ARM® DS-5

Version 5.26

Debugger User Guide

ARM®

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
ARM DUI0446Z

ARM® DS-5

Debugger User Guide

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.

Release Information

Document History

Issue	Date	Confidentiality	Change
A	30 June 2010	Non-Confidential	First release
B	30 September 2010	Non-Confidential	Update for DS-5 version 5.2
C	30 November 2010	Non-Confidential	Update for DS-5 version 5.3
D	30 January 2011	Non-Confidential	Update for DS-5 version 5.4
E	30 May 2011	Non-Confidential	Update for DS-5 version 5.5
F	30 July 2011	Non-Confidential	Update for DS-5 version 5.6
G	30 September 2011	Non-Confidential	Update for DS-5 version 5.7
H	30 November 2012	Non-Confidential	Update for DS-5 version 5.8
I	28 February 2012	Non-Confidential	Update for DS-5 version 5.9
J	30 May 2012	Non-Confidential	Update for DS-5 version 5.10
K	30 July 2012	Non-Confidential	Update for DS-5 version 5.11
L	30 October 2012	Non-Confidential	Update for DS-5 version 5.12
M	15 December 2012	Non-Confidential	Update for DS-5 version 5.13
N	15 March 2013	Non-Confidential	Update for DS-5 version 5.14
O	14 June 2013	Non-Confidential	Update for DS-5 version 5.15
P	13 September 2013	Non-Confidential	Update for DS-5 version 5.16
Q	13 December 2013	Non-Confidential	Update for DS-5 version 5.17
R	14 March 2014	Non-Confidential	Update for DS-5 version 5.18
S	27 June 2014	Non-Confidential	Update for DS-5 version 5.19
T	17 October 2014	Non-Confidential	Update for DS-5 version 5.20
U	20 March 2015	Non-Confidential	Update for DS-5 version 5.21
V	15 July 2015	Non-Confidential	Update for DS-5 version 5.22
W	15 October 2015	Non-Confidential	Update for DS-5 version 5.23
X	15 March 2016	Non-Confidential	Update for DS-5 version 5.24
Y	15 July 2016	Non-Confidential	Update for DS-5 version 5.25
Z	18 November 2016	Non-Confidential	Update for DS-5 version 5.26

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.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

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 signed written agreement covering this document with ARM, then the 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.

Words and logos marked with ® or ™ are registered trademarks or trademarks of ARM Limited or its affiliates in the EU 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 *http://www.arm.com/about/trademark-usage-guidelines.php*

Copyright © 2010-2016, 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

http://www.arm.com

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Contents
ARM® DS-5 Debugger User Guide

Preface

About this book 17

Chapter 1 Introduction to DS-5 Debugger

1.1 Overview: DS-5 Debugger and important concepts 1-21
1.2 Overview: ARM® CoreSight™ debug and trace components 1-22
1.3 Overview: Debugging multi-core (SMP and AMP), big.LITTLE™ , and multi-cluster targets 1-23
1.4 Overview: Debugging ARM®-based Linux applications 1-27
1.5 Overview: Linux application rewind 1-28
1.6 Debugger concepts 1-30

Chapter 2 Configuring debug connections in DS-5 Debugger

2.1 Overview: Debug connections in DS-5 Debugger 2-34
2.2 Launching DS-5 and connecting to DS-5 Debugger 2-36
2.3 Configuring a connection to a bare-metal hardware target 2-38
2.4 Configuring trace for bare-metal or Linux kernel targets 2-43
2.5 Configuring a connection to a Linux application using gdbserver 2-46
2.6 Configuring a connection to a Linux kernel 2-48
2.7 Using Fixed Virtual Platform (FVP)s with DS-5 2-50
2.8 Configuring application rewind for Linux 2-57
2.9 Configuring an Events view connection to a bare-metal target 2-63
2.10 Exporting or importing an existing launch configuration 2-65
2.11 Disconnecting from a target 2-68

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 3 Controlling Target Execution

3.1 Overview: Breakpoints and Watchpoints 3-70
3.2 Running, stopping, and stepping through an application 3-72
3.3 Working with breakpoints 3-74
3.4 Working with watchpoints 3-75
3.5 Importing and exporting breakpoints and watchpoints 3-77
3.6 Viewing the properties of a breakpoint or a watchpoint 3-78
3.7 Associating debug scripts to breakpoints 3-80
3.8 Conditional breakpoints 3-81
3.9 Assigning conditions to an existing breakpoint 3-82
3.10 Conditional watchpoints 3-84
3.11 Assigning conditions to an existing watchpoint 3-85
3.12 Pending breakpoints and watchpoints 3-87
3.13 Setting a tracepoint 3-89
3.14 Handling UNIX signals 3-90
3.15 Handling processor exceptions 3-92
3.16 Cross-trigger configuration 3-94
3.17 Using semihosting to access resources on the host computer 3-95
3.18 Working with semihosting 3-97
3.19 Configuring the debugger path substitution rules 3-99

Chapter 4 Working with the Target Configuration Editor

4.1 About the Target Configuration Editor 4-103
4.2 Target configuration editor - Overview tab 4-104
4.3 Target configuration editor - Memory tab 4-106
4.4 Target configuration editor - Peripherals tab 4-108
4.5 Target configuration editor - Registers tab 4-110
4.6 Target configuration editor - Group View tab 4-112
4.7 Target configuration editor - Enumerations tab 4-114
4.8 Target configuration editor - Configurations tab 4-115
4.9 Scenario demonstrating how to create a new target configuration file 4-117
4.10 Creating a power domain for a target 4-128
4.11 Creating a Group list 4-129
4.12 Importing an existing target configuration file 4-131
4.13 Exporting a target configuration file 4-133

Chapter 5 Examining the Target

5.1 Examining the target execution environment 5-136
5.2 Examining the call stack 5-137
5.3 About trace support 5-138
5.4 About post-mortem debugging of trace data 5-141

Chapter 6 Debugging Embedded Systems

6.1 About endianness 6-143
6.2 About accessing AHB, APB, and AXI buses 6-144
6.3 About virtual and physical memory 6-145
6.4 About address spaces 6-146
6.5 About debugging hypervisors 6-148
6.6 About debugging big.LITTLE systems 6-149
6.7 About debugging bare-metal symmetric multiprocessing systems 6-150

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.8 About debugging multi-threaded applications 6-152
6.9 About debugging shared libraries 6-153
6.10 About OS awareness 6-155
6.11 About debugging TrustZone enabled targets 6-160
6.12 About debugging a Unified Extensible Firmware Interface (UEFI) 6-162
6.13 About debugging MMUs 6-163
6.14 About Debug and Trace Services Layer (DTSL) 6-165
6.15 About CoreSight™ Target Access Library 6-166
6.16 About debugging caches 6-167
6.17 About DS-5 Debugger support for overlays 6-170

Chapter 7 Debugging with Scripts

7.1 Exporting DS-5 Debugger commands generated during a debug session 7-172
7.2 Creating a DS-5 Debugger script 7-173
7.3 Creating a CMM-style script 7-174
7.4 Support for importing and translating CMM scripts 7-175
7.5 About Jython scripts 7-177
7.6 Jython script concepts and interfaces 7-179
7.7 Creating Jython projects in Eclipse for DS-5 7-180
7.8 Creating a Jython script 7-183
7.9 Running a script 7-185
7.10 Use case scripts 7-187
7.11 Metadata for use case scripts 7-188
7.12 Definition block for use case scripts 7-189
7.13 Defining the Run method for use case scripts 7-191
7.14 Defining the options for use case scripts 7-192
7.15 Defining the validation method for use case scripts 7-195
7.16 Example use case script definition 7-196
7.17 Multiple use cases in a single script 7-197
7.18 usecase list command 7-198
7.19 usecase help command 7-199
7.20 usecase run command 7-200

Chapter 8 Running DS-5 Debugger from the operating system command-line or from a script

8.1 Overview: Running DS-5 Debugger from the command-line or from a script 8-203
8.2 Command-line debugger options 8-204
8.3 Running a debug session from a script 8-209
8.4 Specifying a custom configuration database using the command-line 8-211
8.5 Capturing trace data using the command-line debugger 8-213
8.6 DS-5 Debugger command-line console keyboard shortcuts 8-215

Chapter 9 Working with the Snapshot Viewer

9.1 About the Snapshot Viewer 9-217
9.2 Components of a Snapshot Viewer initialization file 9-219
9.3 Connecting to the Snapshot Viewer 9-222
9.4 Considerations when creating debugger scripts for the Snapshot Viewer 9-223

Chapter 10 Platform Configuration

10.1 DS-5 Configuration perspective 10-225

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.2 About importing platform and model configurations 10-226
10.3 About platform bring-up in DS-5 10-228
10.4 ARM debug and trace architecture 10-229
10.5 About the Platform Configuration Editor view 10-230
10.6 Creating a platform configuration 10-231
10.7 Editing a platform configuration in the PCE 10-236
10.8 About the device hierarchy in the PCE view 10-242
10.9 Manual platform configuration 10-244
10.10 Configuring your debug hardware unit for platform autodetection 10-246
10.11 Creating a new model configuration 10-248
10.12 Importing a custom model 10-250
10.13 Model Devices and Cluster Configuration 10-252
10.14 Adding a configuration database to DS-5 10-253
10.15 Configuration Database panel 10-255
10.16 Extending your configuration database 10-257

Chapter 11 DS-5 Debug Perspectives and Views

11.1 App Console view 11-263
11.2 ARM Asm Info view 11-265
11.3 ARM assembler editor 11-266
11.4 Breakpoints view 11-268
11.5 C/C++ editor 11-272
11.6 Commands view 11-275
11.7 Debug Control view 11-278
11.8 Stack view 11-282
11.9 Disassembly view 11-285
11.10 Events view 11-289
11.11 Event Viewer Settings dialog box 11-291
11.12 Expressions view 11-294
11.13 Functions view 11-298
11.14 History view 11-300
11.15 Memory view 11-302
11.16 MMU view 11-308
11.17 Modules view 11-312
11.18 Registers view 11-314
11.19 OS Data view 11-319
11.20 Overlays view 11-320
11.21 Cache Data view 11-321
11.22 Screen view 11-323
11.23 Scripts view 11-326
11.24 Target Console view 11-328
11.25 Target view 11-329
11.26 Trace view 11-331
11.27 Trace Control view 11-334
11.28 Variables view 11-337
11.29 Timed Auto-Refresh Properties dialog box 11-343
11.30 Memory Exporter dialog box 11-344
11.31 Memory Importer dialog box 11-345
11.32 Fill Memory dialog box 11-346
11.33 Export Trace Report dialog box 11-347

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.34 Breakpoint Properties dialog box 11-349
11.35 Watchpoint Properties dialog box 11-352
11.36 Tracepoint Properties dialog box 11-353
11.37 Manage Signals dialog box 11-354
11.38 Functions Filter dialog box 11-356
11.39 Script Parameters dialog box 11-357
11.40 Debug Configurations - Connection tab 11-358
11.41 Debug Configurations - Files tab 11-361
11.42 Debug Configurations - Debugger tab 11-364
11.43 Debug Configurations - OS Awareness tab 11-367
11.44 Debug Configurations - Arguments tab 11-368
11.45 Debug Configurations - Environment tab 11-370
11.46 DTSL Configuration Editor dialog box 11-372
11.47 About the Remote System Explorer 11-374
11.48 Remote Systems view 11-375
11.49 Remote System Details view 11-376
11.50 Target management terminal for serial and SSH connections 11-377
11.51 Remote Scratchpad view 11-378
11.52 Remote Systems terminal for SSH connections 11-379
11.53 Terminal Settings dialog box 11-380
11.54 Debug Hardware Configure IP view 11-382
11.55 Debug Hardware Firmware Installer view 11-384
11.56 Connection Browser dialog box 11-387
11.57 DS-5 Debugger menu and toolbar icons 11-388

Chapter 12 Troubleshooting

12.1 ARM Linux problems and solutions 12-392
12.2 Enabling internal logging from the debugger 12-393
12.3 Target connection problems and solutions 12-394

Chapter 13 File-based Flash Programming in ARM DS-5

13.1 About file-based flash programming in ARM® DS-5 13-396
13.2 Flash programming configuration 13-398
13.3 Creating an extension database for flash programming 13-400
13.4 About using or extending the supplied ARM® Keil® flash method 13-401
13.5 About creating a new flash method 13-403
13.6 About testing the flash configuration 13-407
13.7 About flash method parameters 13-408
13.8 About getting data to the flash algorithm 13-409
13.9 About interacting with the target 13-410

Chapter 14 Writing OS Awareness for DS-5 Debugger

14.1 About Writing operating system awareness for DS-5 Debugger 14-418
14.2 Creating an OS awareness extension 14-419
14.3 Implementing the OS awareness API 14-423
14.4 Enabling the OS awareness 14-425
14.5 Implementing thread awareness 14-430
14.6 Implementing data views 14-433
14.7 Advanced OS awareness extension 14-436
14.8 Programming advice and noteworthy information 14-438

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 15 **Debug and Trace Services Layer (DTSL)**

15.1 Additional DTSL documentation and files 15-440
15.2 Need for DTSL 15-441
15.3 DS-5 configuration database 15-446
15.4 DTSL as used by DS-5 Debugger 15-452
15.5 Main DTSL classes and hierarchy 15-454
15.6 DTSL options 15-462
15.7 DTSL support for SMP and AMP configurations 15-468
15.8 DTSL Trace 15-472
15.9 Extending the DTSL object model 15-479
15.10 Debugging DTSL Jython code within DS-5 Debugger 15-484
15.11 DTSL in stand-alone mode 15-488

Chapter 16 **Reference**

16.1 Standards compliance in DS-5 Debugger 16-495
16.2 DS-5 Debug perspective keyboard shortcuts 16-496
16.3 About loading an image on to the target 16-497
16.4 About loading debug information into the debugger 16-499
16.5 About passing arguments to main() 16-501
16.6 Running an image 16-502
16.7 Updating multiple debug hardware units 16-503

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

List of Figures
ARM® DS-5 Debugger User Guide

Figure 1-1 Versatile Express A9x4 SMP configuration 1-23
Figure 1-2 Core 1 stopped on stepi command 1-24
Figure 2-1 MyBareMetalConfig - Connection tab 2-39
Figure 2-2 MyBareMetalConfig - Files tab 2-40
Figure 2-3 MyBareMetalConfig - Debugger tab 2-41
Figure 2-4 Select the debug configuration 2-43
Figure 2-5 Select Trace capture method 2-44
Figure 2-6 Select the processors you want to trace 2-45
Figure 2-7 Debug Configurations - ARM FVP - Base_AEMv8A_AEMv8A 2-51
Figure 2-8 My_BareMetal_Model_Configuration - Debug Control view 2-53
Figure 2-9 Debug Configurations - ARM FVP (Installed with DS-5) 2-54
Figure 2-10 Application Debug with Rewind Support - Connect to already running application 2-59
Figure 2-11 Events view with data from the ITM source 2-64
Figure 2-12 Export launch configuration dialog box 2-65
Figure 2-13 Launch configuration selection panels 2-66
Figure 2-14 Launch configuration file selection panels 2-67
Figure 2-15 Disconnecting from a target 2-68
Figure 3-1 Debug Control view 3-72
Figure 3-2 Viewing breakpoints 3-74
Figure 3-3 Setting a data watchpoint on a data symbol 3-75
Figure 3-4 Import and export breakpoints and watchpoints 3-77
Figure 3-5 Viewing the properties of a breakpoint 3-78
Figure 3-6 Viewing the properties of a data watchpoint 3-79

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Figure 3-7 Breakpoint Properties dialog ... 3-82
Figure 3-8 Watchpoint Properties dialog ... 3-85
Figure 3-9 Manage signals dialog (UNIX signals) ... 3-90
Figure 3-10 Manage Signals dialog ... 3-92
Figure 3-11 Typical layout between top of memory, stack, and heap ... 3-95
Figure 3-12 Set Path Substitution ... 3-99
Figure 3-13 Path Substitution dialog box ... 3-100
Figure 3-14 Edit Substitute Path dialog box ... 3-100
Figure 4-1 Specifying TCF files in the Debug Configurations window ... 4-103
Figure 4-2 Target configuration editor - Overview tab ... 4-105
Figure 4-3 Target configuration editor - Memory tab ... 4-107
Figure 4-4 Target configuration editor - Peripherals tab ... 4-109
Figure 4-5 Target configuration editor - Registers tab ... 4-111
Figure 4-6 Target configuration editor - Group View tab ... 4-112
Figure 4-7 Target configuration editor - Configuration tab ... 4-116
Figure 4-8 LED register and bitfields ... 4-117
Figure 4-9 Core module and LCD control register ... 4-117
Figure 4-10 Creating a Memory map ... 4-118
Figure 4-11 Creating a peripheral ... 4-119
Figure 4-12 Creating a standalone register ... 4-120
Figure 4-13 Creating a peripheral register ... 4-121
Figure 4-14 Creating enumerations ... 4-122
Figure 4-15 Assigning enumerations ... 4-123
Figure 4-16 Creating remapping rules ... 4-124
Figure 4-17 Creating a memory region for remapping by a control register ... 4-125
Figure 4-18 Applying the Remap_RAM_block1 map rule ... 4-126
Figure 4-19 Applying the Remap_ROM map rule ... 4-127
Figure 4-20 Power Domain Configurations ... 4-128
Figure 4-21 Creating a group list ... 4-129
Figure 4-22 Selecting an existing target configuration file ... 4-131
Figure 4-23 Importing the target configuration file ... 4-132
Figure 4-24 Exporting to C header file ... 4-133
Figure 4-25 Selecting the files ... 4-134
Figure 5-1 Target execution environment ... 5-136
Figure 5-2 Stack view showing information for a selected core ... 5-137
Figure 6-1 Threading call stacks in the Debug Control view ... 6-152
Figure 6-2 Adding individual shared library files ... 6-153
Figure 6-3 Modifying the shared library search paths ... 6-154
Figure 6-4 Cache Data view (showing L1 TLB cache) ... 6-167
Figure 6-5 DTSL Configuration Editor (Cache RAMs configuration tab) ... 6-168
Figure 7-1 Commands generated during a debug session ... 7-172
Figure 7-2 PyDev project wizard ... 7-180
Figure 7-3 PyDev project settings ... 7-181
Figure 7-4 Jython auto-completion and help ... 7-183
Figure 7-5 Scripts view ... 7-185
Figure 8-1 Enable trace in the DTSL options ... 8-213
Figure 8-2 Command-line debugger connection with DTSL option enabled ... 8-214
Figure 10-1 New PCE project ... 10-231
Figure 10-2 Platform creation options ... 10-232
Figure 10-3 Enter CMM script parameters ... 10-233

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Figure 10-4 Debug hardware firmware update notification during platform configuration 10-233
Figure 10-5 Create new configuration database 10-234
Figure 10-6 New platform information 10-235
Figure 10-7 Component Connections 10-236
Figure 10-8 Missing slaves 10-236
Figure 10-9 Device hierarchy 10-237
Figure 10-10 Add Core Trace 10-237
Figure 10-11 Add CTI Trigger 10-238
Figure 10-12 User added component connections 10-239
Figure 10-13 Project Explorer 10-239
Figure 10-14 Full debug and trace 10-240
Figure 10-15 Debug Activities 10-240
Figure 10-16 DTSL Options 10-241
Figure 10-17 Device hierarchy 10-242
Figure 10-18 Devices Panel 10-243
Figure 10-19 Autodetect settings 10-246
Figure 10-20 Configuration Database 10-249
Figure 10-21 Model Devices and Cluster Configuration tab 10-252
Figure 10-22 Adding a configuration database 10-253
Figure 10-23 Configuration Database panel 10-256
Figure 11-1 App Console view 11-263
Figure 11-2 ARM Asm Info view 11-265
Figure 11-3 ARM assembler editor 11-266
Figure 11-4 Breakpoints view showing breakpoints and sub-breakpoints 11-268
Figure 11-5 C/C++ editor 11-272
Figure 11-6 Show disassembly for selected source line 11-274
Figure 11-7 Commands view 11-275
Figure 11-8 Debug Control view 11-278
Figure 11-9 Show in Stack option 11-282
Figure 11-10 Stack view showing information for a selected core 11-282
Figure 11-11 Stack view locked to a selected context 11-283
Figure 11-12 Disassembly view 11-285
Figure 11-13 Events view (Shown with all ports enabled for an ETB:ITM trace source) 11-289
Figure 11-14 Event Viewer Settings (Shown with all Masters and Channels enabled for an ETR:STM trace source) 11-291
Figure 11-15 Expressions view 11-294
Figure 11-16 Functions view 11-298
Figure 11-17 History view 11-300
Figure 11-18 Memory view 11-302
Figure 11-19 Memory view with Show Cache option enabled 11-304
Figure 11-20 Memory view preferences 11-306
Figure 11-21 MMU Translation tab view 11-308
Figure 11-22 MMU Tables tab view 11-309
Figure 11-23 Memory Map tab view 11-310
Figure 11-24 MMU settings 11-310
Figure 11-25 Modules view showing shared libraries 11-312
Figure 11-26 Registers view (with all columns displayed) 11-314
Figure 11-27 Search for registers 11-315
Figure 11-28 Registers access rights 11-316
Figure 11-29 OS Data view (showing Keil CMSIS-RTOS RTX Tasks) 11-319

