

3. Click **New Debug Connection** to launch the debug connection wizard:

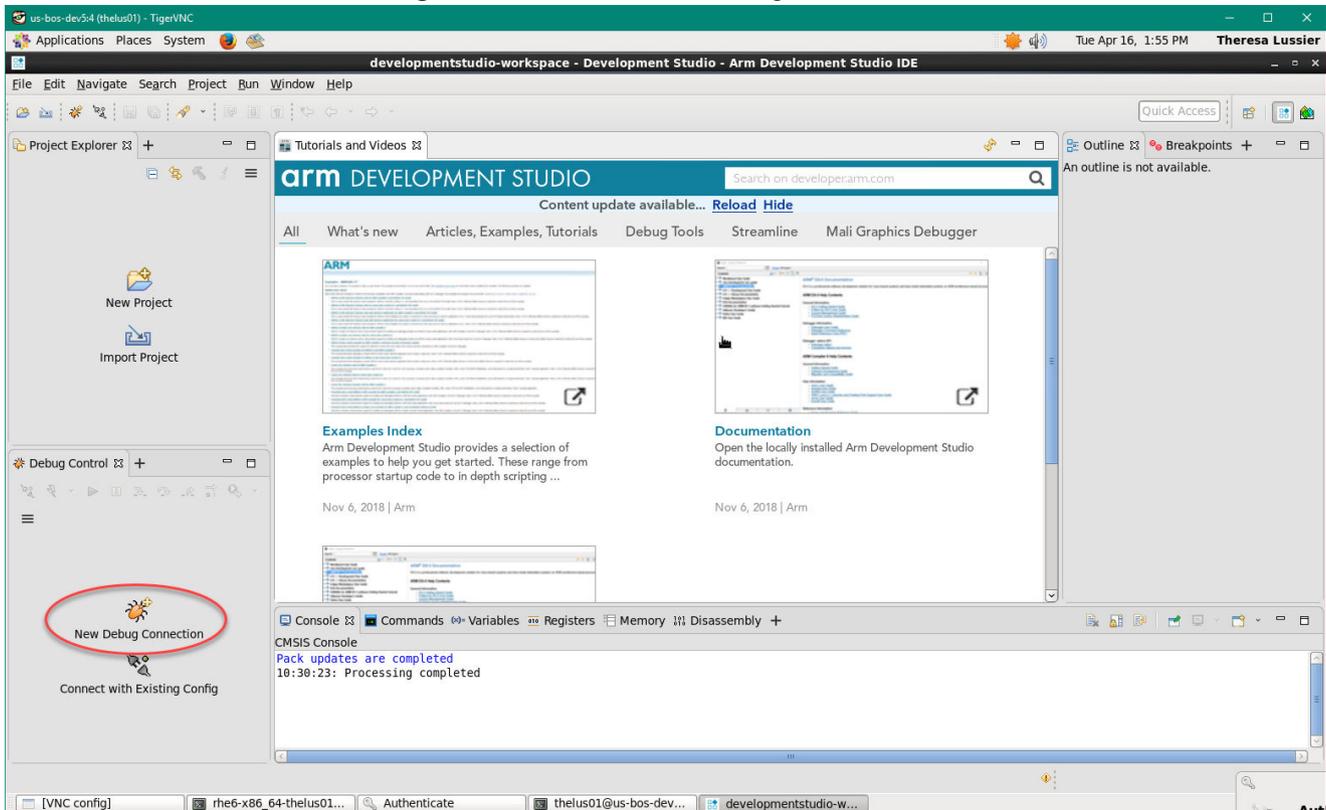


Figure 4-1 Click New Debug Connection

4. In the New Debug Connection wizard, select **Model Connection** and click **Next**:

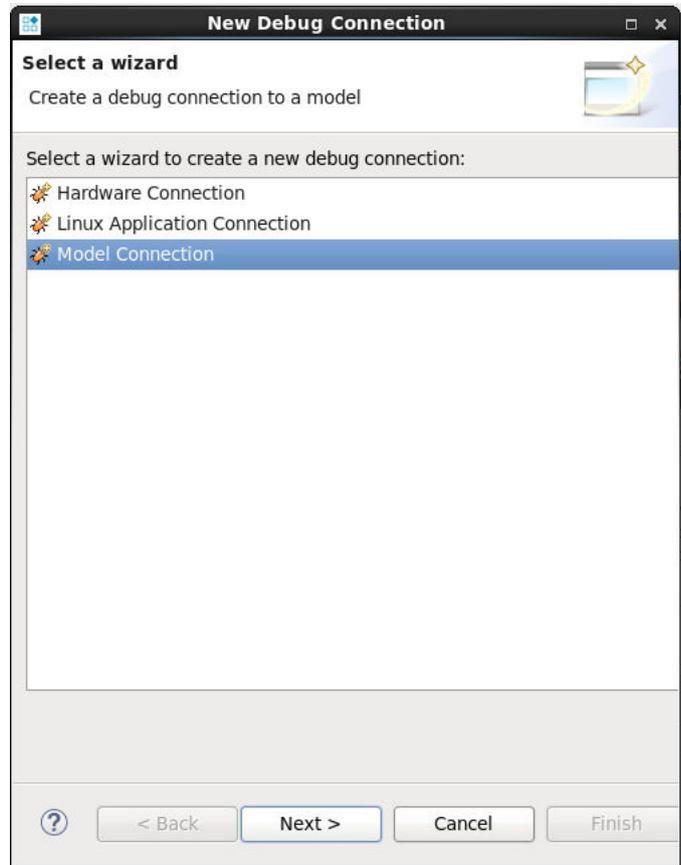


Figure 4-2 Select model connection as the debug connection type