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Figure 11-30 Overlays view 11-320
Figure 11-31 Cache Data view (showing L1 TLB cache) 11-321
Figure 11-32 Screen buffer parameters 11-323
Figure 11-33 Screen view 11-324
Figure 11-34 Scripts view 11-326
Figure 11-35 Target view 11-329
Figure 11-36 Trace view with a scale of 100:1 11-331
Figure 11-37 Trace Control view 11-334
Figure 11-38 Variables view 11-337
Figure 11-39 Timed Auto-Refresh Properties dialog box 11-343
Figure 11-40 Memory Exporter dialog box 11-344
Figure 11-41 Memory Importer dialog box 11-345
Figure 11-42 Fill Memory dialog box 11-346
Figure 11-43 Export Trace Report dialog box 11-348
Figure 11-44 Breakpoint properties dialog box 11-349
Figure 11-45 Watchpoint Properties dialog box 11-352
Figure 11-46 Tracepoint Properties dialog box 11-353
Figure 11-47 Manage Signals dialog box 11-354
Figure 11-48 Function filter dialog box 11-356
Figure 11-49 Script Parameters dialog box 11-357
Figure 11-50 Connection tab (Shown with connection configuration for an FVP with virtual file system support enabled) 11-360
Figure 11-51 Files tab (Shown with file system configuration for an application on an FVP) 11-362
Figure 11-52 Debugger tab (Shown with settings for application starting point and search paths) 11-366
Figure 11-53 OS Awareness tab 11-367
Figure 11-54 Arguments tab 11-369
Figure 11-55 New Environment Variable dialog box 11-370
Figure 11-56 Environment tab (Shown with environment variables configured for an FVP) 11-371
Figure 11-57 DTSL Configuration Editor (Shown with Trace capture method set to DSTREAM) 11-372
Figure 11-58 Remote Systems view 11-375
Figure 11-59 Remote System Details view 11-376
Figure 11-60 Terminal view 11-377
Figure 11-61 Remote Scratchpad 11-378
Figure 11-62 Remote Systems terminal 11-379
Figure 11-63 Terminal Settings dialog box 11-380
Figure 11-64 Debug Hardware Configure IP view 11-382
Figure 11-65 Debug Hardware Firmware Installer view 11-384
Figure 11-66 Connection Browser (Showing a USB connected DSTREAM) 11-387
Figure 13-1 DS-5 File Flash Architecture 13-397
Figure 14-1 Eclipse preferences for mydb 14-420
Figure 14-2 Custom OS awareness displayed in Eclipse Debug Configurations dialog 14-422
Figure 14-3 myos waiting for symbols to be loaded 14-426
Figure 14-4 myos waiting for the target to stop 14-427
Figure 14-5 myos Enabled 14-428
Figure 14-6 myos waiting for the OS to be initialised 14-429
Figure 14-7 myos Debug Control view data 14-431
Figure 14-8 myos Empty Tasks table 14-434
Figure 14-9 myos populated Tasks table 14-435
Figure 14-10 OS awareness with parameters 14-437
Figure 15-1 A simple CoreSight Design 15-441

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Figure 15-2 Initial DS-5 Debugger SW Stack 15-443
Figure 15-3 Post DTSL DS-5 Debugger SW Stack 15-444
Figure 15-4 DTSL Configuration class hierarchy 15-454
Figure 15-5 DTSL Device object hierarchy 15-455
Figure 15-6 DTSL Trace Source class hierarchy 15-457
Figure 15-7 DTSL Trace Capture Objects 15-458
Figure 15-8 MEM-AP Access Ports 15-459
Figure 15-9 MEM-AP Class Hierarchy 15-460
Figure 15-10 DTSL Option Classes 15-462
Figure 15-11 DSTREAM Trace Options 15-464
Figure 15-12 Example use of CTI for H/W execution synchronization 15-471
Figure 15-13 Trace Generation 15-472
Figure 15-14 DTSL Trace Decoding Stages for DSTREAM 15-473
Figure 15-15 DTSL Trace Pipeline Hierarchy 15-474
Figure 15-16 ETB Trace Decode Pipeline Stages 15-474
Figure 15-17 Example of Multiple Trace Capture Devices 15-475
Figure 15-18 STM Object Model 15-478
Figure 15-19 Launcher panel reporting DTSL Jython script error 15-484
Figure 15-20 Connection Error Dialog 15-485
Figure 16-1 Load File dialog box 16-497
Figure 16-2 Load additional debug information dialog box 16-500

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

List of Tables
ARM® DS-5 Debugger User Guide

Table 3-1 Semihosting trap instructions and encodings 3-96
Table 4-1 DMA map register SYS_DMAPSR0 4-117
Table 4-2 Control bit that remaps an area of memory 4-118
Table 10-1 Elements used in the components.xml file 10-257
Table 11-1 Function icons 11-298
Table 11-2 Files tab options available for each Debug operation 11-361
Table 11-3 DS-5 Debugger icons 11-388
Table 11-4 Perspective icons 11-389
Table 11-5 View icons 11-389
Table 11-6 View markers 11-389
Table 11-7 Miscellaneous icons 11-390
Table 15-1 CTI Signal Connections 15-470

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Preface

This preface introduces the *ARM® DS-5 Debugger User Guide*.

It contains the following:

- *About this book* on page 17.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

About this book

This book describes how to use the debugger to debug Linux applications, bare-metal, *Real-Time Operating System* (RTOS), and Linux platforms.

Using this book

This book is organized into the following chapters:

Chapter 1 Introduction to DS-5 Debugger
Introduces DS-5 Debugger and some important debugger concepts.

Chapter 2 Configuring debug connections in DS-5 Debugger
Describes how to configure and connect to a debug target using ARM DS-5 Debugger.

Chapter 3 Controlling Target Execution
Describes how to control the target when certain events occur or when certain conditions are met.

Chapter 4 Working with the Target Configuration Editor
Describes how to use the editor when developing a project for an ARM target.

Chapter 5 Examining the Target
This chapter describes how to examine registers, variables, memory, and the call stack.

Chapter 6 Debugging Embedded Systems
Gives an introduction to debugging embedded systems.

Chapter 7 Debugging with Scripts
Describes how to use scripts containing debugger commands to enable you to automate debugging operations.

Chapter 8 Running DS-5 Debugger from the operating system command-line or from a script
This chapter describes how to use DS-5 Debugger from the operating system command-line or from a script.

Chapter 9 Working with the Snapshot Viewer
This chapter describes how to work with the Snapshot Viewer.

Chapter 10 Platform Configuration
You can configure models and hardware platforms using DS-5.

Chapter 11 DS-5 Debug Perspectives and Views
Describes the DS-5 Debug perspective and related views in the Eclipse *Integrated Development Environment* (IDE).

Chapter 12 Troubleshooting
Describes how to diagnose problems when debugging applications using DS-5 Debugger.

Chapter 13 File-based Flash Programming in ARM DS-5
Describes the file-based flash programming options available in DS-5.

Chapter 14 Writing OS Awareness for DS-5 Debugger
Describes the OS awareness feature available in DS-5.

Chapter 15 Debug and Trace Services Layer (DTSL)
Describes the DS-5 Debugger *Debug and Trace Services Layer* (DTSL).

Chapter 16 Reference
Lists other information that might be useful when working with DS-5 Debugger.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

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 *ARM® DS-5 Debugger User Guide*.
- The number ARM DUI0446Z.
- 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.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Other information

- *ARM Information Center*.
- *ARM Technical Support Knowledge Articles*.
- *Support and Maintenance*.
- *ARM Glossary*.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 1
Introduction to DS-5 Debugger

Introduces DS-5 Debugger and some important debugger concepts.

It contains the following sections:

- *1.1 Overview: DS-5 Debugger and important concepts* on page 1-21.
- *1.2 Overview: ARM® CoreSight™ debug and trace components* on page 1-22.
- *1.3 Overview: Debugging multi-core (SMP and AMP), big.LITTLE™ , and multi-cluster targets* on page 1-23.
- *1.4 Overview: Debugging ARM®-based Linux applications* on page 1-27.
- *1.5 Overview: Linux application rewind* on page 1-28.
- *1.6 Debugger concepts* on page 1-30.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

1.1 Overview: DS-5 Debugger and important concepts

DS-5 Debugger is part of ARM® DS-5 Development Studio and helps you find the cause of software bugs on ARM processor-based targets and Fixed Virtual Platform (FVP) targets.

From device bring-up to application debug, it can be used to develop code on an RTL simulator, virtual platform, and hardware, to help get your products to market quickly.

DS-5 Debugger supports:

- Loading images and symbols.
- Running images.
- Breakpoints and watchpoints.
- Source and instruction level stepping.
- CoreSight and non-CoreSight trace (Embedded Trace Macrocell Architecture Specification v3.0 and above).
- Accessing variables and register values.
- Viewing the contents of memory.
- Navigating the call stack.
- Handling exceptions and Linux signals.
- Debugging bare-metal code.
- Debugging multi-threaded Linux applications.
- Debugging the Linux kernel and Linux kernel modules.
- Debugging multicore and multi-cluster systems, including big.LITTLE.
- Debugging Real-Time Operating Systems (RTOSs).
- Debugging from the command-line.
- Performance analysis using Streamline.
- A comprehensive set of debugger commands that can be executed in the Eclipse Integrated Development Environment (IDE), script files, or a command-line console.
- GDB debugger commands, making the transition from open source tools easier.
- A small subset of third party CMM-style commands sufficient for running target initialization scripts.

Using DS-5 Debugger, you can debug bare-metal and Linux applications with comprehensive and intuitive views, including synchronized source and disassembly, call stack, memory, registers, expressions, variables, threads, breakpoints, and trace.

To help you get started, follow these tutorials which show you how to run and debug applications in DS-5:

- *Getting Started with ARM® DS-5.*
- *Debugging bare-metal applications on an FVP using DS-5 and GCC compiler.*
- *Linux application debugging using ARM® DS-5.*

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

1.2 Overview: ARM® CoreSight™ debug and trace components

CoreSight™ defines a set of hardware components for ARM-based SoCs. DS-5 Debugger uses the CoreSight components in your SoC to provide debug and performance analysis features.

Examples of common CoreSight components include:

- *DAP: Debug Access Port*
- *ECT: Embedded Cross Trigger*
- *TMC: Trace Memory Controller*
  - *ETB: Embedded Trace Buffer*
  - *ETF: Embedded Trace FIFO*
  - *ETR: Embedded Trace Router*
- *ETM: Embedded Trace Macrocell*
- *PTM: Program Trace Macrocell*
- *ITM: Instrumentation Trace Macrocell*
- *STM: System Trace Macrocell*

Examples of how these components are used by DS-5 Debugger include:

- The **Trace** view displays data collected from PTM and ETM components.
- The **Events** view displays data collected from ITM and STM components.
- Debug connections can make use of the ECT to provide synchronized starting and stopping of groups of cores, for example, stop all the cores in an SMP group simultaneously, or halt heterogeneous cores simultaneously to allow whole system debug at a particular point in time.

If you are using an SoC that is supported out-of-the-box with DS-5 Debugger, then you just need to select the correct platform (SoC) in the **Debug Configuration** dialog to configure a debug connection. If you are using an SoC that is not supported by DS-5 Debugger by default, then you must first define a custom platform in DS-5 Debugger's configuration database using the **Platform Configuration Editor** tool.

For all platforms, whether built-in or manually created, you can use the **Platform Configuration Editor** (PCE) to easily define the debug topology between various components available on the platform. See the *Platform Configuration Editor* on page 10-230 for details.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

1.3 Overview: Debugging multi-core (SMP and AMP), big.LITTLE™ , and multi-cluster targets

DS-5 Debugger is developed with multicore debug in mind for bare-metal, Linux kernel, or application-level software development.

Awareness for Symmetric Multi-Processing (SMP), Asymmetric Multi-Processing (AMP), and big.LITTLE™ configurations is embedded in DS-5 Debugger, allowing you to see which core, or cluster a thread is executing on.

When debugging applications in DS-5 Debugger, multicore configurations such as SMP or big.LITTLE require no special setup process. DS-5 Debugger includes predefined configurations, backed up by the *Platform Configuration Editor* on page 10-230 which enables further customization. The nature of the connection determines how DS-5 Debugger behaves, for example stopping and starting all cores simultaneously in a SMP system.

1.3.1 Debugging SMP systems

From the point of view of DS-5 Debugger, *Symmetric Multi Processing* (SMP) refers to a set of architecturally identical cores that are tightly coupled together and used as a single multi-core execution block. Also, from the point of view of the debugger, they must be started and halted together.

DS-5 Debugger expects an SMP system to meet the following requirements:

- The same ELF image running on all processors.
- All processors must have identical debug hardware. For example, the number of hardware breakpoint and watchpoint resources must be identical.
- Breakpoints and watchpoints must only be set in regions where all processors have identical physical and virtual memory maps. Processors with separate instances of identical peripherals mapped to the same address are considered to meet this requirement. Private peripherals of ARM multicore processors is a typical example.

Configuring and connecting

To enable SMP support in the debugger, you must first configure a debug session in the **Debug Configurations** dialog. Configuring a single SMP connection is all that you require to enable SMP support in the debugger.

Targets that support SMP debugging have SMP mentioned against them.

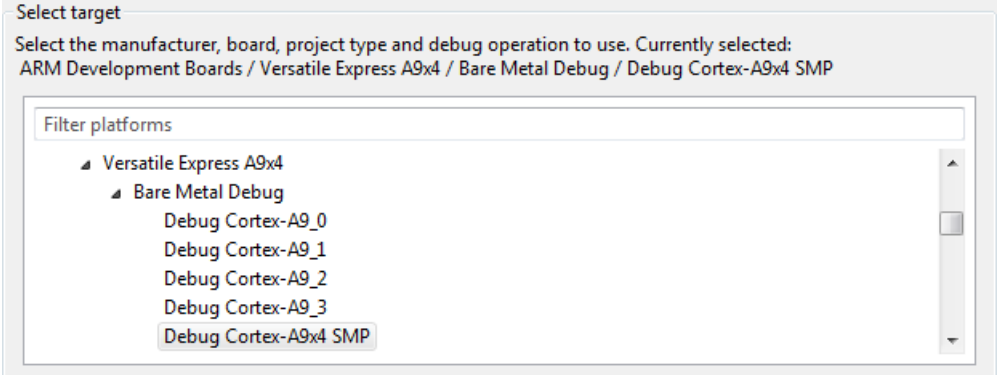


Figure 1-1 Versatile Express A9x4 SMP configuration

Once connected to your target, use the **Debug Control** view to work with all the cores in your SMP system.

Image and symbol loading

When debugging an SMP system, image and symbol loading operations apply to all the SMP processors.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

For image loading, this means that the image code and data are written to memory once, through one of the processors, and are assumed to be accessible through the other processors at the same address because they share the same memory.

For symbol loading, this means that debug information is loaded once and is available when debugging any of the processors.

Running, stepping, and stopping

When debugging an SMP system, attempting to run one processor automatically starts running all the other processors in the system. Similarly, when one processor stops, either because you requested it or because of an event such as a breakpoint being hit, then all the other processors in the system stop.

For instruction level single-stepping commands, `stepi` and `nexti`, the currently selected processor steps one instruction.

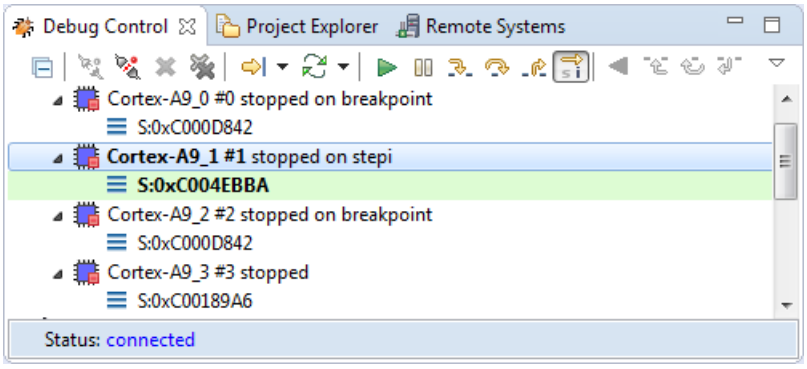


Figure 1-2 Core 1 stopped on stepi command

The exception to this is when a `nexti` operation is required to step over a function call, in which case, the debugger sets a breakpoint and then runs all processors. All other stepping commands affect all processors.

Depending on your system, there might be a delay between different cores running or stopping. This delay can be very large because the debugger must run and stop each core individually. However, hardware cross-trigger implementations in most SMP systems ensure that the delays are minimal and are limited to a few processor clock cycles.

In rare cases, one processor might stop, and one or more of the other processors might not respond. This can occur, for example, when a processor running code in secure mode has temporarily disabled debug ability. When this occurs, the **Debug Control** view displays the individual state of each processor, running or stopped, so you can see which ones have failed to stop. Subsequent run and step operations might not operate correctly until all the processors stop.

Breakpoints, watchpoints, and signals

By default, when debugging an SMP system, breakpoint, watchpoint, and signal (vector catch) operations apply to all processors. This means that you can set one breakpoint to trigger when any of the processors execute code that meets the criteria. When the debugger stops due to a breakpoint, watchpoint, or signal, then the processor that causes the event is listed in the **Commands** view.

Breakpoints or watchpoints can be configured for one or more processors by selecting the required processor in the relevant **Properties** dialog box. Alternatively, you can use the `break-stop-on-cores` command. This feature is not available for signals.

Examining target state

Views of the target state, including **Registers**, **Call stack**, **Memory**, **Disassembly**, **Expressions**, and **Variables** contain content that is specific to a processor. Views such as **Breakpoints**, **Signals**, and **Commands** are shared by all the processors in the SMP system, and display the same contents regardless of which processor is currently selected.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Trace

If you are using a connection that enables trace support, you can view trace for each of the processors in your system using the **Trace** view.

By default, the **Trace** view shows trace for the processor that is currently selected in the **Debug Control** view. Alternatively, you can choose to link a **Trace** view to a specific processor by using the **Linked: context** toolbar option for that **Trace** view. Creating multiple **Trace** views linked to specific processors enables you to view the trace from multiple processors at the same time.

Note

The indexes in the different **Trace** views do not necessarily represent the same point in time for different processors.

1.3.2 Debugging AMP Systems

From the point of view of DS-5 Debugger, *Asymmetric Multi Processing* (AMP) refers to a set of cores which operate in an uncoupled manner. The cores can be of different architectures or of the same architecture but not operating in an SMP configuration. Also, from the point of view of the debugger, it depends on the implementation whether the cores need to be started or halted together.

An example of this might be a Cortex-A5 device coupled with a Cortex-M4, combining the benefits of an MCU running an RTOS which provides low-latency interrupt with an application processor running Linux. These are often found in industrial applications where a rich user-interface might need to interact closely with a safety-critical control system, combining multiple cores into an integrated SoC for efficiency gains.

Bare metal debug on AMP Systems

DS-5 Debugger supports simultaneous debug of the cores in AMP devices. In this case, you need to launch a debugger connection to each one of the cores and clusters in the system. Each one of these connections is treated independently, so images, debug symbols, and OS awareness are kept separate for each connection. For instance, you will normally load an image and its debug symbols for each AMP processor. With multiple debug sessions active, you can compare content in the **Registers**, **Disassembly**, and **Memory** views by opening multiple views and linking them to multiple connections, allowing you to view the state of each processor at the same time.

It is possible to connect to a system in which there is a cluster or big.LITTLE subsystem working in SMP mode, for example, running Linux, with extra processors working in AMP mode for example, running their own bare-metal software or an RTOS. DS-5 Debugger is capable of supporting these devices by just connecting the debugger to each core or subsystem separately.

1.3.3 Debugging big.LITTLE™ Systems

A big.LITTLE system optimizes for both high performance and low power consumption over a wide variety of workloads. It achieves this by including one or more high performance processors alongside one or more low power processors.

Awareness for big.LITTLE configurations is built into DS-5 Debugger, allowing you to establish a bare-metal, Linux kernel, or Linux application debug connection, just as you would for a single core processor.

Note

For the software required to enable big.LITTLE support in your own OS, visit the big.LITTLE Linaro git repository.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Bare-metal debug on big.LITTLE™ systems

For bare-metal debugging on big.LITTLE systems, you can establish an SMP connection within DS-5 Debugger. In this case, all the processors in the big.LITTLE system are brought under the control of the debugger. The debugger monitors the power state of each processor as it runs and displays it in the **Debug Control** view and on the command -line. Processors that are powered-down are visible to the debugger, but cannot be accessed. The remaining functionality of the debugger is equivalent to an SMP connection to a homogenous cluster of cores.

Linux application debug on big.LITTLE™ systems

For Linux application debugging on big.LITTLE systems, you can establish a `gdbserver` connection within DS-5 Debugger. Linux applications are typically unaware of whether they are running on a big processor or a LITTLE processor because this is hidden by the operating system. Therefore, there is no difference when debugging a Linux application on a big.LITTLE system as compared to application debug on any other system.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

1.4 Overview: Debugging ARM®-based Linux applications

DS-5 Debugger supports debugging Linux applications and libraries that are written in *C*, *C++*, and *ARM assembly*.

The integrated suite of tools in DS-5 facilitates rapid development of optimal code for your target device.

For Linux applications, communication between the debugger and the debugged application is achieved using `gdbserver`. As an alternative to Linux application debug, you also can use `undodb-server` instead of `gdbserver`. `undodb-server` provides the ability to debug backwards as well as forwards, and is known as Application Rewind. See *Application Rewind* on page 1-28 for more information.

Related concepts

6.9 About debugging shared libraries on page 6-153.

Related tasks

2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.

2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.

2.6 Configuring a connection to a Linux kernel on page 2-48.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

1.5 Overview: Linux application rewind

Application rewind is a DS-5 Debugger feature that allows you to debug backwards as well as forwards, through the execution of Linux applications.

Using this feature, you can both run and step, including hitting breakpoints and watchpoints. You can also view the contents of recorded memory, registers, and variables at any point in your application's execution. Debugging backwards, can cut down the time it takes to find a bug from hours to minutes since you do not have to recreate the same steps that caused a crash, which can be difficult in the case of non-deterministic bugs.

For errors as simple as an uninitialized or out-of-range array index, or application crashes caused by null pointers, the application rewind feature can prove extremely useful, especially since a crash might not even occur in the same source file as the one with the bug.

Note

Application Rewind is only supported in DS-5 Professional Edition and DS-5 Ultimate Edition.

Application rewind versus conventional debugging techniques

Trace is an extremely effective tool for debugging system issues as it can record a complete picture of execution and is non-intrusive. Bare-metal or kernel debugging uses trace for this purpose by recording instructions that are executed on a processor over a period of time.

However, from the debugger's view, it is not practical to use trace on Linux applications, because:

- In production systems, trace might not be exposed, so cannot be accessed.
- It can be time-consuming to track an application that migrates between cores.
- On a multicore SoC, a trace buffer can fill rapidly, limiting the amount of time available for recording program execution. Also, in situations where a bug occurs long before the application crash, the trace buffer might not be large enough to capture the full event.

Classic `printf` debugging techniques present a different set of challenges. It is difficult to know how often you need to stage `printf` statements and the statement might have a “probe-effect” on your code. Also, rebuilding an application every time an annotation is added can be time-consuming.

For these reasons, when debugging user-space applications over TCP/IP or USB, a different approach is required.

How does application rewind work?

Application rewind debug sessions are launched from the debug configurations panel and can be either controlled from the graphical debugger or the command line debugger.

Application rewind works in a similar way to standard debugging of Linux applications using a TCP/IP or USB connection, though instead of using `gdbserver`, it uses a custom debug agent. This custom debug agent records a copy-on-write snapshot of the application being debugged, along with non-deterministic inputs. This allows the debugger to reconstruct a complete picture of program execution.

Note

Debugging your application using application rewind results in increased memory consumption on your target and might slow down your application. The exact impact is dependent on the behavior of your application. Applications that perform large amounts of I/O are likely to experience increased memory consumption during the recording process.

Once a bug is recorded, replay is deterministic, with exactly the same behavior observed with each rewind and play.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related concepts

2.8 Configuring application rewind for Linux on page 2-57.

Related tasks

2.8.1 Connecting to an existing application and starting an application rewind session on page 2-58.
2.8.2 Downloading your application and application rewind server to the target system on page 2-60.
2.8.3 Starting the application rewind server and debugging the target-resident application on page 2-61.
2.8.1 Connecting to an existing application and starting an application rewind session on page 2-58.
2.8.2 Downloading your application and application rewind server to the target system on page 2-60.
2.8.3 Starting the application rewind server and debugging the target-resident application on page 2-61.

Related references

2.1 Overview: Debug connections in DS-5 Debugger on page 2-34.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

1.6 Debugger concepts

Lists some of the useful concepts to be aware of when working with DS-5 Debugger.

AMP

Asymmetric Multi-Processing (AMP) system has multiple processors that may be different architectures. See *1.3.2 Debugging AMP Systems* on page 1-25 for more information.

Bare-metal

A bare-metal embedded application is one which does not run on an OS.

BBB

The old name for the MTB.

CADI

Component Architecture Debug Interface. This is the API used by debuggers to control models.

Configuration database

The configuration database is where DS-5 Debugger stores information about the processors, devices, and boards it can connect to.

The database exists as a series of `.xml` files, python scripts, `.rvc` files, `.rcf` files, and other miscellaneous files within the `<DS-5 installation directory>/sw/debugger/configdb/` directory.

DS-5 comes pre-configured with support for a wide variety of devices out-of-the-box, and you can view these within the **Debug Configuration** dialog within Eclipse IDE.

You can also add support for your own devices using the *Platform Configuration Editor (PCE)* tool.

Contexts

Each processor in the target can run more than one process. However, the processor only executes one process at any given time. Each process uses values stored in variables, registers, and other memory locations. These values can change during the execution of the process.

The context of a process describes its current state, as defined principally by the call stack that lists all the currently active calls.

The context changes when:

- A function is called.
- A function returns.
- An interrupt or an exception occurs.

Because variables can have class, local, or global scope, the context determines which variables are currently accessible. Every process has its own context. When execution of a process stops, you can examine and change values in its current context.

CTI

The Cross Trigger Interface (CTI) combines and maps trigger requests, and broadcasts them to all other interfaces on the Embedded Cross Trigger (ECT) sub-system. See *3.16 Cross-trigger configuration* on page 3-94 for more information.

DAP

The Debug Access Port (DAP) is a control and access component that enables debug access to the complete SoC through system master ports. See *Debug Access Port* for more information.

Debugger

A debugger is software running on a host computer that enables you to make use of a debug adapter to examine and control the execution of software running on a debug target.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Debug agent

A debug agent is hardware or software, or both, that enables a host debugger to interact with a target. For example, a debug agent enables you to read from and write to registers, read from and write to memory, set breakpoints, download programs, run and single-step programs, program flash memory, and so on.

`gdbserver` is an example of a software debug agent.

Debug session

A debug session begins when you connect the debugger to a target for debugging software running on the target and ends when you disconnect the debugger from the target.

Debug target

A debug target is an environment where your program runs. This environment can be hardware, software that simulates hardware, or a hardware emulator.

A hardware target can be anything from a mass-produced development board or electronic equipment to a prototype product, or a printed circuit board.

During the early stages of product development, if no hardware is available, a simulation or software target might be used to simulate hardware behavior. A *Fixed Virtual Platform* (FVP) is a software model from ARM that provides functional behavior equivalent to real hardware.

Note

Even though you might run an FVP on the same host as the debugger, it is useful to think of it as a separate piece of hardware.

Also, during the early stages of product development, hardware emulators are used to verify hardware and software designs for pre-silicon testing.

Debug adapter

A debug adapter is a physical interface between the host debugger and hardware target. It acts as a debug agent. A debug adapter is normally required for bare-metal start/stop debugging real target hardware, for example, using JTAG.

Examples include DSTREAM and the ULINK family of debug and trace adapters.

DSTREAM

ARM DSTREAM combined debug and trace unit. See *DSTREAM* for more information..

DTSL

Debug and Trace Services Layer (DTSL) is a software layer within the DS-5 Debugger stack. DTSL is implemented as a set of Java classes which are typically implemented (and possibly extended) by Jython scripts. A typical DTSL instance is a combination of Java and Jython. ARM has made DTSL available for your own use so that you can create programs (Java or Jython) to access/control the target platform.

DWARF

DWARF is a debugging format used to describe programs in C and other similar programming languages. It is most widely associated with the ELF object format but it has been used with other object file formats.

ELF

Executable and Linkable Format (ELF) is a common standard file format for executables, object code, shared libraries, and core dumps.

ETB

Embedded Trace Buffer (ETB) is an optional on-chip buffer that stores trace data from different trace sources. You can use a debugger to retrieve captured trace data.

ETF

Embedded Trace FIFO (ETF) is a trace buffer that uses a dedicated SRAM as either a circular capture buffer, or as a FIFO. The trace stream is captured by an ATB input that can then be output over an ATB output or the Debug APB interface. The ETF is a configuration option of the Trace Memory Controller (TMC).

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

ETM

Embedded Trace Macrocell (ETM) is an optional debug component that enables reconstruction of program execution. The ETM is designed to be a high-speed, low-power debug tool that supports trace.

ETR

Embedded Trace Router (ETR) is a CoreSight component which routes trace data to system memory or other trace sinks, such as HSSTP.

FVP

Fixed Virtual Platform (FVP) enables development of software without the requirement for actual hardware. The functional behavior of the FVP is equivalent to real hardware from a programmers view.

ITM

Instruction Trace Macrocell (ITM) is a CoreSight component which delivers code instrumentation output and specific hardware data streams.

jRDDI

The Java API implementation of RDDI.

Jython

An implementation of the Python language which is closely integrated with Java.

MTB

Micro Trace Buffer. This is used in the Cortex-M0 and Cortex-M0+.

PTM

Program Trace Macrocell (PTM) is a CoreSight component which is paired with a core to deliver instruction only program flow trace data.

RDDI

RealView Device Debug Interface (RDDI) is a C-level API which allows access to target debug and trace functionality, typically through a DSTREAM box, or a CADI model.

RVI

ARM Realview ICE unit, predecessor to DSTREAM.

Scope

The scope of a variable is determined by the point within an application at which it is defined. Variables can have values that are relevant within:

- A specific class only (class).
- A specific function only (local).
- A specific file only (static global).
- The entire application (global).

SMP

A Symmetric Multi-Processing (SMP) system has multiple processors with the same architecture. See *1.3.1 Debugging SMP systems* on page 1-23 for more information.

STM

System Trace Macrocell (STM) is a CoreSight component which delivers code instrumentation output and other hardware generated data streams.

TPIU

Trace Port Interface Unit (TPIU) is a CoreSight component which delivers trace data to an external trace capture device.

TMC

The Trace Memory Controller (TMC) enables you to capture trace using:

- The debug interface such as 2-pin serial wire debug.
- The system memory such as a dynamic Random Access Memory (RAM)
- The high-speed links that already exist in the System-on-Chip (SoC) peripheral.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 2
Configuring debug connections in DS-5 Debugger

Describes how to configure and connect to a debug target using ARM DS-5 Debugger.

It contains the following sections:

- *2.1 Overview: Debug connections in DS-5 Debugger* on page 2-34.
- *2.2 Launching DS-5 and connecting to DS-5 Debugger* on page 2-36.
- *2.3 Configuring a connection to a bare-metal hardware target* on page 2-38.
- *2.4 Configuring trace for bare-metal or Linux kernel targets* on page 2-43.
- *2.5 Configuring a connection to a Linux application using gdbserver* on page 2-46.
- *2.6 Configuring a connection to a Linux kernel* on page 2-48.
- *2.7 Using Fixed Virtual Platform (FVP)s with DS-5* on page 2-50.
- *2.8 Configuring application rewind for Linux* on page 2-57.
- *2.9 Configuring an Events view connection to a bare-metal target* on page 2-63.
- *2.10 Exporting or importing an existing launch configuration* on page 2-65.
- *2.11 Disconnecting from a target* on page 2-68.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.1 Overview: Debug connections in DS-5 Debugger

You can set up connections to debug bare-metal targets, Linux kernel, and Linux applications. You can also use the **Snapshot Viewer** feature to view previously captured application states.

Bare-metal debug connections

Bare-metal targets run without an underlying operating system. To debug bare-metal targets using DS-5 Debugger:

- If debugging on hardware, use a debug hardware adapter connected to the host workstation and the debug target.
- If debugging on a model, use a CADI-compliant connection between the debugger and a model.
- For RTL simulators and hardware emulators, use VSTREAM to create connections.

Linux kernel debug connections

DS-5 Debugger supports source-level debugging of a Linux kernel. For example, you can set breakpoints in the kernel code, step through the source, inspect the call stack, and watch variables. The connection methodology is similar to bare-metal debug connections.

Linux application debug connections

For Linux application debugging in DS-5 Debugger, you can connect to your target using TCP/IP or serial connection.

Before attempting to connect to your target, you need to ensure that:

- `gdbserver` is present on the target.

  Note

  — If `gdbserver` is not installed on the target, either see the documentation for your Linux distribution or check with your provider.
  — See the *Debug System Requirements* section in the latest DS-5 Release Notes for information about the minimum required version of `gdbserver`.
  — For ARMv8 AArch64 targets, you need to use the *AArch64 gdbserver*.

- `ssh daemon` (`sshd`) must be running on the target to use the **Remote System Explorer** (RSE) in DS-5.
- `sftp-server` must be present on the target to use RSE for file transfers.
- Application rewind server running on the target if you are planning to use application rewind.

  Note

  The application rewind server file *`undodb-server`* can be found in the *`DS-5_install_directory`*`\arm\undodb\linux` folder.

Snapshot Viewer

Use the **Snapshot Viewer** to analyze and debug a read-only representation of the application state of your processor using previously captured data. For more information, see *Chapter 9 Working with the Snapshot Viewer* on page 9-216.

This is useful in scenarios where interactive debugging with a target is not possible.

Related concepts

1.4 Overview: Debugging ARM®-based Linux applications on page 1-27.
9.1 About the Snapshot Viewer on page 9-217.
1.5 Overview: Linux application rewind on page 1-28.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related tasks

2.3 Configuring a connection to a bare-metal hardware target on page 2-38.

2.6 Configuring a connection to a Linux kernel on page 2-48.

2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.

2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.

2.8.1 Connecting to an existing application and starting an application rewind session on page 2-58.

2.8.2 Downloading your application and application rewind server to the target system on page 2-60.

2.8.3 Starting the application rewind server and debugging the target-resident application on page 2-61.

Related references

Chapter 9 Working with the Snapshot Viewer on page 9-216.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.2 Launching DS-5 and connecting to DS-5 Debugger

After installing DS-5, use the options relevant to your operating system to launch Eclipse for DS-5. Then, create a debug configuration to connect to DS-5 Debugger.

Procedure

1. Launch Eclipse for DS-5:
   - On Windows, select **Start** > **All Programs** > **ARM DS-5** > **Eclipse for DS-5**.
   - On Linux:
     — If you installed the DS-5 shortcut during installation, you can select **Eclipse for DS-5** from your list of applications.
     — To run DS-5 from the command-line:
     1. Open a command-line terminal.

        Note

        Ensure that `DS-5_install_directory/bin/` is available in your `PATH` environment variable.

     2. Enter `eclipse` at the prompt.

     Tip

     On Linux, you can also use `suite_exec` to configure the environment variables correctly for DS-5. Run `DS-5_install_directory/bin/suite_exec <shell>` to open a shell with the `PATH` and other environment variables correctly configured. Run `suite_exec` with no arguments for help. For more information, see *Installing DS-5*.

2. Select **Window** > **Open Perspective** > **DS-5 Debug** from the main menu.
3. To connect to a target:
   - If you have not run a debug session previously, then you must configure a connection between the debugger and the target before you can start any debugging tasks.
   - If you have run a debug session previously, then you can select a target connection in the **Debug Control** view and click on the **Connect to Target** toolbar icon.

Related tasks

8.2 Command-line debugger options on page 8-204.
2.8.1 Connecting to an existing application and starting an application rewind session on page 2-58.
2.8.2 Downloading your application and application rewind server to the target system on page 2-60.
2.8.3 Starting the application rewind server and debugging the target-resident application on page 2-61.
2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.
2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.
2.6 Configuring a connection to a Linux kernel on page 2-48.
2.3 Configuring a connection to a bare-metal hardware target on page 2-38.
2.9 Configuring an Events view connection to a bare-metal target on page 2-63.

Related references

2.1 Overview: Debug connections in DS-5 Debugger on page 2-34.
11.40 Debug Configurations - Connection tab on page 11-358.
11.41 Debug Configurations - Files tab on page 11-361.
11.42 Debug Configurations - Debugger tab on page 11-364.
11.44 Debug Configurations - Arguments tab on page 11-368.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.45 Debug Configurations - Environment tab on page 11-370.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.3 Configuring a connection to a bare-metal hardware target

To configure a connection to a bare-metal hardware target, create a debug configuration in DS-5 Debugger with the appropriate settings. Then, connect to your hardware target using JTAG or Serial Wire Debug (SWD) using DSTREAM or a similar debug hardware adapter. To connect to a bare-metal model target, use the same procedure and use the appropriate model settings.

Prerequisites

- Ensure that your target is powered on and is working. See the documentation supplied with the target for more information.
- Ensure that the debug hardware adapter connecting your target with your workstation is powered on and working.
- If using DSTREAM, ensure that your target is connected correctly to the DSTREAM unit. If the target is connected and powered, the **TARGET** LED illuminates green, and the appropriate **VTREF** LED on the DSTREAM probe illuminates.

Procedure

1. From the main menu, select **Window** > **Open Perspective** > **DS-5 Debug**.
2. From the main menu, select **Run** > **Debug Configurations** to open the **Debug Configuration** dialog.
3. In the configuration tree, select **DS-5 Debugger** and then click **New** to create a new configuration.
4. Enter a suitable name for the new configuration, in the **Name** field. For example, **My_BareMetal_Configuration**.
5. Use the **Connection** tab to specify the target and connection settings:
   a. In the **Select target** area of the dialog, browse and select the platform you require. For example, to connect to the CoreTile Express A9x4 (V2P-CA9) running on the Versatile Express motherboard, browse and select **ARM Development Boards** > **Versatile Express A9x4** > **Bare Metal Debug** > **Debug Cortex-A9x4 SMP**.

      Note

      For custom targets, you can create suitable debug configuration files using the Platform Configuration Editor (PCE). The configuration files can then be added to the **Configuration Database** which enables you to find the targets in the **Connections** tab. See the *Platform Configuration chapter* on page 10-224 for details.

      b. Select your debug hardware unit in the **Target Connection** list. For example, **DSTREAM**.
      c. If you need to, **Edit** the Debug and Trace Services Layer (DTSL) settings in the **DTSL Configuration Editor** to configure additional debug and trace settings for your target.
      d. In the **Connections** area, enter the **Connection** name or IP address of your debug hardware adapter. If your connection is local, click **Browse** and select the connection using the **Connection Browser**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

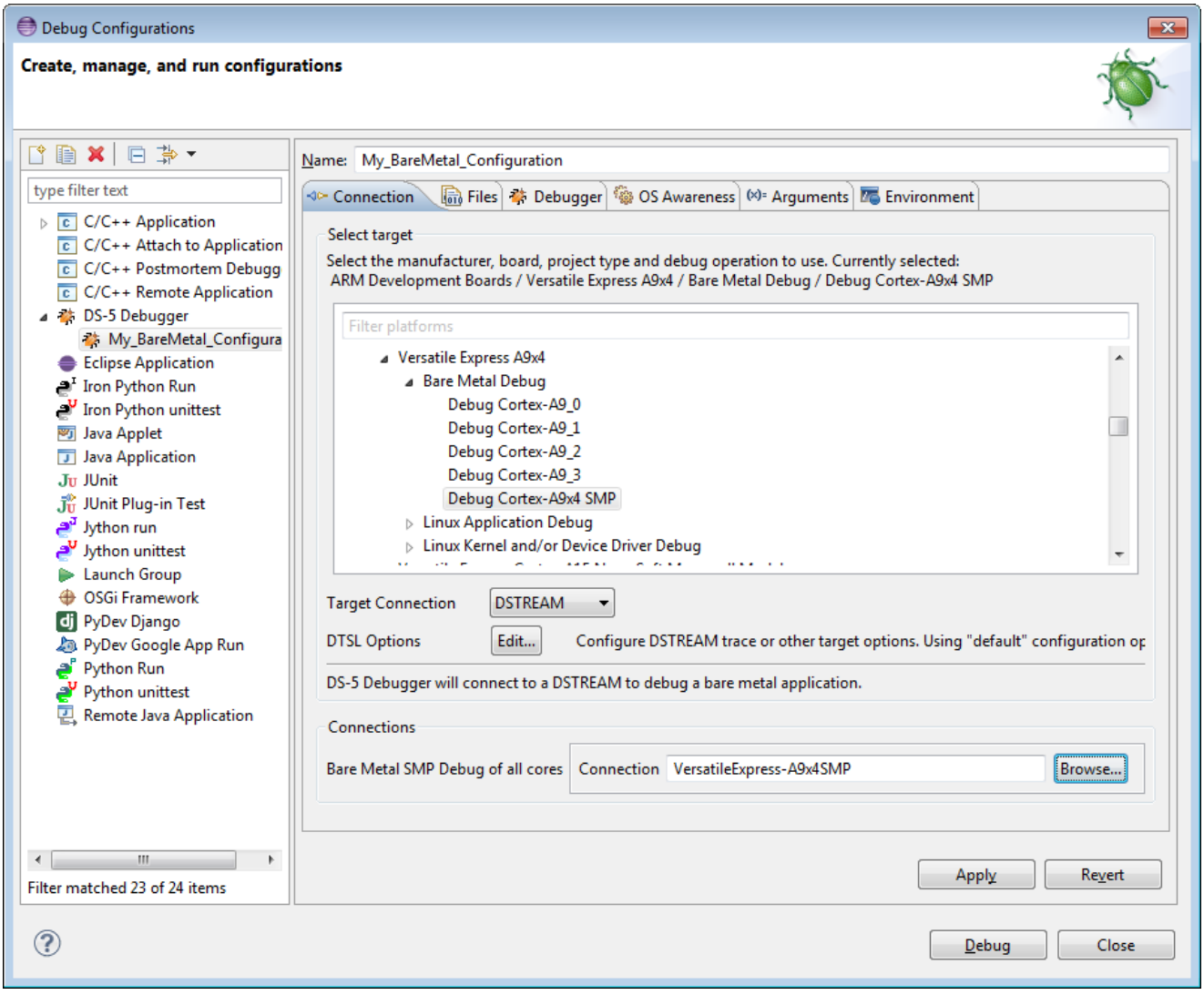


Figure 2-1 MyBareMetalConfig - Connection tab

6. Use the **Files** tab to specify your application and additional resources to download to the target:
   a. If you want to load your application on the target at connection time, in the **Target Configuration** area, specify your application in the **Application on host to download** field.
   b. If you want to debug your application at source level, select **Load symbols**.
   c. If you want to load additional resources, for example, additional symbols or peripheral description files from a directory, use the **Files** area to add them. Click + to add resources, click − to remove resources.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