5. In the Debug Connection dialog box, enter a name in the **Debug connection name** field and click **Next**:

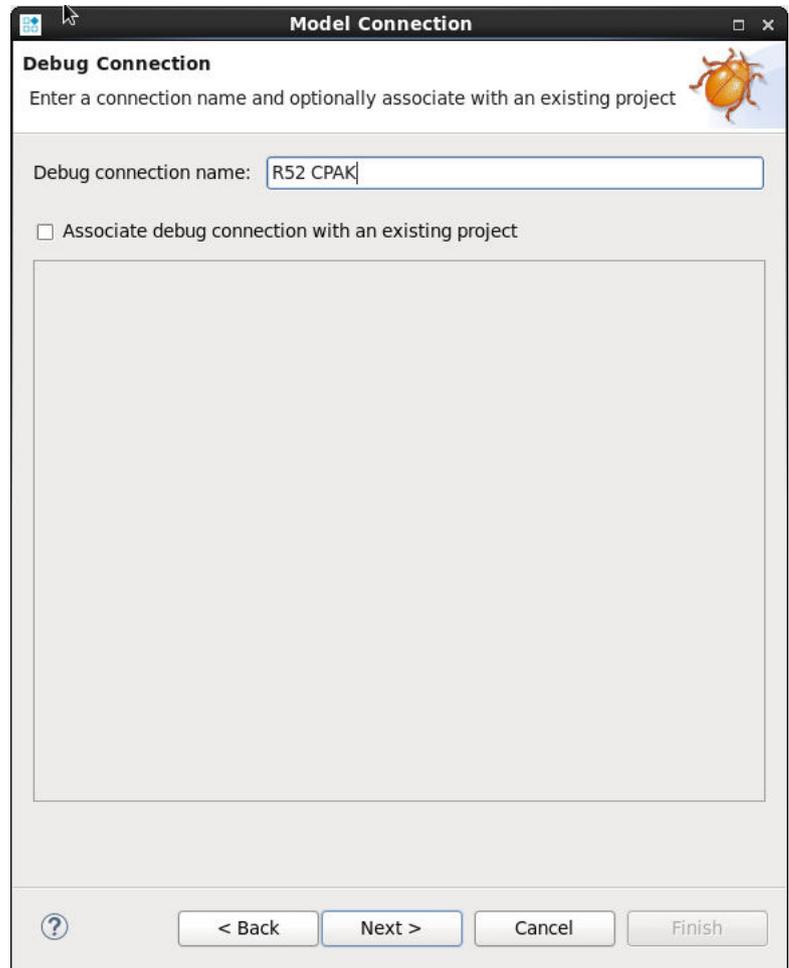


Figure 4-3 Name the debug connection

6. In the Target Selection dialog box, click **Add a new model**:

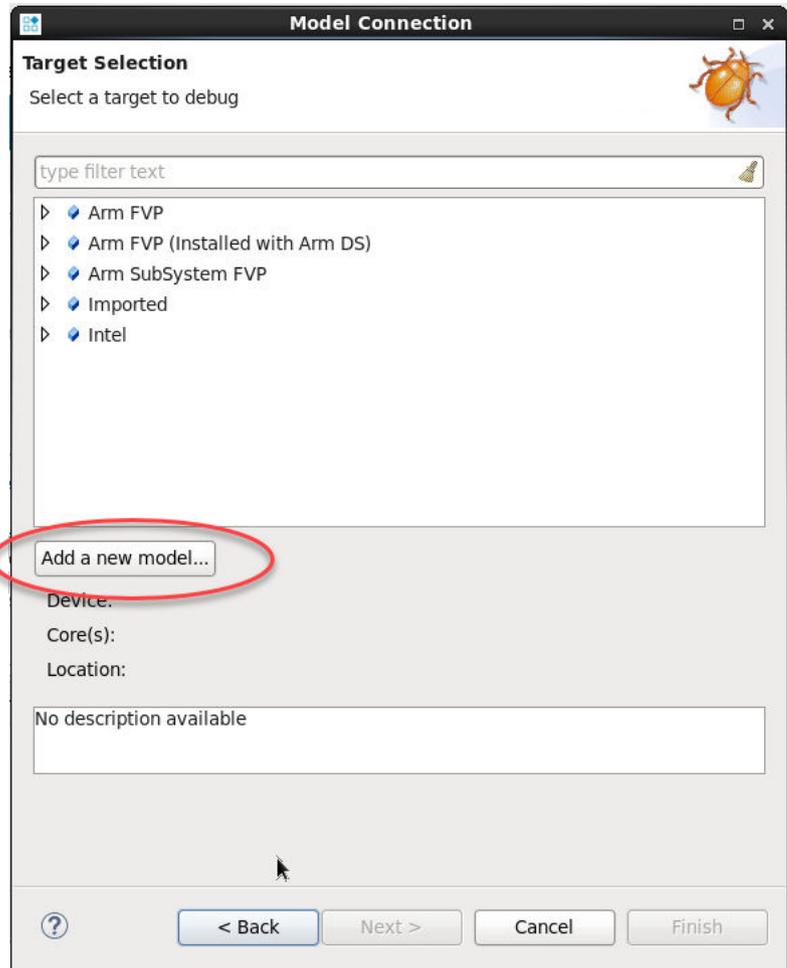


Figure 4-4 Add a new model

7. In the **Select Method for Connecting to Model:** dialog box, select **Browse for model running on local host** and click **Next**.
8. Click **Browse**.
9. In the **Model Running on Local Host** dialog box, click **Browse**. Development Studio searches for SystemC simulation sessions running on the host, and displays them in the **Model Browser** dialog box:

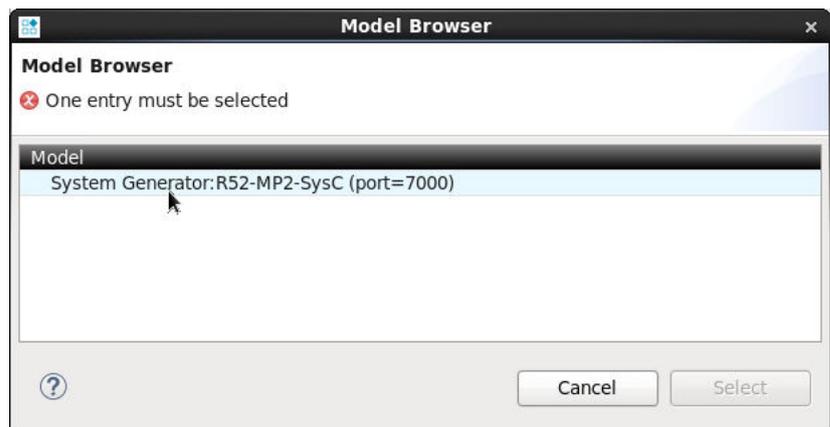


Figure 4-5 Model Browser

10. Select the model for debug and click **Select**.
11. Click **Finish**.

Result

Arm Development Studio connects to the model and displays the cores available for debug:

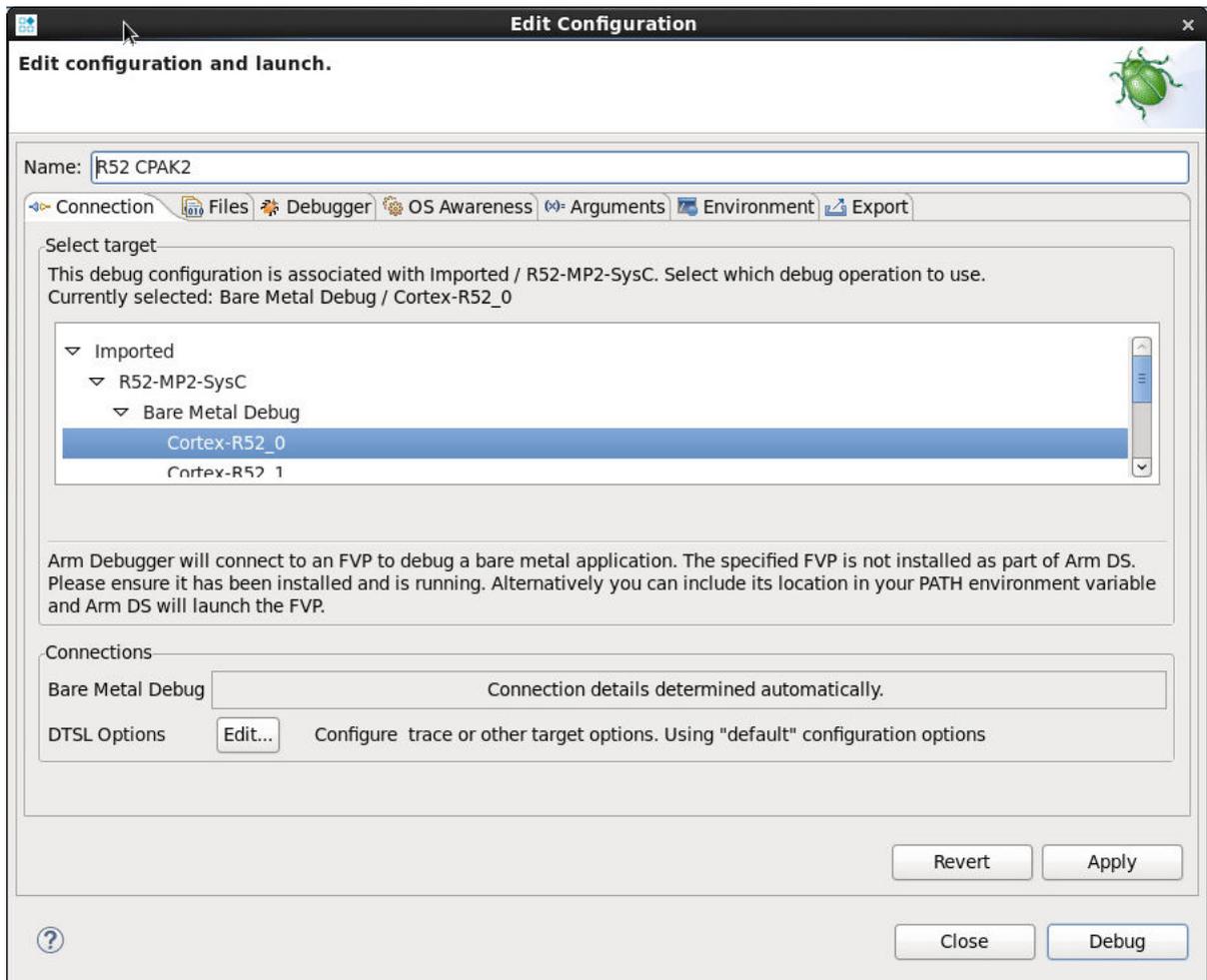


Figure 4-6 Core available for debug

Related information

- [Arm® Development Studio Getting Started Guide \(101469\)](#)
- [Arm® Development Studio User Guide \(101470\)](#)

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
<code>enable_remote_cadi</code>	bool	false	true, false	false	Allow connections from remote hosts.
<code>listen_address</code>	string	"127.0.0.1"	""	false	If <code>enable_remote_cadi</code> is set, this parameter is the network address the server listens on.
<code>port</code>	int	0x7b8b	0x1 - 0xffff	false	If <code>enable_remote_cadi</code> is set, this parameter is the TCP port the server listens on.
<code>range</code>	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 5-56](#) 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® Development Studio User Guide* (101470).

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 on the console from which the simulation was run:

```
Warning: stop at a debug point failed: Simulation suspended before these target(s)
could reach debug point:cr8_core.cpu1;cr8_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 [4.1 Restrictions and limitations on page 4-36](#)). 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
```

- Change the timeout setting (see [4.7 Changing the timeout setting on page 4-47](#))

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 5-49.](#)
- [5.2 *scx::scx_load_application* on page 5-50.](#)
- [5.3 *scx::scx_set_parameter* on page 5-51.](#)
- [5.4 *scx::scx_get_parameter* on page 5-52.](#)
- [5.5 *scx::scx_get_parameter_list* on page 5-53.](#)
- [5.6 *scx::scx_cpulimit* on page 5-54.](#)
- [5.7 *scx::scx_timelimit* on page 5-55.](#)
- [5.8 *scx::scx_parse_and_configure* on page 5-56.](#)
- [5.9 *scx::scx_print_statistics* on page 5-60.](#)

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 Cycle Model reference platforms with TLM models. For reference platforms with pin-level models, specifying `--application` has no effect and results in multiple warnings. The application for reference platforms with pin-level models is determined by the contents of the hex files in the reference platforms `Systems` directory. See the reference platforms `README` 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 reference system `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 cr8_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
.
.
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
```

```
cortextr8_core.ACLKENST=1 # (int , run-time ) default =
'0x1' : ACLKENST enable parameter
cortextr8_core.AFVALIDMD0=0 # (int , run-time ) default =
'0x0' : Default value for AFVALIDMD0
cortextr8_core.AFVALIDMD1=0 # (int , run-time ) default =
'0x0' : Default value for AFVALIDMD1
cortextr8_core.AFVALIDMD2=0 # (int , run-time ) default =
'0x0' : Default value for AFVALIDMD2
cortextr8_core.AFVALIDMD3=0 # (int , run-time ) default =
'0x0' : Default value for AFVALIDMD3
.
.
.
```

--list-regs

This option prints a list of model registers that are supported for viewing with a debugger. See the Technical Reference Manual for your IP for register descriptions.

For example:

```
$ ./system_test --list-regs
```

--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 cortextr8_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
cortextr8_core.cpu0     : 0.00 KIPS ( 0 Inst)
cortextr8_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.
-