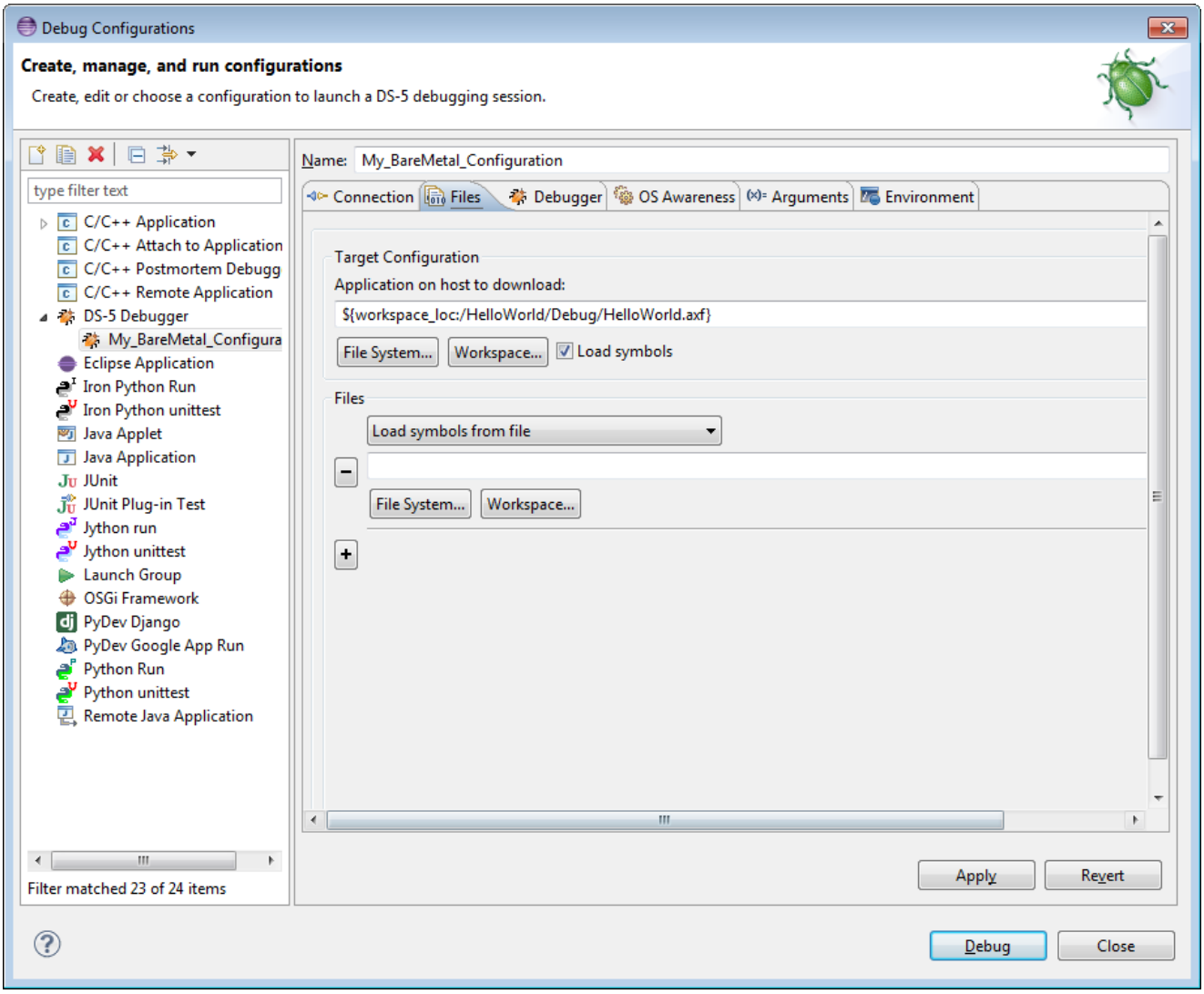


Figure 2-2 MyBareMetalConfig - Files tab

7. Use the **Debugger** tab to configure debugger settings.
   a. In the **Run control** area:
      - Specify if you want to **Connect only** to the target or **Debug from entry point**. If you want to start debugging from a specific symbol, select **Debug from symbol**.
      - If you need to run target or debugger initialization scripts, select the relevant options and specify the script paths.
      - If you need to specify *debugger commands* at debugger start up, select **Execute debugger commands** options and specify the commands.
   b. The debugger uses the Eclipse workspace as the default working directory on the host. If you want to change the default location, deselect the **Use default** option under **Host working directory** and specify the location you want.
   c. In the **Paths** area, specify any directories on the host to search for files of your application using the **Source search directory** field.
   d. If you need to use additional resources, click + to add resources, click − to remove resources.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

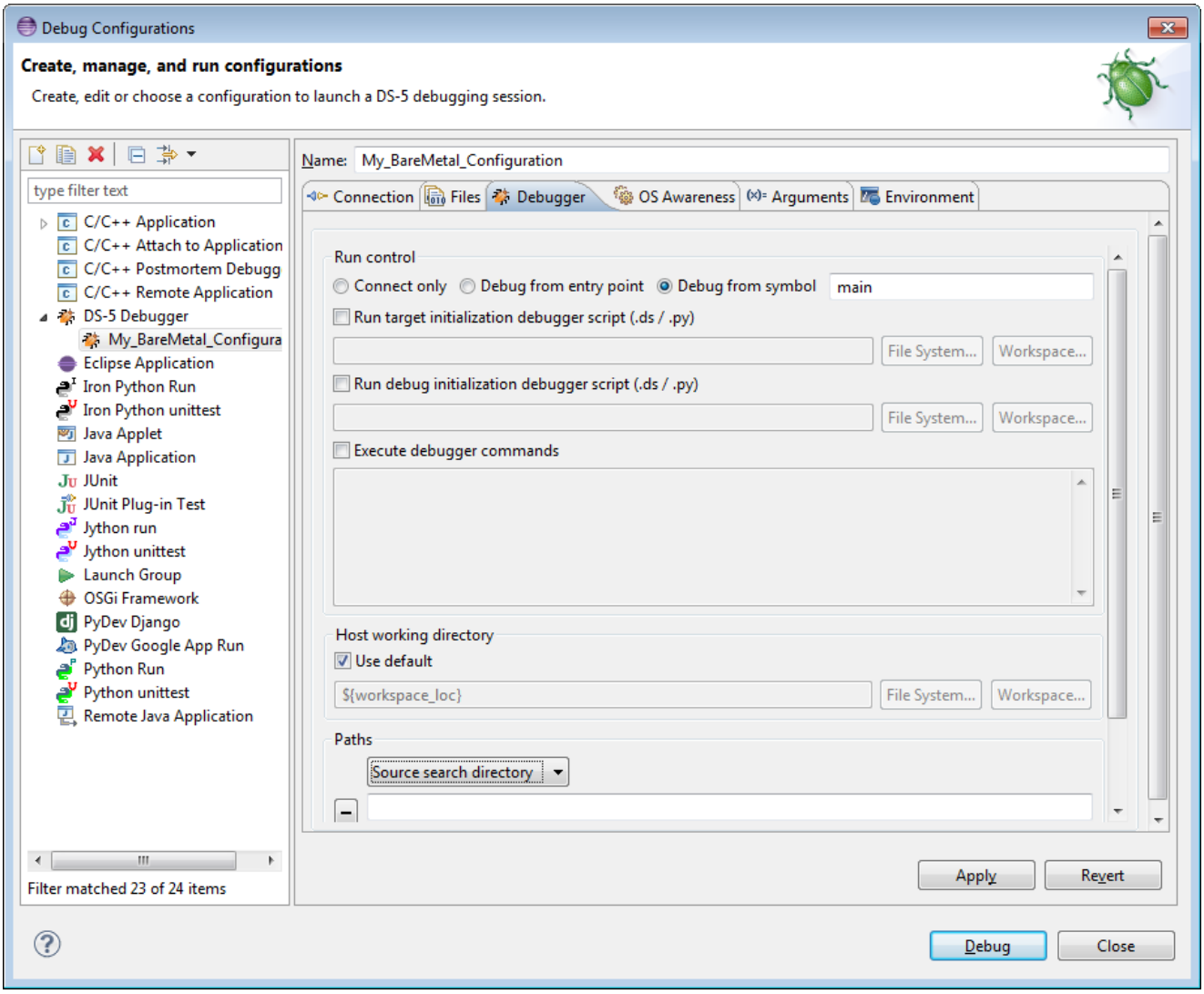


Figure 2-3 MyBareMetalConfig - Debugger tab

8. If required, use the **Arguments** tab to to enter arguments that are passed, using semihosting, to the `main()` function of the application when the debug session starts.
9. If required, use the **Environment** tab to create and configure environment variables to pass into the launch configuration when it is executed.
10. Click **Apply** to save the configuration settings.
11. Click **Debug** to connect to the target and start the debugging session.

The **DS-5 Debug** perspective starts up presenting the relevant views and editors.

For specific help in a selected view, press **F1** on your keyboard and use the dynamic help.

Related tasks

2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.
2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.
2.6 Configuring a connection to a Linux kernel on page 2-48.
2.9 Configuring an Events view connection to a bare-metal target on page 2-63.

Related references

Chapter 10 Platform Configuration on page 10-224.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.40 Debug Configurations - Connection tab on page 11-358.
11.41 Debug Configurations - Files tab on page 11-361.
11.42 Debug Configurations - Debugger tab on page 11-364.
11.43 Debug Configurations - OS Awareness tab on page 11-367.
11.44 Debug Configurations - Arguments tab on page 11-368.
11.45 Debug Configurations - Environment tab on page 11-370.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.4 Configuring trace for bare-metal or Linux kernel targets

You can configure trace for bare-metal or Linux kernel targets using the DTSL options that DS-5 Debugger provides.

After configuring trace for your target, you can connect to your target and capture trace data.

Procedure

1. In DS-5 Debugger, select **Window** > **Open Perspective** > **Other** > **DS-5 Debug**.
2. Select **Run** > **Debug Configurations** to open the **Debug Configurations** launcher panel.
3. Select the DS-5 Debugger debug configuration for your target in the left-hand pane.

   If you want to create a new debug configuration for your target, then select **DS-5 Debugger** from the left-hand pane and then click the **New** button. Then select your bare-metal or Linux kernel target from the **Connection** tab.

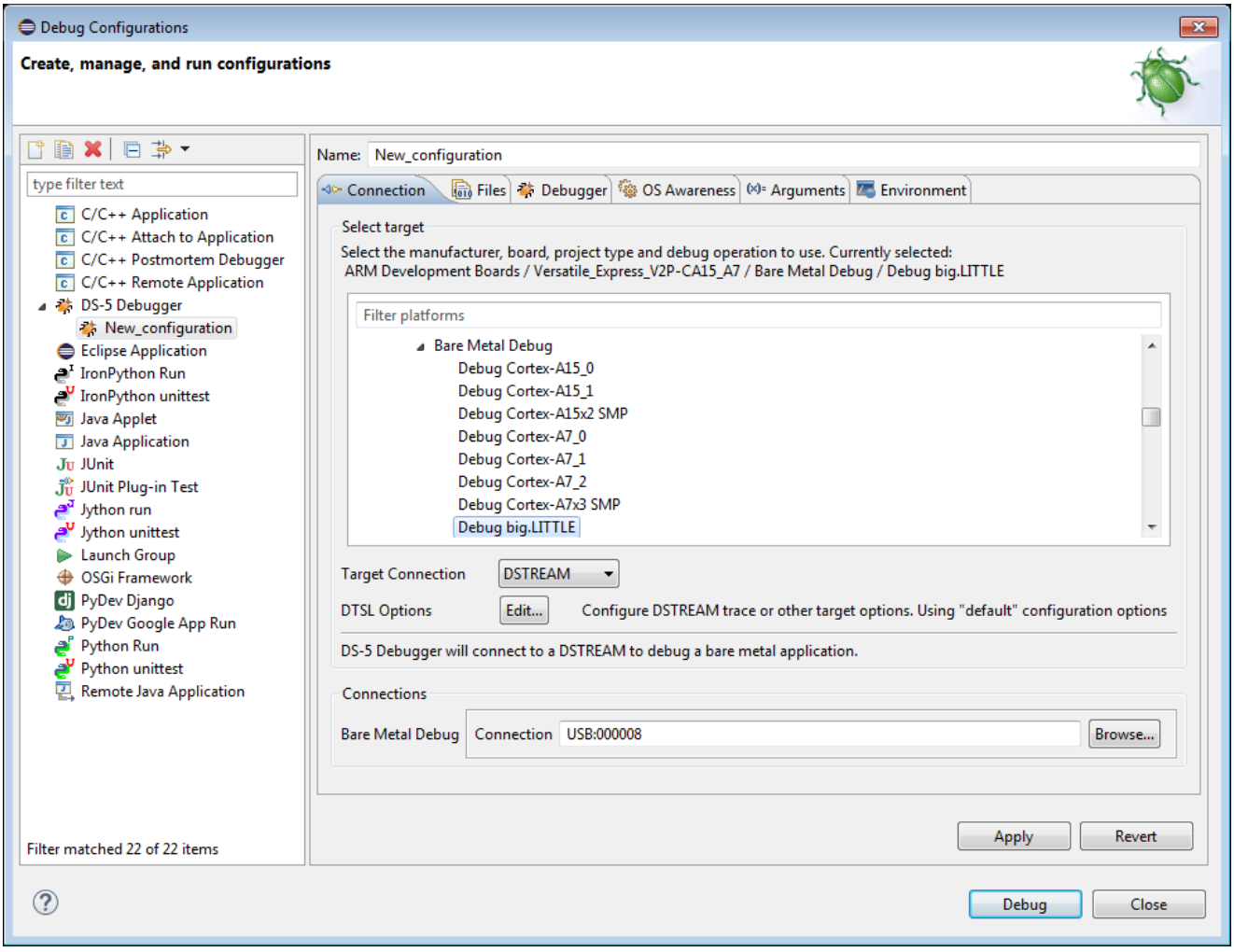


Figure 2-4 Select the debug configuration

4. In the **Connection** tab, after you have selected your target, click the DTSL Options **Edit** button. This shows the **DTSL Configuration Editor** dialog box where you can configure trace.
5. Depending on your target platform, the **DTSL Configuration Editor** provides different options to configure trace. Use the various tabs to configure trace.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

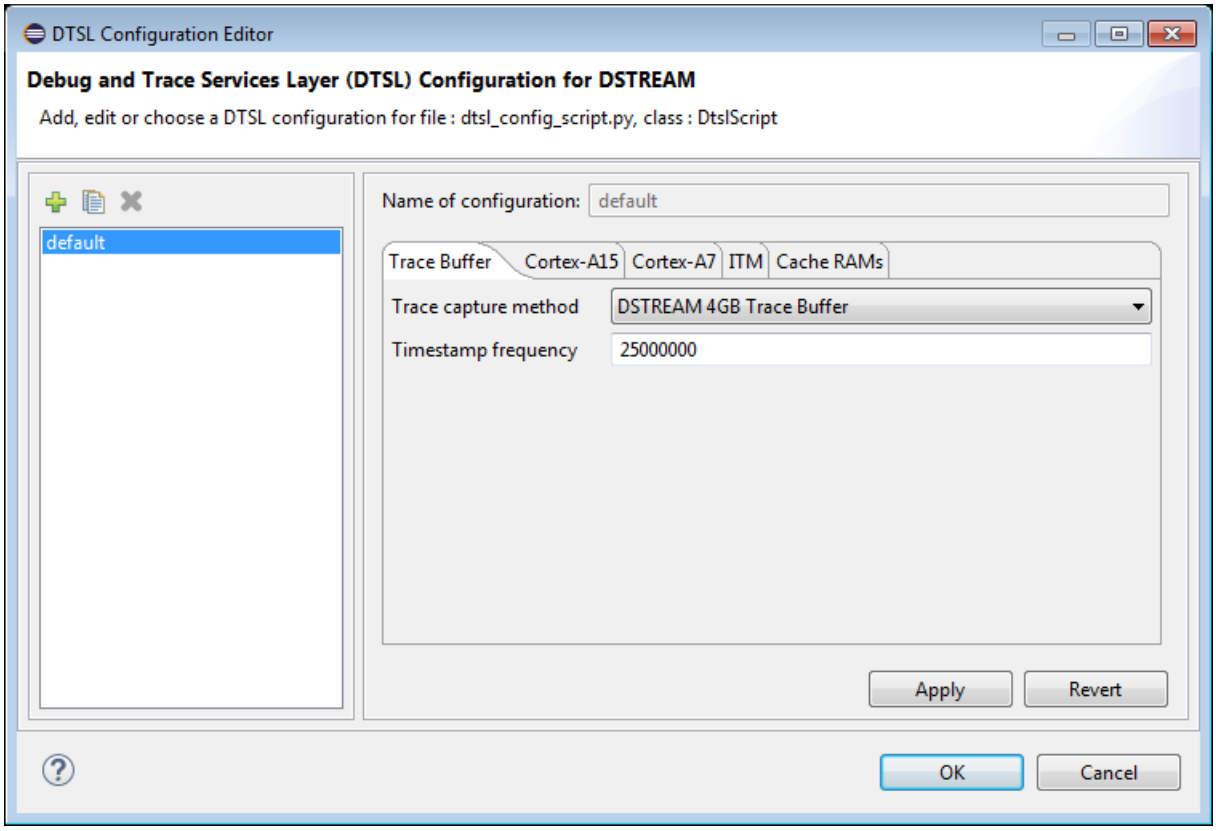


Figure 2-5 Select Trace capture method

a. For **Trace capture method** select the trace buffer you want to use to capture trace.
b. The **DTSL Configuration Editor** shows the processors on the target that are capable of trace. Click the processor tab you want and then select the option to enable trace for the individual processors you want to capture trace.

——— **Note** ———

The options to enable trace might be nested. In this example, you must select **Enable Cortex-A15 core trace**, to enable the other options. Then you must select **Enable Cortex-A15 0 trace** to enable trace on core 0 of the Cortex-A15 processor cluster.

———

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

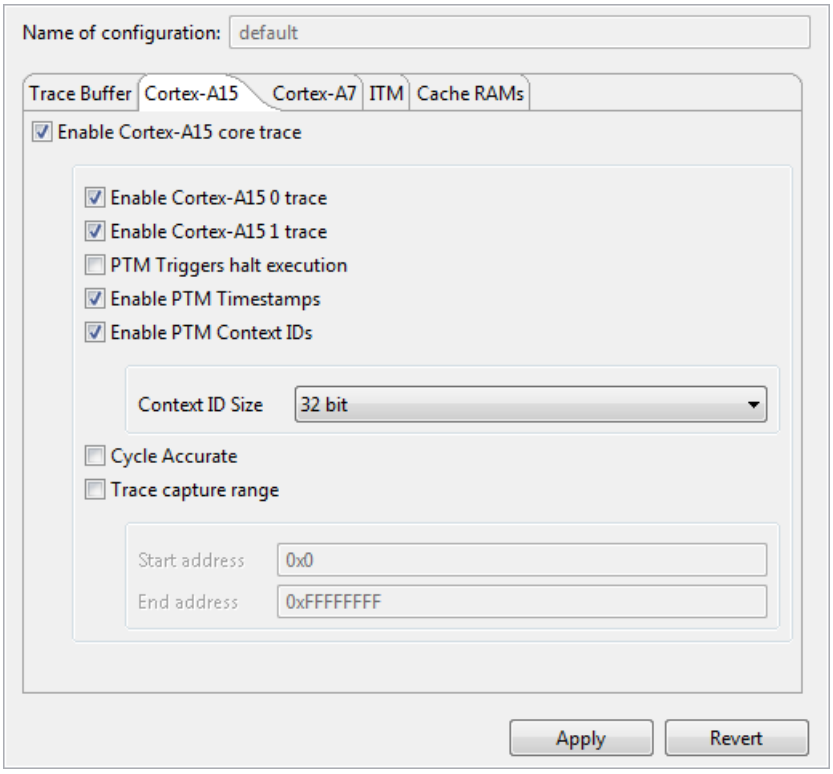


Figure 2-6 Select the processors you want to trace

c. Select any other trace related options you require in the **DTSL Configuration Editor**.
d. Click **Apply** and then click **OK**. This configures the debug configuration for trace capture.

6. Use the other tabs in the **Debug Configurations Editor** to configure the other aspects of your debug connection.
7. Click **Apply** to save your debug configuration. When you use this debug configuration to connect, run, and stop your target, you can see the trace data in the **Trace** view.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.5 Configuring a connection to a Linux application using gdbserver

For Linux application debugging, you can configure DS-5 Debugger to connect to a Linux application using `gdbserver`.

Prerequisites

Before connecting, you must:

- Set up the target with an *Operating System* (OS) installed and booted. See the documentation supplied with the target for more information.
- Obtain the target IP address or name for the connection between the debugger and the debug hardware adapter. If the target is in your local subnet, click **Browse** and select your target.
- If required, set up a *Remote Systems Explorer (RSE)* on page 11-374 connection to the target.

Note

If you are connecting to an already running `gdbserver`, then you must ensure that it is installed and running on the target.

To run `gdbserver` and the application on the target use: `gdbserver port path/myApplication`

Where:

- `port` is the connection port between `gdbserver` and the application.
- `path/myApplication` is the application that you want to debug.

Procedure

1. Select **Window** > **Open Perspective** > **DS-5 Debug** from the main menu.
2. Select **Debug Configurations...** from the **Run** menu.
3. Select **DS-5 Debugger** from the configuration tree and then click on **New** to create a new configuration.
4. In the **Name** field, enter a suitable name for the new configuration.
5. Click on the **Connection** tab to configure a DS-5 Debugger target connection:
   a. Select the required platform, **Linux Application Debug** project type and the required debug operation.
   b. Configure the connection between the debugger and `gdbserver`.
6. Click on the **Files** tab to define the target environment and select debug versions of the application file and libraries on the host that you want the debugger to use.
   a. In the **Target Configuration** panel, select the application on the host that you want to download to the target and specify the location on the target where you want to store the selected file.
   b. In the **Files** panel, select the files on the host that you want the debugger to use to load the debug information. If required, you can also specify other files on the host that you want to download to the target.

   Note

   Options in the **Files** tab are dependent on the type of debug operation that you select.

7. Click on the **Debugger** tab to configure the debugger settings.
   a. In the **Run control** panel, specify the actions that you want the debugger to do after connecting to the target.
   b. Configure the host working directory or use the default.
   c. In the **Paths** panel, specify any source or library search directories on the host that the debugger uses when it displays source code.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

8. If required, click on the **Arguments** tab to enter arguments that are passed to the application when the debug session starts.
9. If required, click on the **Environment** tab to create and configure the target environment variables that are passed to the application when the debug session starts.
10. Click on **Apply** to save the configuration settings.
11. Click on **Debug** to connect to the target.
12. Debugging requires the **DS-5 Debug** perspective. If the **Confirm Perspective Switch** dialog box opens, click **Yes** to switch perspective.

When connected and the **DS-5 Debug** perspective opens you are presented with all the relevant views and editors.

For more information on these options, press **F1** on your keyboard to display dynamic context help.

Related tasks

2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.

2.6 Configuring a connection to a Linux kernel on page 2-48.

2.3 Configuring a connection to a bare-metal hardware target on page 2-38.

2.9 Configuring an Events view connection to a bare-metal target on page 2-63.

Related references

11.40 Debug Configurations - Connection tab on page 11-358.

11.41 Debug Configurations - Files tab on page 11-361.

11.42 Debug Configurations - Debugger tab on page 11-364.

11.43 Debug Configurations - OS Awareness tab on page 11-367.

11.44 Debug Configurations - Arguments tab on page 11-368.

11.45 Debug Configurations - Environment tab on page 11-370.

11.50 Target management terminal for serial and SSH connections on page 11-377.

12.1 ARM Linux problems and solutions on page 12-392.

12.3 Target connection problems and solutions on page 12-394.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.6 Configuring a connection to a Linux kernel

Use these steps to configure a connection to a Linux target and load the Linux kernel into memory. The steps also describe how to add a pre-built loadable module to the target.

Prerequisites

Before connecting, you must:

- Obtain the target IP address or name for the connection between the debugger and the debug hardware adapter.
- If required, set up a *Remote Systems Explorer (RSE)* on page 11-374 connection to the target.

Procedure

1. Select **Window** > **Open Perspective** > **DS-5 Debug** from the main menu.
2. Select **Debug Configurations...** from the **Run** menu.
3. Select **DS-5 Debugger** from the configuration tree and then click on **New** to create a new debug configuration.
4. In the **Name** field, enter a suitable name for the new debug configuration.
5. Click on the **Connection** tab to configure a DS-5 Debugger target connection:
   a. Select the required platform, **Linux Kernel and/or Devices Driver Debug** project type and the required debug operation.
   b. Configure the connection between the debugger and the debug hardware adapter.
6. Click on the **Debugger** tab to configure the debugger settings.
   a. In the **Run** control panel, select **Connect only** and set up initialization scripts as required.

      Note

      Operating System (OS) support is automatically enabled when a Linux kernel vmlinux symbol file is loaded into the debugger from the DS-5 Debugger launch configuration. However, you can manually control this using the `set os` command.

      For example, if you want to delay the activation of operating system support until after the kernel has booted and the *Memory Management Unit* (MMU) is initialized, then you can configure a connection that uses a target initialization script to *disable operating system support*.

      b. Select the **Execute debugger commands** option.
      c. In the field provided, enter commands to *load debug symbols* for the kernel and any kernel modules that you want to debug, for example:

```
add-symbol-file <path>/vmlinux S:0
add-symbol-file <path>/modex.ko
```

      Note

      - The path to the vmlinux must be the same as your build environment.
      - In the above example, the kernel image is called vmlinux, but this could be named differently depending on your kernel image.
      - In the above example, `S:0` loads the symbols for secure space with 0 offset. The offset and memory space prefix is dependent on your target. When working with multiple memory spaces, ensure that you load the symbols for each memory space.

      d. Configure the host working directory or use the default.
      e. In the **Paths** panel, specify any source search directories on the host that the debugger uses when it displays source code.
7. Click on **Apply** to save the configuration settings.
8. Click on **Debug** to connect to the target.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

9. Debugging requires the DS-5 Debug perspective. If the **Confirm Perspective Switch** dialog box opens, click **Yes** to switch perspective.

When connected and the DS-5 Debug perspective opens, you are presented with all the relevant views and editors.

For more information on these options, press **F1** on your keyboard to display dynamic context help.

Tip

By default, for this type of connection, all processor exceptions are handled by Linux on the target. Once connected, you can use the **Manage Signals** dialog box in the **Breakpoints** view menu to modify the default handler settings.

Related concepts

6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.
6.7 About debugging bare-metal symmetric multiprocessing systems on page 6-150.

Related tasks

2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.
2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.
2.3 Configuring a connection to a bare-metal hardware target on page 2-38.
2.9 Configuring an Events view connection to a bare-metal target on page 2-63.

Related references

11.40 Debug Configurations - Connection tab on page 11-358.
11.41 Debug Configurations - Files tab on page 11-361.
11.42 Debug Configurations - Debugger tab on page 11-364.
11.43 Debug Configurations - OS Awareness tab on page 11-367.
11.44 Debug Configurations - Arguments tab on page 11-368.
11.45 Debug Configurations - Environment tab on page 11-370.
11.50 Target management terminal for serial and SSH connections on page 11-377.
12.1 ARM Linux problems and solutions on page 12-392.
12.3 Target connection problems and solutions on page 12-394.

Related information

Debugging a loadable kernel module.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.7 Using *Fixed Virtual Platform* (FVP)s with DS-5

A *Fixed Virtual Platform* (FVP) is a software model of a development platform, including processors and peripherals.

FVPs are provided as executables, and some are included in DS-5.

Depending on your requirements, you can:

- *Configure a connection to an FVP model for bare-metal application debug.* on page 2-50
- *Configure a connection to an FVP model for Linux application debug.* on page 2-53
- *From the command-line, configure a connection to an FVP model for bare-metal application debug* on page 2-55.
- *Import your custom FVP model into DS-5.* on page 10-250

Note

ARM FVPs not provided with DS-5 installation must be defined in the `PATH` environment variable of your OS to be available for DS-5.

You must add the *`DS-5_install_directory`*`/bin` directory to your `PATH` environment variable and restart Eclipse.

- For Windows, enter `set PATH=<your model path>\bin;%PATH%`
- For Linux, enter `export PATH=<your model path>/bin:$PATH`

To ensure that the modified path is available in future sessions:

- For Windows, right-click **My Computer** > **Properties** > **Advanced system settings** > **Environment Variables** and under **User Variables**, create a `PATH` variable with the value `<your model path>\bin`, or else append `;<your model path>\bin` to any existing `PATH` variable.
- For Linux, set up the `PATH` in the appropriate shell configuration file. For example, in `.bashrc`, add the line `export PATH=<your model path>/bin:$PATH`

2.7.1 Configuring a connection to an external *Fixed Virtual Platform* (FVP) for bare-metal application debug

You can use DS-5 to connect to an external *Fixed Virtual Platform* (FVP) model for bare-metal debugging.

This topic explains how to:

- Create a debug configuration to connect to the Base_AEMv8A_AEMv8A FVP model and load your application on the model.
- Start up the Base_AEMv8A_AEMv8A FVP model separately with the appropriate settings.
- Start a debug session in DS-5 to connect and attach to the running Base_AEMv8A_AEMv8A FVP model.

Tip

- Configuring a connection to a built-in FVP model follows a similar sequence of steps. DS-5 launches built-in FVPs automatically when you start up a debug connection.
- FVPs installed with your edition of DS-5 are listed under the **ARM FVP (Installed with DS-5)** tree. To see which FVPs are available with your license, compare *DS-5 editions*.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Prerequisites

- The FVP model that you are connecting to must be available in the DS-5 configuration database so you can select it in the **Debug Configurations** dialog. If the FVP model is not available, *you must first import it* on page 10-250.
- To load and execute the application on your FVP model using DS-5, your application must first be built with the appropriate compiler and linker options so that it can run on your model. To locate the options and parameters required to build your application, check the documentation for your compiler and linker.
- You must have the appropriate licenses installed to run your FVP model from the command line.

Procedure

1. Create a debug configuration to connect to the Base_AEMv8A_AEMv8A FVP model:
   a. From the main menu, select **Run** > **Debug Configurations...**.
   b. In the configuration tree, select **DS-5 Debugger** and then click **New** to create a configuration.
   c. In the **Name** field, enter a suitable name for the new configuration, for example, `My_BareMetal_Model_Configuration`.
   d. In the **Connection** tab, in the **Select target** panel, browse and select **ARM FVP** > **Base_AEMv8A_AEMv8A** > **Bare Metal Debug** > **Debug ARMAEMv8-A-MP_0**.

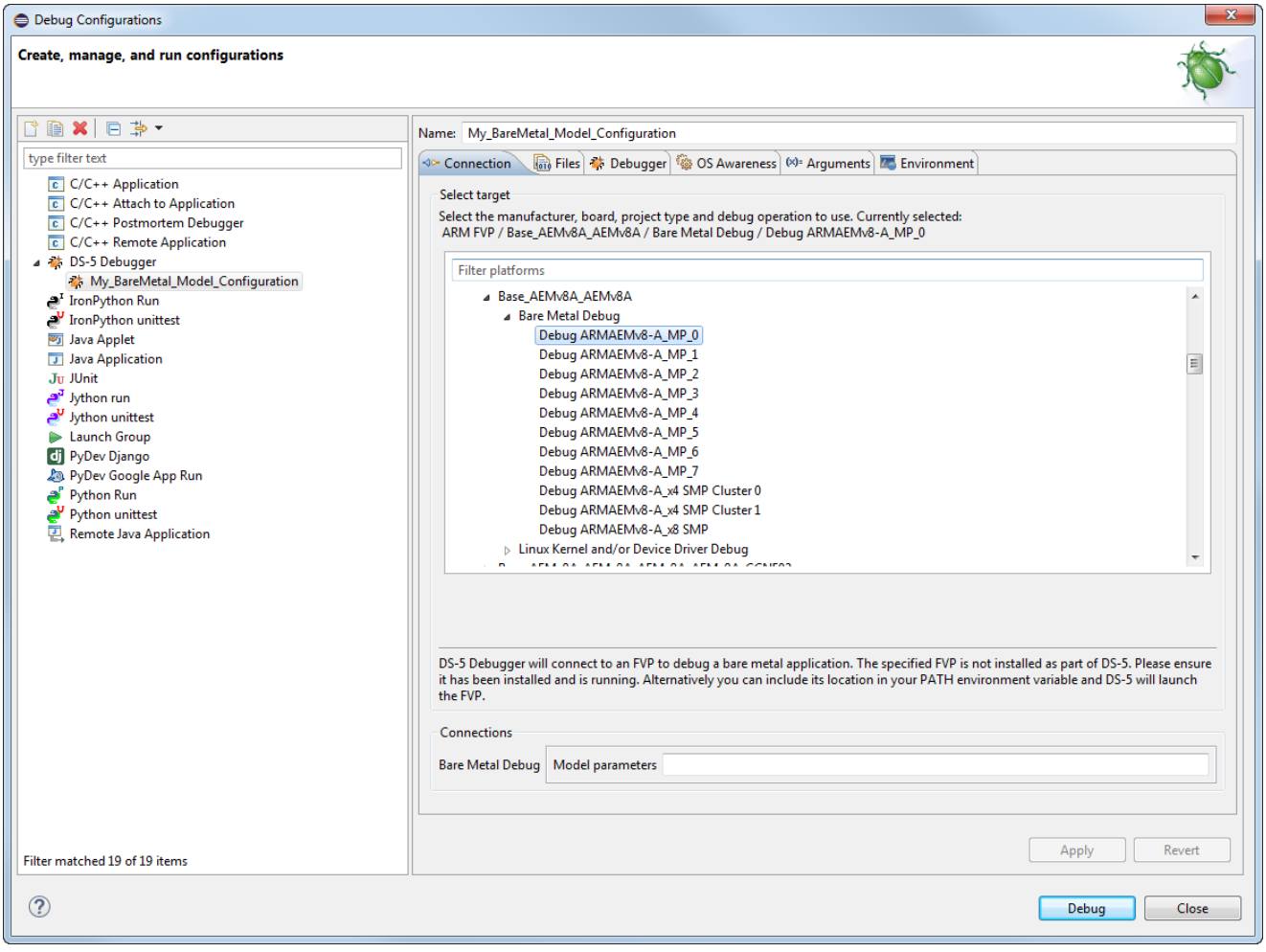


Figure 2-7 Debug Configurations - ARM FVP - Base_AEMv8A_AEMv8A

   e. In the **Files** tab, in **Target Configuration** > **Application on host to download**, specify the application that you want to load on the model.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

f. In the **Debugger** tab, specify the actions that you want the debugger to perform after connecting to the target.
g. If required, click the **OS Awareness** tab to select the appropriate operating system awareness when the debug session starts.
h. If required, click the **Arguments** tab to enter arguments that are passed to the application when the debug session starts.
i. If required, click the **Environment** tab to create and configure the target environment variables that are passed to the application when the debug session starts.
j. Click **Apply** and then **Close** to save the configuration settings and close the **Debug Configurations** dialog.
   You have now created a debug configuration to connect to to the Base_AEMv8A_AEMv8A target. You can view the debug configuration in the **Debug Control** view. The next step is to start up the Base_AEMv8A_AEMv8A model with the appropriate settings so that DS-5 can connect to it when you start your debugging session.

2. Open a terminal window and navigate to the installation directory of the Base_AEMv8A_AEMv8A model.
3. Start up the Base_AEMv8A_AEMv8A separately with the appropriate options and parameters.

   For example, to run the `FVP_Base_AEMv8A-AEMv8A.exe` FVP model on Windows platforms, at the command prompt enter:
   `FVP_Base_AEMv8A-AEMv8A.exe -S -C cluster0.NUM_CORES=0x1 -C bp.secure_memory=false -C cache_state_modelled=0`

   - `FVP_Base_AEMv8A-AEMv8A.exe` - The executable for the FVP model on Windows platforms.
   - `-S` or `--cadi-server` - Starts the CADI server so that DS-5 Debugger can connect to the FVP model.
   - `-C` or `--parameter` - Sets the parameter you want to use when running the FVP model.
   - `cluster0.NUM_CORES=0x1` - Specifies the number of cores to activate on the cluster in this instance.
   - `bp.secure_memory=false` - Sets the security state for memory access. In this example, memory access is disabled.
   - `cache_state_modelled=0` - Sets the core cache state. In this example, it is disabled.

   The required parameters and options depend on your individual requirements. Check the documentation for your FVP to locate the appropriate parameters.

   You can find the options and parameters that are used in this example in the *Fixed Virtual Platforms FVP Reference Guide*. You can also enter `--list-params` after the FVP executable name to print available platform parameters.

   The FVP is now running in the background awaiting incoming CADI connection requests from DS-5 debugger.
4. In the **Debug Control** view, double-click the debug configuration that you created.
   Debugging requires the **DS-5 Debug** perspective. If the **Confirm Perspective Switch** dialog box opens, click **Yes** to switch perspective. When connected and the **DS-5 Debug perspective** opens, you are presented with all the relevant views and editors.

   This starts the debug connection, loads the application on the model, and loads the debug information into the debugger.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

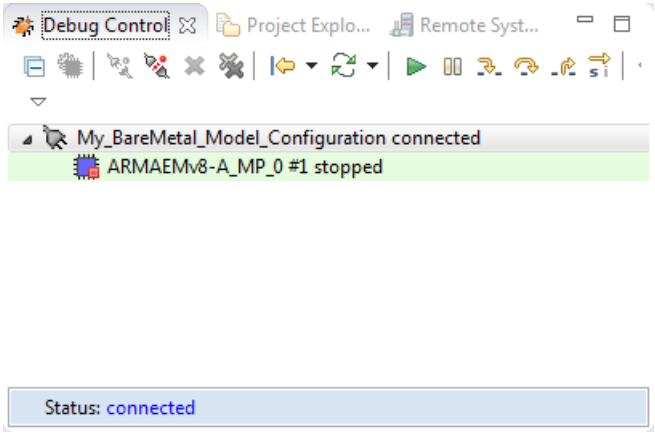


Figure 2-8 My_BareMetal_Model_Configuration - Debug Control view

Click ▶ to continue running your application.

2.7.2 Configuring a connection to a built-in *Fixed Virtual Platform* (FVP) model for Linux application debug

You can use DS-5 to connect to a *Fixed Virtual Platform* (FVP) model for Linux application debugging.

Using the **Debug Configurations** dialog box, you can configure DS-5 Debugger to either:

- Connect to a `gdbserver` and application already running on the FVP.
- Connect to the FVP, start `gdbserver`, and debug an application already present on the target.

Use the described options to configure a connection to the Cortex®-A9x1 FVP (preconfigured to boot ARM Embedded Linux) supplied with DS-5. Connecting to other FVPs available in the DS-5 configuration database follow a similar sequence of steps.

Tip

FVPs installed with your edition of DS-5 are listed under the **ARM FVP (Installed with DS-5)** tree. Compare *DS-5 editions* to see which FVPs are available with your license.

Procedure

1. From the main menu, select **Window** > **Run** > **Debug Configurations...**.
2. In the configuration tree, select **DS-5 Debugger** and then click **New** to create a new configuration.
3. In the **Name** field, enter a suitable name for the new configuration, for example, `Hello World`.
4. In the **Connection** tab, in the **Select target** panel, browse and select **ARM FVP (Installed with DS-5)** > **Cortex-A9x1 pre-configured to boot ARM Embedded Linux** > **Linux Application Debug**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

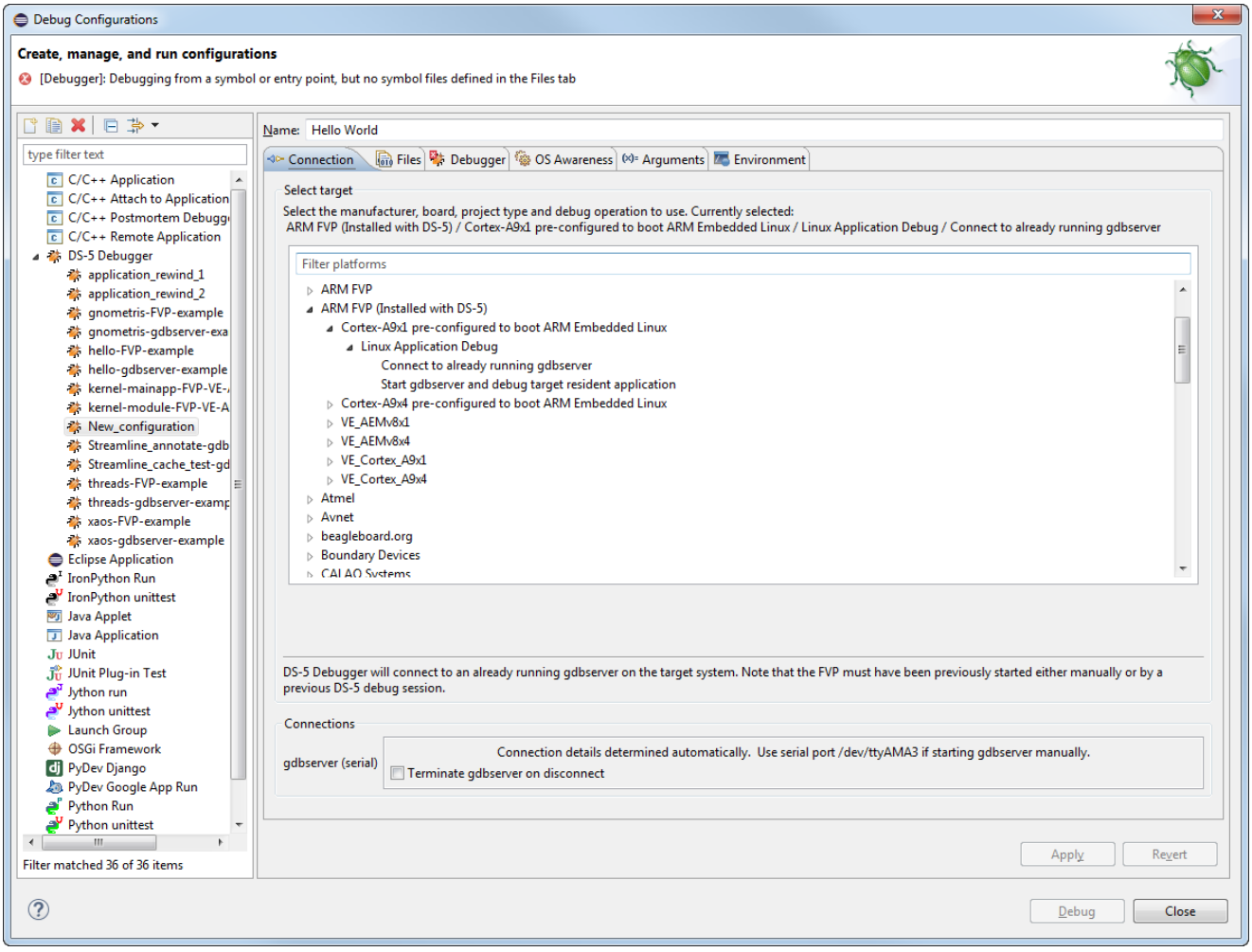


Figure 2-9 Debug Configurations - ARM FVP (Installed with DS-5)

- If you want to connect to a FVP with the application and `gdbserver` already running on it, select **Connect to already running gdbserver** and configure the options.

  Note

  To use this option, the FVP must already be started and Linux booted, either manually or by a previous DS-5 debug session.

  1. In the **Connections** area, under **gdbserver (serial)**, select **Terminate gdbserver on disconnect** if you want to terminate the `gdbserver` when disconnecting from the FVP.
  2. In the **Files** tab, use the **Load symbols from file** option in the **Files** panel to specify symbol files.
  3. In the **Debugger** tab, specify the actions that you want the debugger to perform after connecting to the target.
  4. If required, click on the **Arguments** tab to enter arguments that are passed to the application when the debug session starts.
  5. If required, click on the **Environment** tab to create and configure the target environment variables that are passed to the application when the debug session starts.
- If you want to connect to a FVP, start `gdbserver`, and debug an application already present on the target, select **Start gdbserver and debug target resident application**, and configure the options.
  1. In the **Model parameters** area, the **Enable virtual file system support** option maps directories on the host to a directory on the target. The Virtual File System (VFS) enables the FVP to run an application and related shared library files from a directory on the local host.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

— The **Enable virtual file system support** option is selected by default. Deselect the option if you do not want virtual file system support.
— If the **Enable virtual file system support** option is enabled, by default, your current workspace location is used as the directory on the host that will be seen by the target as the writable mount point. If you want to specify a different location, specify it here.

2. In the **Files** tab, specify the location of the **Application on target** and the **Target working directory**. If you need to load symbols, use the **Load symbols from file** option in the **Files** panel.
3. In the **Debugger** tab, specify the actions that you want the debugger to perform after connecting to the target.
4. If required, click on the **Arguments** tab to enter arguments that are passed to the application when the debug session starts.
5. If required, click on the **Environment** tab to create and configure the target environment variables that are passed to the application when the debug session starts.

5. Either click **Apply** to save the configuration settings or click **Debug** if you want to connect to the target and begin debugging immediately. Alternatively, click **Close** to close the **Debug Configurations** dialog box. Use the **Debug Control** view to connect to the target associated with this debug configuration.

Debugging requires the **DS-5 Debug** perspective. If the **Confirm Perspective Switch** dialog box opens, click **Yes** to switch perspective. When connected and the **DS-5 Debug perspective** opens, you are presented with all the relevant views and editors.

For more information on these options, press **F1** on your keyboard to display dynamic context help.

Related tasks

2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.
2.6 Configuring a connection to a Linux kernel on page 2-48.
2.3 Configuring a connection to a bare-metal hardware target on page 2-38.
2.9 Configuring an Events view connection to a bare-metal target on page 2-63.

Related references

11.40 Debug Configurations - Connection tab on page 11-358.
11.41 Debug Configurations - Files tab on page 11-361.
11.42 Debug Configurations - Debugger tab on page 11-364.
11.43 Debug Configurations - OS Awareness tab on page 11-367.
11.44 Debug Configurations - Arguments tab on page 11-368.
11.45 Debug Configurations - Environment tab on page 11-370.

Related information

Model Shell options for Fast Models.

2.7.3 Configuring a connection from the command-line to a built-in *Fixed Virtual Platform* (FVP)

You can configure a connection to a *Fixed Virtual Platform* (FVP) using the command-line only mode available in DS-5.

Using the command-line only mode, you can automate debug and trace activities. By automating a debug session, you can save significant time and avoid repetitive tasks such as stepping through code at source level.

This example shows you how to configure a connection to a built-in FVP model in DS-5.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Prerequisites

- The FVP model that you are connecting to must be available in the DS-5 configuration database so you can select it. If the FVP model is not available, you must first import it. See *10.12 Importing a custom model* on page 10-250 for information about importing a CADI-compliant model.
- To load and execute the application on your FVP model using DS-5, your application must first be built with the appropriate compiler and linker options so that it can run on your model. To locate the options and parameters required to build your application, check the documentation for your compiler and linker.
- You must have the appropriate licenses installed to run your FVP model from the command line.

Procedure

1. Open a DS-5command prompt:
   - On Windows, select **Start** > **All Programs** > **ARM DS-5** > **DS-5 Command Prompt**.
   - On Linux, add the `DS-5_install_directory/bin` location to your *PATH* environment variable and then open a UNIX bash shell.
2. To connect to the ARM FVP Cortex-A9x4 FVP model and specify an image to load from your workspace, at the command prompt, enter:

   ```
   debugger --cdb-entry "ARM FVP::VE_Cortex_A9x4::Bare Metal Debug::Bare Metal Debug::Debug
   Cortex-A9x4 SMP" --image "C:\DS-5_Workspace\HelloWorld\Debug\HelloWorld.axf"
   ```

   DS-5 starts the ARM FVP Cortex-A9x4 FVP and loads the image. When connected to your target, use any of the *DS-5 Debugger commands* to access the target and start debugging.

   For example, *info registers* displays all application level registers.

   See *Chapter 8 Running DS-5 Debugger from the operating system command-line or from a script* on page 8-202 for more information about how to use DS-5 Debugger from the operating system command-line or from a script.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.8 Configuring application rewind for Linux

Application rewind uses a custom debug agent, undodb-server, that records the execution of your application as it runs. Use the options available under **Application Debug with Rewind Support** in the **Debug Configurations** dialog to connect to Linux targets.

Note

- Application rewind does not follow forked processes.
- When debugging backwards, you can only view the contents of recorded memory, registers, or variables. You cannot edit or change them.
- Application rewind supports architecture ARMv5TE targets and later.

The connection options are:

- Connect to already running application.

  This option requires you to load your application and the application rewind server on your target and start the application rewind server manually before attempting a connection between DS-5 and your target.

  undodb-server is the custom debug agent used by application rewind. This option requires you to load your application and the application rewind server on your target manually. When a connection is established, DS-5 starts a new application rewind server session on your target to debug your application.
- Start undodb-server and debug target-resident application.

  undodb-server is the custom debug agent used by application rewind. This option requires you to load your application and the application rewind server on your target manually. When a connection is established, DS-5 starts a new application rewind server session on your target to debug your application.
- Download and debug application.

  When a connection is established using this option, DS-5 downloads your application and the application rewind server on to the target system, and starts a new application rewind server session to debug your application.

Note

Application rewind custom debug agent implements a buffer on the target to store history for recorded executions. The default is a straight buffer, which records events until the buffer limit is reached, and then stops the execution. At this point, you can either increase the size of the buffer or change the buffer to be circular. When using a circular buffer, once the limit of the circular buffer is reached, instead of stopping execution, the data wraps around and overwrites old content. A circular buffer ensures that execution does not stop when the buffer limit is reached, but you lose the execution history beyond the point where data wrapped around.

- To change buffer limits, use the command `set debug-agent history-buffer-size "size"`

  Where `size` specifies the amount of memory. You can specify the value in kilobytes (`K`), megabytes (`M`), or gigabytes (`G`).

  For example, `set debug-agent history-buffer-size "256.00 M"`.

  Since the buffer is implemented in the target RAM, increasing the buffer size can also hinder performance by affecting memory usage. For this reason, when increasing the buffer size, set the buffer to a value that also provides maximum performance.
- To change buffer type, use the command `set debug-agent history-buffer-type "type"`

  Where `type` specifies the type of buffer, which is either `straight` or `circular`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

For example, `set debug-agent history-buffer-type "circular"`.

2.8.1 Connecting to an existing application and starting an application rewind session

Use the **Connect to already running application** option to set up a connection to an existing application rewind server session on your target.

Prerequisites

Before connecting to an existing application rewind server session, you must:

- Set up the target with an *Operating System* (OS) installed and booted. See the documentation supplied with the target for more information.
- Ensure that the *`undodb-server`* file found in the *`DS-5_install_directory`*`\arm\undodb\linux` folder is copied to your target.
- Ensure that the application that you want to debug is copied to the target.
- Ensure that the application rewind server session is running and connected to your application.

Note

To run the application rewind server and the application on the target, use:

`undodb-server --connect-port port path/myApplication`

Where:

`port` is a TCP/IP port number of your choice that is used by application rewind server to communicate with DS-5 Debugger.

`path/myApplication` is the application that you want to debug.

Procedure

1. From the main menu, select **Window** > **Open Perspective** > **Other** > **DS-5 Debug** to switch to the **DS-5 Debug** perspective.
2. From the **Run** menu, select **Debug Configurations...**.
3. Select **DS-5 Debugger** from the configuration tree and then click **New launch configuration** to create a new configuration.
4. In the **Name** field, enter a suitable name for the new configuration.
5. Select the **Connection** tab to configure the target connection:
   a. In the **Select target** panel, select **Linux Application Debug** > **Application Debug with Rewind Support** > **Connections via undodb-server** > **Connect to already running application**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

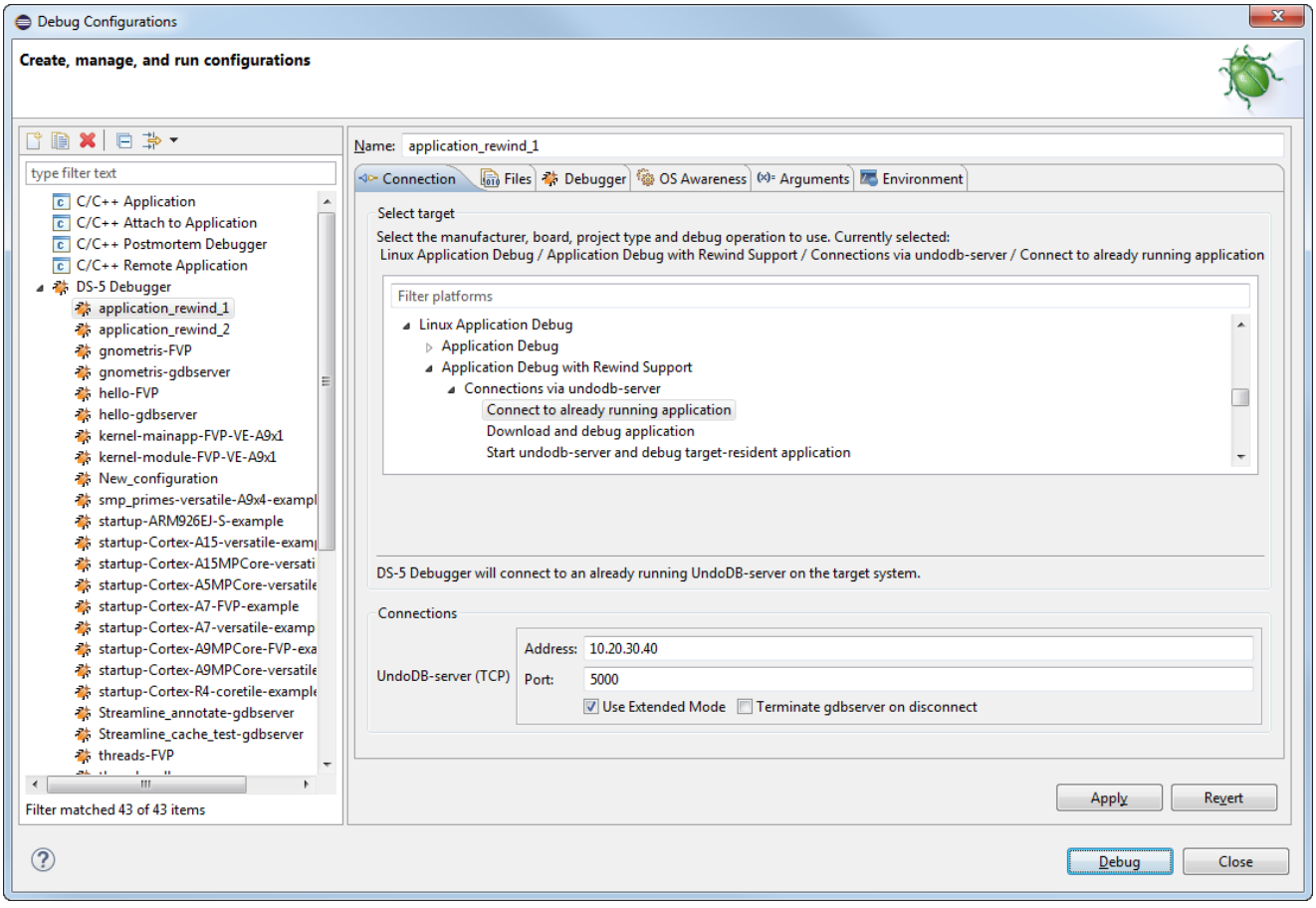


Figure 2-10 Application Debug with Rewind Support - Connect to already running application

   b. Enter the **Address** of the connection you want to connect to.
   c. Enter the **UndoDB-server (TCP) Port** that you want to connect to.

6. Select the **Files** tab and in the **Files** panel, select the files on the host that you want the debugger to use to load the debug information from. If required, you can also specify other files on the host that you want to download to the target.
7. Select the **Debugger** tab to configure the debugger settings.
   a. In the **Run control** panel, specify the actions that you want the debugger to perform after connecting to the target.
   b. In the **Host working directory** panel, configure the host working directory or use the default.
   c. In the **Paths** panel, specify any source or library search directories on the host that the debugger uses when it displays source code.
8. Click **Apply** to save the configuration settings.
9. Click **Debug** to connect to the target.

When connected, you are presented with all the relevant views and editors.

For more information on these options, press **F1** on your keyboard to display dynamic context help.

Related concepts

1.5 Overview: Linux application rewind on page 1-28.

Related references

11.40 Debug Configurations - Connection tab on page 11-358.
11.41 Debug Configurations - Files tab on page 11-361.
11.42 Debug Configurations - Debugger tab on page 11-364.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.43 Debug Configurations - OS Awareness tab on page 11-367.
11.44 Debug Configurations - Arguments tab on page 11-368.
11.45 Debug Configurations - Environment tab on page 11-370.
2.1 Overview: Debug connections in DS-5 Debugger on page 2-34.

2.8.2 Downloading your application and application rewind server to the target system

Use the **Download and debug application** option to download your application and application rewind server to the target system and start a new application rewind session.

Prerequisites

Before connecting, you must:

- Set up the target with an *Operating System* (OS) installed and booted. See the documentation supplied with the target for more information.
- Obtain the IP address or name of the target.
- Set up a *Remote Systems Explorer* (RSE) connection to the target.

Procedure

1. From the main menu, select **Window** > **Open Perspective** > **Other** > **DS-5 Debug** to switch to the **DS-5 Debug** perspective.
2. From the **Run** menu, select **Debug Configurations...**.
3. Select **DS-5 Debugger** from the configuration tree and then click **New launch configuration** to create a new configuration.
4. In the **Name** field, enter a suitable name for the new configuration.
5. Select the **Connection** tab to configure the target connection:
   a. In the **Select target** panel, select **Linux Application Debug** > **Application Debug with Rewind Support** > **Connections via undodb-server** > **Download and debug application**.
   b. Select your **RSE connection** from the list.
   c. Accept the default values for the **UndoDB-server (TCP) Port**.
6. Select the **Files** tab to define the application file and libraries.
   a. In the **Target Configuration** panel, select the application on the host that you want to download to the target and specify the location on the target where you want to store the selected file.
   b. In the **Files** panel, select the files on the host that you want the debugger to use to load the debug information. If required, you can also specify other files on the host that you want to download to the target.

   Note

   Options in the **Files** tab are dependent on the type of debug operation that you select.

7. Select the **Debugger** tab to configure the debugger settings.
   a. In the **Run control** panel, specify the actions that you want the debugger to perform after connecting to the target.
   b. In the **Host working directory** panel, configure the host working directory or use the default.
   c. In the **Paths** panel, specify any source or library search directories on the host that the debugger uses when it displays source code.
8. If required, use the **Arguments** tab to enter arguments that are passed to the application when the debug session starts.
9. If required, use the **Environment** tab to create and configure the target environment variables that are passed to the application when the debug session starts.
10. Click **Apply** to save the configuration settings.
11. Click **Debug** to connect to the target.

When connected, you are presented with all the relevant views and editors.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

For more information on these options, press **F1** on your keyboard to display dynamic context help.

Related concepts

1.5 Overview: Linux application rewind on page 1-28.

Related references

11.40 Debug Configurations - Connection tab on page 11-358.
11.41 Debug Configurations - Files tab on page 11-361.
11.42 Debug Configurations - Debugger tab on page 11-364.
11.43 Debug Configurations - OS Awareness tab on page 11-367.
11.44 Debug Configurations - Arguments tab on page 11-368.
11.45 Debug Configurations - Environment tab on page 11-370.
2.1 Overview: Debug connections in DS-5 Debugger on page 2-34.

2.8.3 Starting the application rewind server and debugging the target-resident application

Use the **Start undodb-server and debug target-resident application** option to start the application rewind server on the target system and debug an existing application.

Prerequisites

Before connecting, you must:

- Set up the target with an *Operating System* (OS) installed and booted. See the documentation supplied with the target for more information.
- Obtain the IP address or name of the target.
- Set up a *Remote Systems Explorer* (RSE) connection to the target.
- Ensure that the application rewind server is available on your target and is added to your `PATH` environment variable.
- Ensure that the application you want to debug is available on the target.

Procedure

1. From the main menu, select **Window** > **Open Perspective** > **Other** > **DS-5 Debug** to switch to the **DS-5 debug** perspective.
2. From the **Run** menu, select **Debug Configurations...**.
3. Select **DS-5 Debugger** from the configuration tree and then click **New launch configuration** to create a new configuration.
4. In the Name field, enter a suitable name for the new configuration.
5. Select the **Connection** tab to configure the target connection:
   a. In the Select target panel, select **Linux Application Debug** > **Application Debug with Rewind Support** > **Connections via undodb-server** > **Start undodb-server and debug target-resident application**.
   b. Select your **RSE connection** from the list.
   c. Accept the default values for the **UndoDB-server (TCP)** Port.
6. Select the **Files** tab to define the location of the Application on target, Target working directory, and additional Files.
   a. In the Target Configuration panel, enter the location of the Application on target and the Target working directory.
   b. In the Files panel, enter or select the location of the files on the target that you want the debugger to use to load additional debug information. If required, you can also specify other files on the host that you want to download to the target.

   Note

   Options in the **Files** tab are dependent on the type of debug operation that you select.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7. Select the **Debugger** tab to configure the debugger settings.
   a. In the Run control panel, specify the actions that you want the debugger to perform after connecting to the target.
   b. In the Host working directory panel, configure the host working directory or use the default.
   c. In the Paths panel, specify any source or library search directories on the host that the debugger uses when it displays source code.
8. If required, use the **Arguments** tab to enter arguments that are passed to the application when the debug session starts.
9. If required, use the **Environment** tab to create and configure the target environment variables that are passed to the application when the debug session starts.
10. Click **Apply** to save the configuration settings.
11. Click **Debug** to connect to the target.

When connected, you are presented with all the relevant views and editors.

For more information on these options, press **F1** on your keyboard to display dynamic context help.

Related concepts

1.5 Overview: Linux application rewind on page 1-28.

Related references

11.40 Debug Configurations - Connection tab on page 11-358.
11.41 Debug Configurations - Files tab on page 11-361.
11.42 Debug Configurations - Debugger tab on page 11-364.
11.43 Debug Configurations - OS Awareness tab on page 11-367.
11.44 Debug Configurations - Arguments tab on page 11-368.
11.45 Debug Configurations - Environment tab on page 11-370.
2.1 Overview: Debug connections in DS-5 Debugger on page 2-34.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.9 Configuring an Events view connection to a bare-metal target

The **Events** view allows you to capture and view textual logging information from bare-metal applications. It also allows you to view packets generated by the *Data Watchpoint and Trace (DWT)* unit on M-profile targets. Logging is captured from your application using annotations that you must add to the source code.

Prerequisites

Before connecting, you must ensure that you:

- Have the IP address or name of the target. If using a local connection, you can click **Browse** and select the target.
- On M-profile targets, set registers appropriately to enable the required *DWT* packets. See the *ARMv7-M Architecture Reference Manual* for more information.
- Annotate your application source code with logging points and recompile it. See the *ITM and Event Viewer Example for Versatile Express Cortex-A9x4* provided with DS-5 examples for more information.

Procedure

1. Select **Window** > **Open Perspective** > **DS-5 Debug** from the main menu.
2. Select **Debug Configurations...** from the **Run** menu.
3. Select **DS-5 Debugger** from the configuration tree and then click **New** to create a new configuration.
4. In the **Name** field, enter a suitable name for the new configuration.
5. Click the **Connection** tab to configure a DS-5 Debugger target connection:
   a. Select the required platform. For example, **ARM Development Boards** > **Versatile Express A9x4** > **Bare Metal Debug** > **Debug Cortex-A9x4 SMP**.
   b. In **Target Connection**, select the target connection type, for example, **DSTREAM**.
   c. In **DTSL Options**, click **Edit** to configure DSTREAM trace and other target options. In the **DTSL Configuration Editor** dialog box which opens:
      - In the **Trace Capture** tab, either select **On Chip Trace Buffer (ETB)** (for a JTAG cable connection) or **DSTREAM 4GB Trace Buffer** (for a Mictor cable connection).
      - In the **ITM** tab, enable or disable ITM trace and select the additional required settings.
6. Click the **Files** tab to define the target environment and select debug versions of the application file and libraries on the host that you want the debugger to use.
   a. In the **Target Configuration** panel, select the application on the host that you want to download to the target.
7. Click the **Debugger** tab to configure the debugger settings.
   a. In the **Run control** panel, specify the actions that you want the debugger to do after connecting to the target.
   b. Configure the host working directory or use the default.
   c. In the **Paths** panel, specify any source search directories on the host that the debugger uses when it displays source code.
8. If required, click the **Arguments** tab to enter arguments that are passed, using semihosting, to the application when the debug session starts.
9. Click **Apply** to save the configuration settings.
10. Click **Debug** to connect to the target. Debugging requires the **DS-5 Debug** perspective. If the **Confirm Perspective Switch** dialog box opens, click **Yes** to switch perspective.
    When connected and the **DS-5 Debug** perspective opens, you are presented with all the relevant views and editors.
11. Click the **Events** view to set up event options.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

a. In the **Events** view, from the **View** menu, select **Events Settings**.
b. In **Select a Trace Source**, ensure that the trace source matches the trace capture method specified earlier.
c. Select the required **Ports/Channels**.
d. On M-profile targets, if required, select any *DWT* packets.
e. Click **OK**.

12. Run the application for a few seconds, and then interrupt it.

You can view the relevant information in the **Events** view. For example:

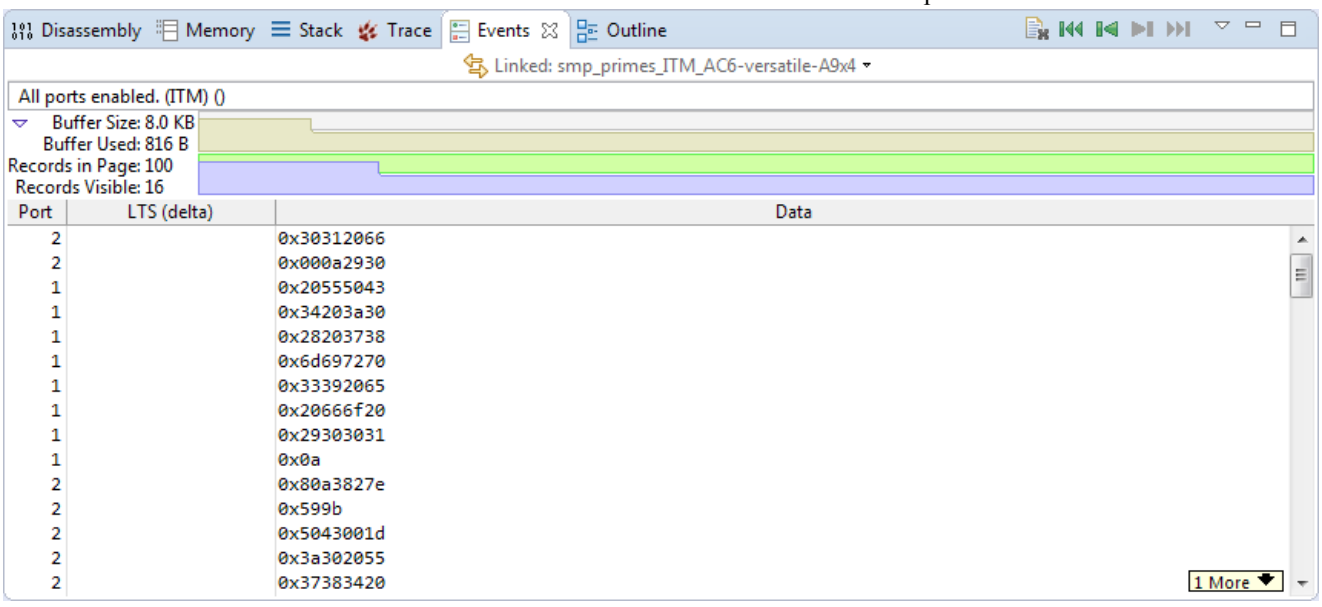


Figure 2-11 Events view with data from the ITM source

For more information on these options, press **F1** on your keyboard to display dynamic context help.

Related tasks

2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.

2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.

2.6 Configuring a connection to a Linux kernel on page 2-48.

2.3 Configuring a connection to a bare-metal hardware target on page 2-38.

Related references

11.40 Debug Configurations - Connection tab on page 11-358.

11.41 Debug Configurations - Files tab on page 11-361.

11.42 Debug Configurations - Debugger tab on page 11-364.

11.43 Debug Configurations - OS Awareness tab on page 11-367.

11.44 Debug Configurations - Arguments tab on page 11-368.

11.45 Debug Configurations - Environment tab on page 11-370.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.10 Exporting or importing an existing launch configuration

In Eclipse, a launch configuration contains all the information to run or debug a program. A DS-5 debug launch configuration typically describes the target to connect to, the communication protocol or probe to use, the application to load on the target, and debug information to load in the debugger.

Exporting an existing launch configuration

1. From the **File** menu, select **Export...**.
2. In the **Export** dialog box, expand the **Run/Debug** group and select **Launch Configurations**.

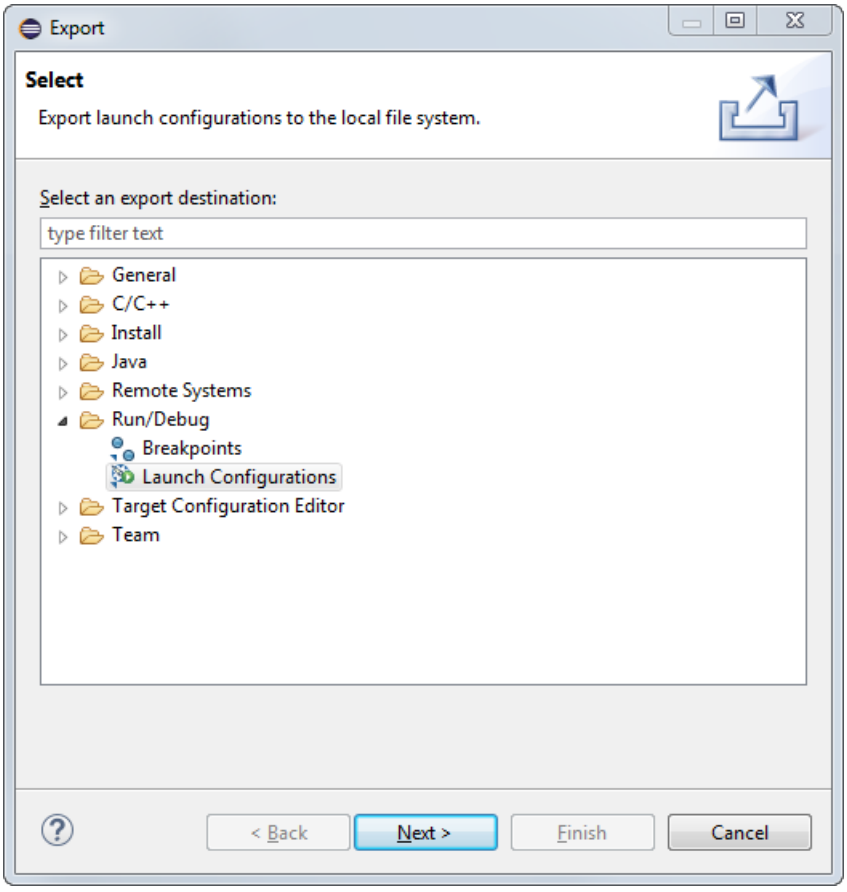


Figure 2-12 Export launch configuration dialog box

3. Click **Next**.
4. In the **Export Launch Configurations** dialog box:
   a. Expand the **DS-5 Debugger** group and then select one or more launch configurations.
   b. Click **Browse...** and select the required location on your local file system and click **OK**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

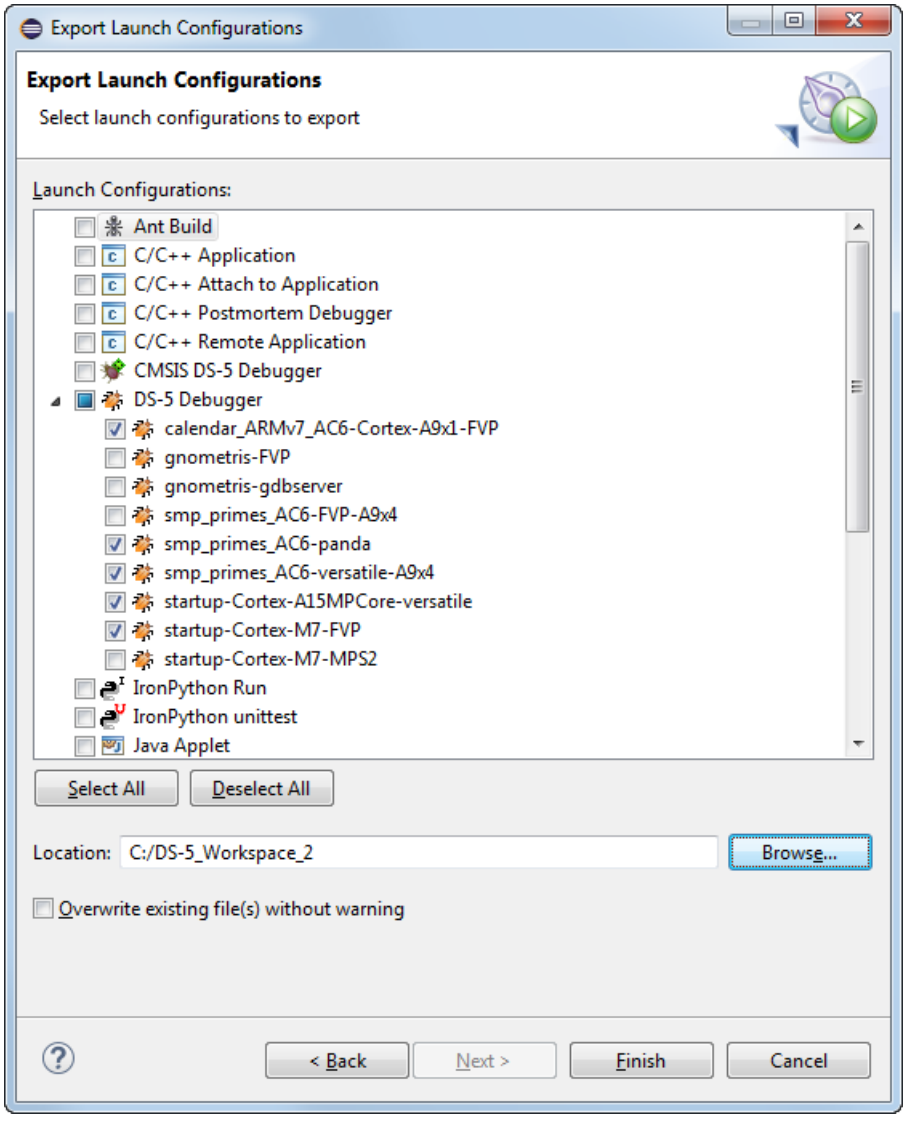


Figure 2-13 Launch configuration selection panels

5. If necessary, select **Overwrite existing file(s) without warning**.
6. Click **Finish**.

The launch configuration files are saved in your selected location with an extension of `.launch`.

Importing an existing launch configuration

1. From the **File** menu, select **Import...**.
2. In the **Import** dialog box, expand the **Run/Debug** group and select **Launch Configurations**.
3. Click **Next**.
4. In the **Import Launch Configurations** dialog box:
   a. In **From Directory**, **Browse** and select an import directory.
   b. In the selection panels, select the folder and the specific launch configurations you want.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

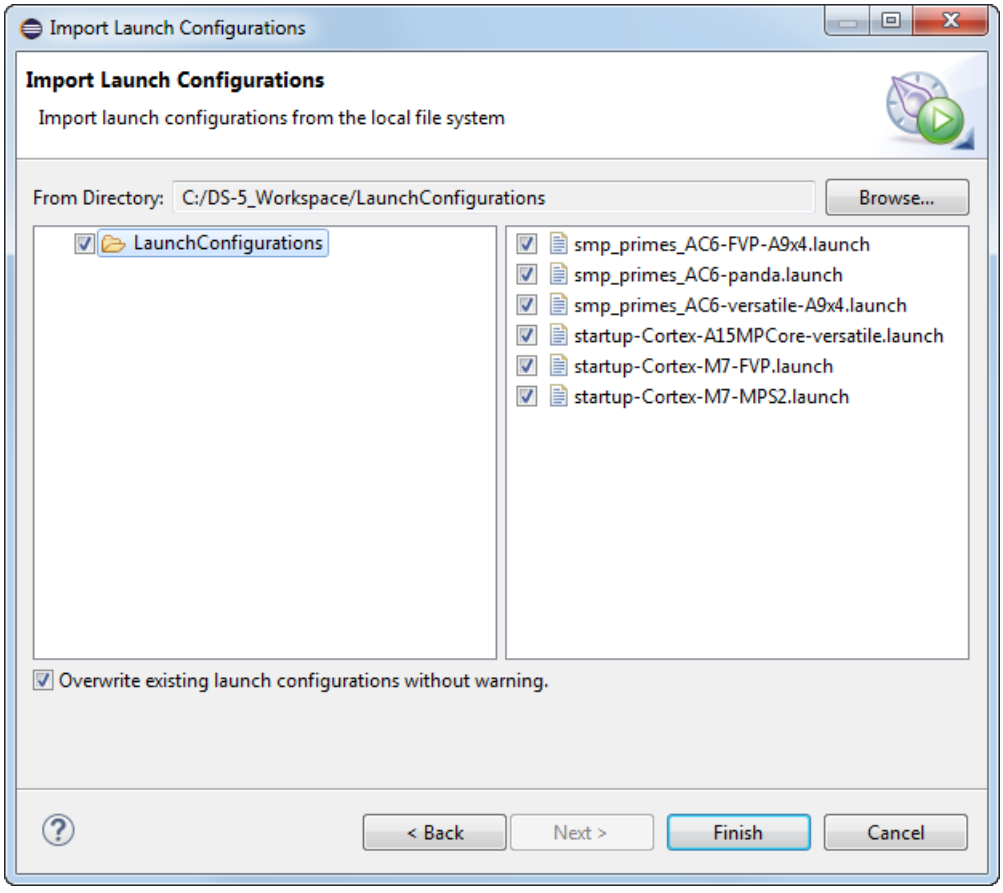


Figure 2-14 Launch configuration file selection panels

c. If necessary, select **Overwrite existing file(s) without warning**.
d. Click **Finish** to complete the import process.

You can view the launch configurations in the **Debug Control** panel.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

2.11 Disconnecting from a target

You can use either the **Debug Control** or **Commands** view to disconnect from a target.

- If using the **Debug Control** view, click on the **Disconnect from Target** toolbar icon in the **Debug Control** view.

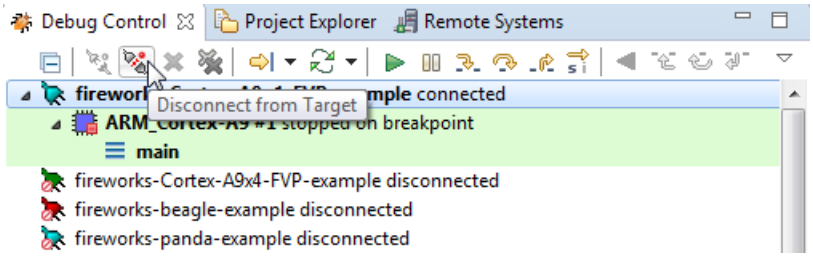


Figure 2-15 Disconnecting from a target

- If using the **Commands** view, enter `quit` in the **Command** field and click **Submit**.

Related references

11.6 Commands view on page 11-275.
11.57 DS-5 Debugger menu and toolbar icons on page 11-388.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 3
Controlling Target Execution

Describes how to control the target when certain events occur or when certain conditions are met.

It contains the following sections:

- *3.1 Overview: Breakpoints and Watchpoints* on page 3-70.
- *3.2 Running, stopping, and stepping through an application* on page 3-72.
- *3.3 Working with breakpoints* on page 3-74.
- *3.4 Working with watchpoints* on page 3-75.
- *3.5 Importing and exporting breakpoints and watchpoints* on page 3-77.
- *3.6 Viewing the properties of a breakpoint or a watchpoint* on page 3-78.
- *3.7 Associating debug scripts to breakpoints* on page 3-80.
- *3.8 Conditional breakpoints* on page 3-81.
- *3.9 Assigning conditions to an existing breakpoint* on page 3-82.
- *3.10 Conditional watchpoints* on page 3-84.
- *3.11 Assigning conditions to an existing watchpoint* on page 3-85.
- *3.12 Pending breakpoints and watchpoints* on page 3-87.
- *3.13 Setting a tracepoint* on page 3-89.
- *3.14 Handling UNIX signals* on page 3-90.
- *3.15 Handling processor exceptions* on page 3-92.
- *3.16 Cross-trigger configuration* on page 3-94.
- *3.17 Using semihosting to access resources on the host computer* on page 3-95.
- *3.18 Working with semihosting* on page 3-97.
- *3.19 Configuring the debugger path substitution rules* on page 3-99.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.1 Overview: Breakpoints and Watchpoints

Breakpoints and watchpoints enable you to stop the target when certain events occur and when certain conditions are met. When execution stops, you can choose to examine the contents of memory, registers, or variables, or you can specify other actions to take before resuming execution.

Breakpoints

A breakpoint enables you to interrupt your application when execution reaches a specific address. When execution reaches the breakpoint, normal execution stops before any instruction stored there is executed.

Types of breakpoints:

- Software breakpoints stop your program when execution reaches a specific address.

  Software breakpoints are implemented by the debugger replacing the instruction at the breakpoint address with a special instruction. Software breakpoints can only be set in RAM.
- Hardware breakpoints use special processor hardware to interrupt application execution. Hardware breakpoints are a limited resource.

You can configure breakpoint properties to make them:

- Conditional

  Conditional breakpoints trigger when an expression evaluates to true or when an ignore counter is reached. See *Conditional breakpoints* on page 3-81 for more information.
- Temporary

  Temporary breakpoints can be hit only once and are automatically deleted afterwards.
- Scripted

  A script file is assigned to a specific breakpoint. When the breakpoint is triggered, then the script assigned to it is executed.

Note

- Memory region and the related access attributes.
- Hardware support provided by your target processor.
- Debug interface used to maintain the target connection.
- Running state if you are debugging an OS-aware application.

The **Target** view shows the breakpoint capabilities of the target.

Considerations when setting breakpoints

Be aware of the following when setting breakpoints:

- The number of hardware breakpoints available depends on your processor. Also, there is a dependency between the number of hardware breakpoints and watchpoints because they use the same processor hardware.
- If an image is compiled with a high optimization level or contains C++ templates, then the effect of setting a breakpoint in the source code depends on where you set the breakpoint. For example, if you set a breakpoint on an inlined function in a C++ template, then a breakpoint is created for each instance of that function or template. Therefore the target can run out of breakpoint resources.
- Enabling a *Memory Management Unit* (MMU) might set a memory region to read-only. If that memory region contains a software breakpoint, then that software breakpoint cannot be removed. Therefore, make sure you clear software breakpoints before enabling the MMU.
- When debugging an application that uses shared objects, breakpoints that are set within a shared object are re-evaluated when the shared object is unloaded. Those with addresses that can be resolved are set and the others remain pending.
- If a breakpoint is set by function name, then only inline instances that have been already *demand loaded* on page 16-499 are found.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Watchpoints

A watchpoint is similar to a breakpoint, but it is the address of a data access that is monitored rather than an instruction being executed. You specify a global variable or a memory address to monitor. Watchpoints are sometimes known as data breakpoints, emphasizing that they are data dependent. Execution of your application stops when the address being monitored is accessed by your application. You can set read, write, or read/write watchpoints.

Considerations when setting watchpoints

Be aware of the following when setting watchpoints:

- Depending on the target, it is possible that a few additional instructions, after the instruction that accessed the variable, might also be executed. This is because of pipelining effects in the processor. This means that the address that your program stops at might not exactly correspond with the instruction that caused the watchpoint to trigger.
- Watchpoints are only supported on scalar values.
- Watchpoints are only supported on global or static data symbols because they are always in scope and at the same address. Local variables are no longer available when you step out of a particular function.
- The number of watchpoints that can be set at the same time depends on the target and the debug connection being used.
- Some targets do not support watchpoints.

Related tasks

3.3 Working with breakpoints on page 3-74.
3.4 Working with watchpoints on page 3-75.

Related references

3.8 Conditional breakpoints on page 3-81.
3.12 Pending breakpoints and watchpoints on page 3-87.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.2 Running, stopping, and stepping through an application

DS-5 Debugger enables you to control the execution of your application by sequentially running, stopping, and stepping at the source or instruction level.

Once you have connected to your target, you can use the options on the stepping toolbar in the **Debug Control** view to run, interrupt, and step through the application. See ***Debug Control*** on page 11-278 for more information.

You can also use the **Commands** view to enter the *execution control* group of commands to control application execution.

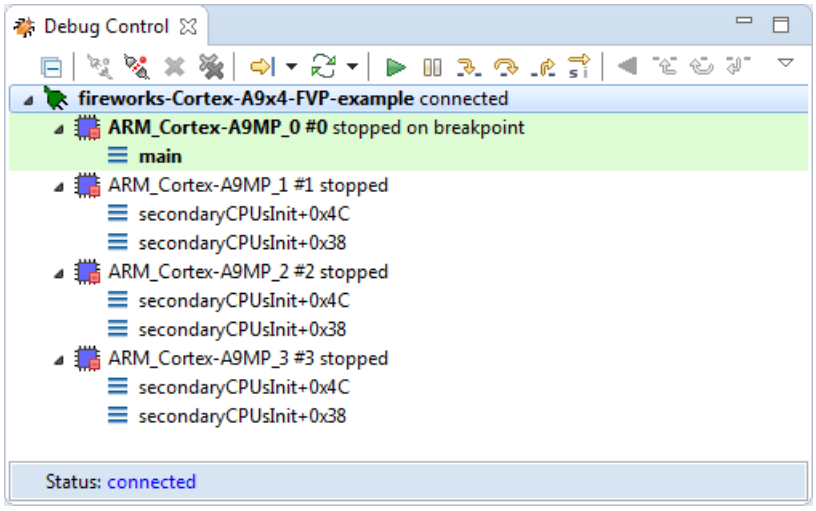


Figure 3-1 Debug Control view

Note

- You must compile your code with debug information to use the source level stepping commands. By default, source level calls to functions with no debug information are stepped over. Use the `set step-mode` command to change this default setting.
- Be aware that when stepping at the source level, the debugger uses temporary breakpoints to stop execution at the specified location. These temporary breakpoints might require the use of hardware breakpoints, especially when stepping through code in ROM or Flash. If the available hardware breakpoint resources are not enough, then the debugger displays an error message.
- Stepping on multicore targets are dependent on SMP/AMP and debugger settings. See *Overview: Debugging multi-core (SMP and AMP), big.LITTLE, and multi-cluster targets* for more information.

There are several ways to step through an application. You can choose to step:

- Source level or instruction level.

  In source level debugging, you step through one line or expression in your source code. For instruction level debugging, you step through one machine instruction. Use the button on the toolbar to switch between source and instruction level debugging modes.
- Into, over, or out of all function calls.

  If your source is compiled with debug information, using the *execution control* group of commands, you can step into, step through, or step out of functions.
- Through multiple statements in a single line of source code, for example a `for` loop.

Toolbar options

- Click to start or resume execution.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

- Click to pause execution.

- Click to step through the code.

- Click to step over code.

- Click to continue running to the next line of code after the selected stack frame finishes.

- Click to change the stepping mode between source line and instruction.

Application rewind-specific options:

- Click to continue running backwards through the code.

- Click to step backwards through the code.

- Click to step backwards over a line of code.

- Click to continue running to the next line of code backwards after the selected stack frame finishes.

Example 3-1 Stepping commands example

To step a specified number of times you must use the **Commands** view to manually execute one of the stepping commands with a number.

For example:

```
steps 5                          # Execute five source statements
stepi 5                          # Execute five instructions
```

See ***Commands** view* on page 11-275 for more information.

Related concepts

6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.

Related references

5.1 Examining the target execution environment on page 5-136.
5.2 Examining the call stack on page 5-137.
3.14 Handling UNIX signals on page 3-90.
3.15 Handling processor exceptions on page 3-92.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.3 Working with breakpoints

The debugger allows you to set software or hardware breakpoints depending on the type of memory available on your target.

Procedure

- To set a breakpoint, double-click in the left-hand marker bar of the C/C++ editor or the **Disassembly** view at the position where you want to set the breakpoint. See ***Disassembly** view* on page 11-285 for more information.
- To temporarily disable a breakpoint, in the **Breakpoints** view, select the breakpoint you want to disable, and either clear the check-box or right-click and select **Disable breakpoints**. To enable the breakpoint, either select the check-box or right-click and select **Enable breakpoints**. See ***Breakpoints** view* on page 11-268 for more information.
- To delete a breakpoint, double-click on the breakpoint marker or right-click on the breakpoint and select **Toggle Breakpoint**.

The following figure shows how breakpoints are displayed in the C/C++ editor, the **Disassembly** view, and the **Breakpoints** view.

Additionally, you can view all breakpoints in your application in the **Breakpoints** view.

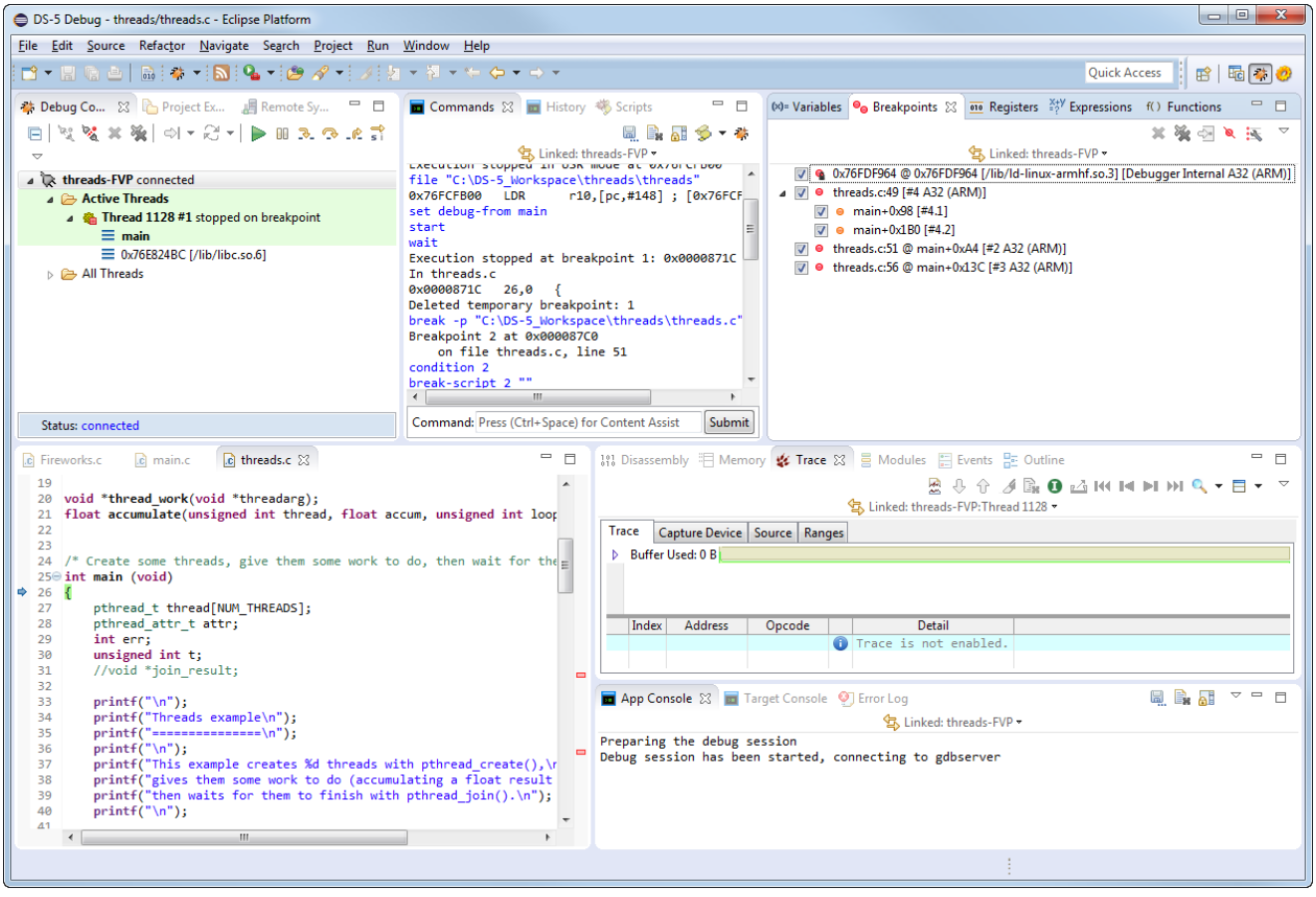


Figure 3-2 Viewing breakpoints

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.4 Working with watchpoints

Watchpoints can be used to stop your target when a specific memory address is accessed by your program.

Procedure

1. To set a watchpoint:
   - If monitoring a global variable, in the **Variables** view, right-click on a data symbol and select **Toggle Watchpoint** to display the **Add Watchpoint** dialog.
   - If monitoring a memory address, in the **Disassembly** view, right-click on a memory address and select **Toggle Watchpoint** to display the **Add Watchpoint** dialog.

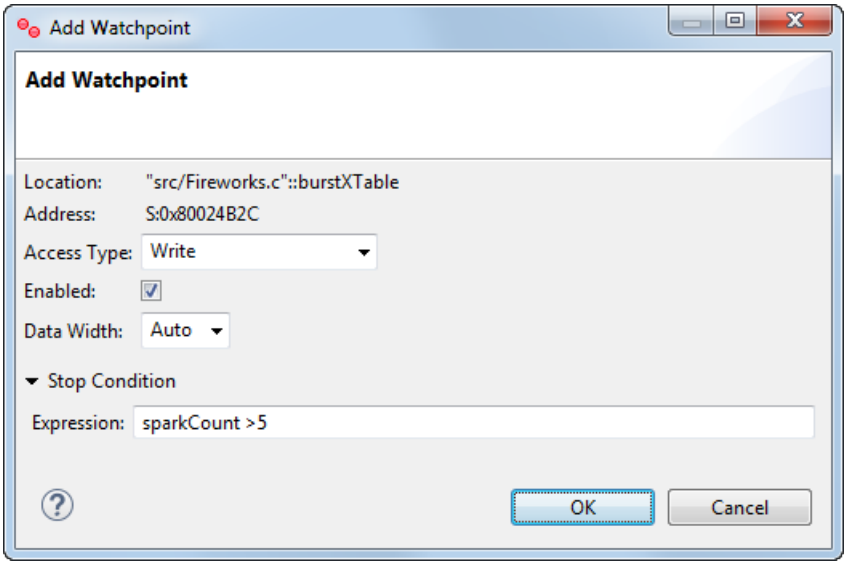


Figure 3-3 Setting a data watchpoint on a data symbol

2. Select the required **Access Type**.

   You can choose:
   - **Read** - To stop the target when a read access occurs.
   - **Write** - To stop the target when a write access occurs.
   - **Access** - To stop the target when either a read or write access occurs.
3. If you want to enable the watchpoint when it is created, select **Enable**.

   Note

   The default is enabled, but if a conditional watchpoint exists, the watchpoint is created disabled. Only one watchpoint can be enabled if a conditional watchpoint exists.

4. Specify the width to watch at the given address, in bits. Accepted values are: 8, 16, 32, and 64 if supported by the target.

   This parameter is optional. The width defaults to:
   - 32 bits for an address.
   - The width corresponding to the type of the symbol or expression, if entered.
5. Expand **Stop Condition** and in the **Expression** field, enter a C-style expression. For example, if your application code has a variable `x`, then you can specify: `x == 10`. If no expression is specified, then the breakpoint or watchpoint condition is deleted.
6. Click **OK** to apply your selection.

   If you created a watchpoint to monitor a global variable, you can view it in the **Variables** view. If you created a watchpoint to monitor a memory address, you can view it in the **Memory** view.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Also, you can view all watchpoints and breakpoints in your application in the **Breakpoints** view.

- To delete a watchpoint, right-click a watchpoint and either select **Remove Watchpoint** or select **Toggle Watchpoint**.
- To disable a watchpoint, right-click a watchpoint and select **Disable Watchpoint** to temporarily disable it. To re-enable it, select **Enable Watchpoint**.

Related tasks

3.11 Assigning conditions to an existing watchpoint on page 3-85.

Related references

11.35 Watchpoint Properties dialog box on page 11-352.

Related information

DS-5 Debugger command: awatch.

DS-5 Debugger command: rwatch.

DS-5 Debugger command: watch.

DS-5 Debugger command: watch.

DS-5 Debugger command: watch-set-property.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.5 Importing and exporting breakpoints and watchpoints

You can import and export DS-5 breakpoints and watchpoints from within the **Breakpoints** view. This makes it possible to reuse your current breakpoints and watchpoints in a different workspace.

To import or export breakpoints and watchpoints to a settings file, use the options in the **Breakpoints** view menu.

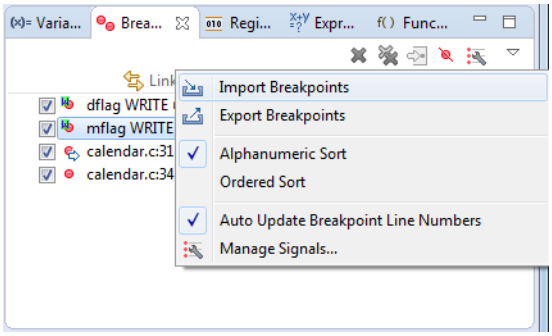


Figure 3-4 Import and export breakpoints and watchpoints

Note

- All breakpoints and watchpoints shown in the **Breakpoints** view are saved.
- Existing breakpoints and watchpoints settings for the current connection are deleted and replaced by the settings from the imported file.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.6 Viewing the properties of a breakpoint or a watchpoint

Once a breakpoint or watchpoint is set, you can view its properties.

Viewing the properties of a breakpoint

There are several ways to view the properties of a breakpoint. You can:

- In the **Breakpoints** view, right-click a breakpoint and select **Properties...**.
- In the **Disassembly** view, right-click a breakpoint and select **Breakpoint Properties**.
- In the code view, right-click a breakpoint and select **DS-5 Breakpoints** > **Breakpoint Properties**.

This displays the **Breakpoint Properties** dialog.

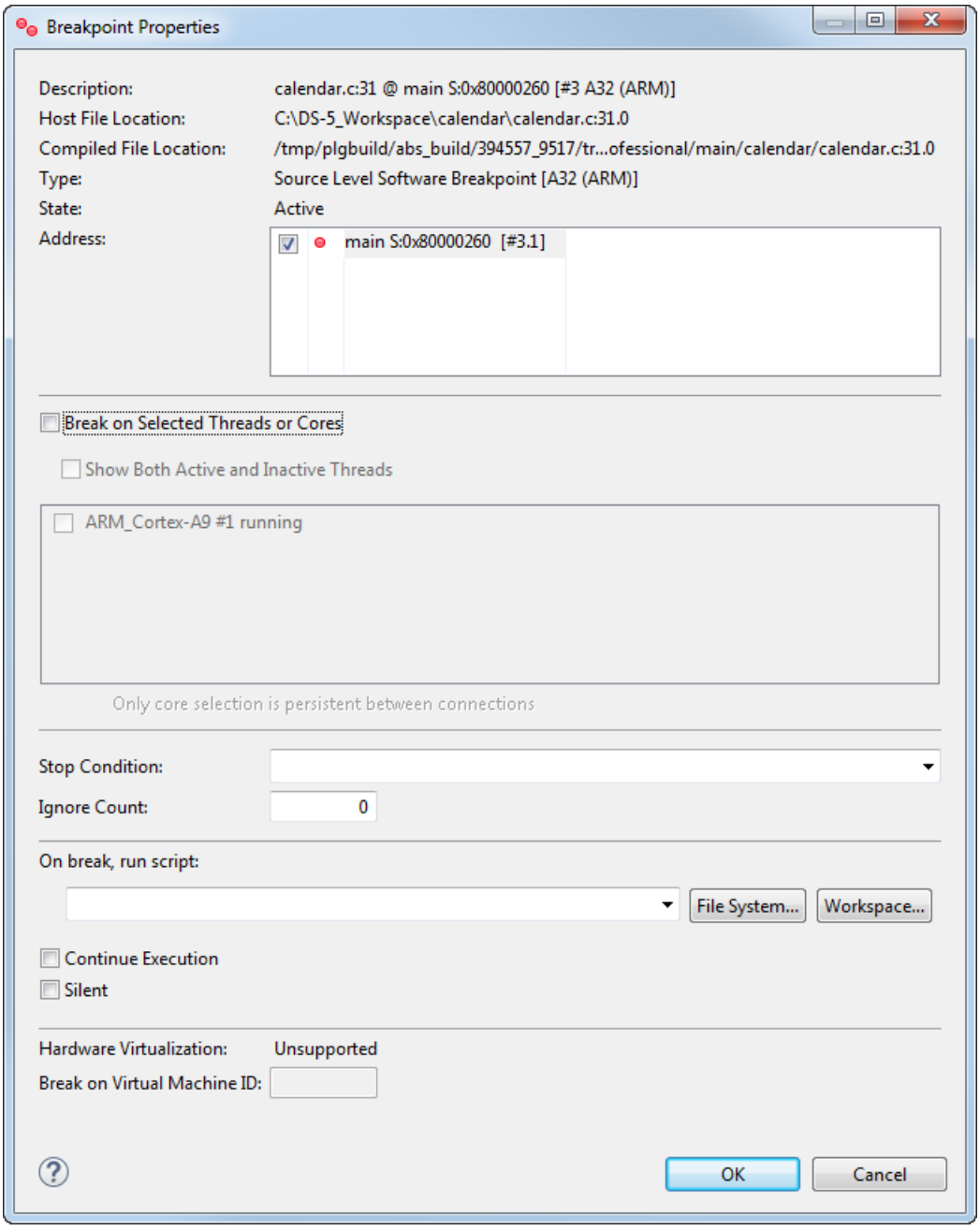


Figure 3-5 Viewing the properties of a breakpoint

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Viewing the properties of a watchpoint

There are several ways to view the properties of a watchpoint. You can:

- In the **Breakpoints** view, right-click a watchpoint and select **Properties...**.
- In the **Variables** view, right-click a watchpoint and select **Watchpoint Properties**.

This displays the **Watchpoint Properties** dialog:

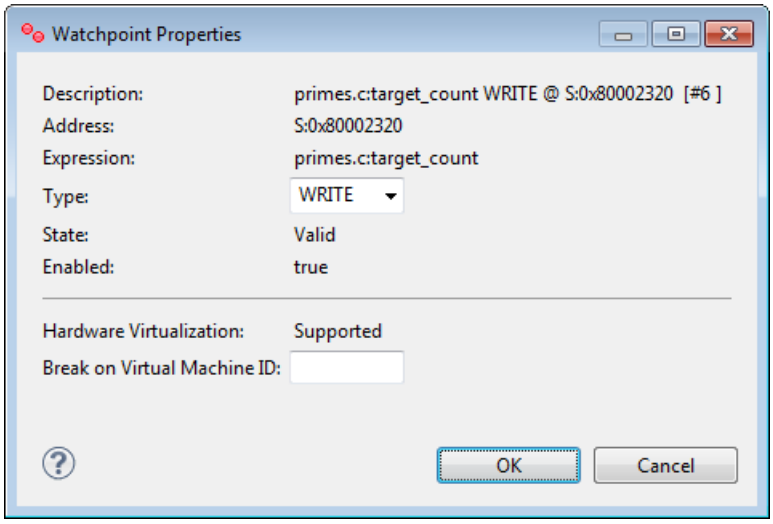


Figure 3-6 Viewing the properties of a data watchpoint

- Use the options available in the **Type** options to change the watchpoint type.
- If your target supports virtualization, enter a virtual machine ID in **Break on Virtual Machine ID**. This allows the watchpoint to stop only at the virtual machine ID you specify.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.7 Associating debug scripts to breakpoints

Using conditional breakpoints, you can run a script each time the selected breakpoint is triggered. You assign a script file to a specific breakpoint, and when the breakpoint is hit, the script executes.

If using the user interface, use the **Breakpoint Properties** dialog box to specify your script. See ***Breakpoint Properties*** on page 11-349 for more information.

If using the command-line, use the `break-script` command to specify your script.

Be aware of the following when using scripts with breakpoints:

- If you assign a script to a breakpoint that has sub-breakpoints, the debugger attempts to execute the script for each sub-breakpoint. If this happens, an error message is displayed. For an example of sub-breakpoints, see *Breakpoints view* on page 11-268.
- Take care with commands you use in a script that is attached to a breakpoint. For example, if you use the `quit` command in a script, the debugger disconnects from the target when the breakpoint is hit.
- If you put the `continue` command at the end of a script, this has the same effect as setting the **Continue Execution** option on the **Breakpoint Properties** dialog box.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.8 Conditional breakpoints

Conditional breakpoints have properties assigned to test for conditions that must be satisfied to trigger the breakpoint. When the underlying breakpoint is hit, the specified condition is checked and if it evaluates to true, then the target remains in the stopped state, otherwise execution resumes.

For example, using conditional breakpoints, you can:

- Test a variable for a given value.
- Execute a function a set number of times.
- Trigger a breakpoint only on a specific thread or processor.

Breakpoints that are set on a single line of source code with multiple statements are assigned as sub-breakpoints to a parent breakpoint. You can enable, disable, and view the properties of each sub-breakpoint in the same way as a single statement breakpoint. Conditions are assigned to top level breakpoints only and therefore affect both the parent breakpoint and sub-breakpoints.

See *Assigning conditions to an existing breakpoint* on page 3-82 for an example. Also, see the details of the `break` command to see how it is used to specify conditional breakpoints.

Note

- Conditional breakpoints can be very intrusive and lower the performance if they are hit frequently since the debugger stops the target every time the breakpoint triggers.
- If you assign a script to a breakpoint that has sub-breakpoints, the debugger attempts to execute the script for each sub-breakpoint. If this happens, an error message is displayed. For an example of sub-breakpoints, see *Breakpoints view* on page 11-268.

Considerations when setting multiple conditions on a breakpoint

Be aware of the following when setting multiple conditions on a breakpoint:

- If you set a **Stop Condition** and an **Ignore Count**, then the **Ignore Count** is not decremented until the **Stop Condition** is met. For example, you might have a breakpoint in a loop that is controlled by the variable `c` and has 10 iterations. If you set the **Stop Condition** `c==5` and the **Ignore Count** to `3`, then the breakpoint might not activate until it has been hit with `c==5` for the fourth time. It subsequently activates every time it is hit with `c==5`.
- If you choose to break on a selected thread or processor, then the **Stop Condition** and **Ignore Count** are checked only for the selected thread or processor.
- Conditions are evaluated in the following order:
  1. Thread or processor.
  2. Condition.
  3. Ignore count.

Related references

11.3 ARM assembler editor on page 11-266.
11.4 Breakpoints view on page 11-268.
11.5 C/C++ editor on page 11-272.
11.6 Commands view on page 11-275.
11.9 Disassembly view on page 11-285.
11.12 Expressions view on page 11-294.
11.15 Memory view on page 11-302.
11.18 Registers view on page 11-314.
11.28 Variables view on page 11-337.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.9 Assigning conditions to an existing breakpoint

Using the options available on the **Breakpoint Properties** dialog, you can specify different conditions for a specific breakpoint.

For example, you can set a breakpoint to be applicable to only specific threads or processors, schedule to run a script when a selected breakpoint is triggered, delay hitting a breakpoint, or specify a conditional expression for a specific breakpoint.

Procedure

1. In the **Breakpoints** view, select the breakpoint that you want to modify and right-click to display the context menu.
2. Select **Properties...** to display the **Breakpoint Properties** dialog box.

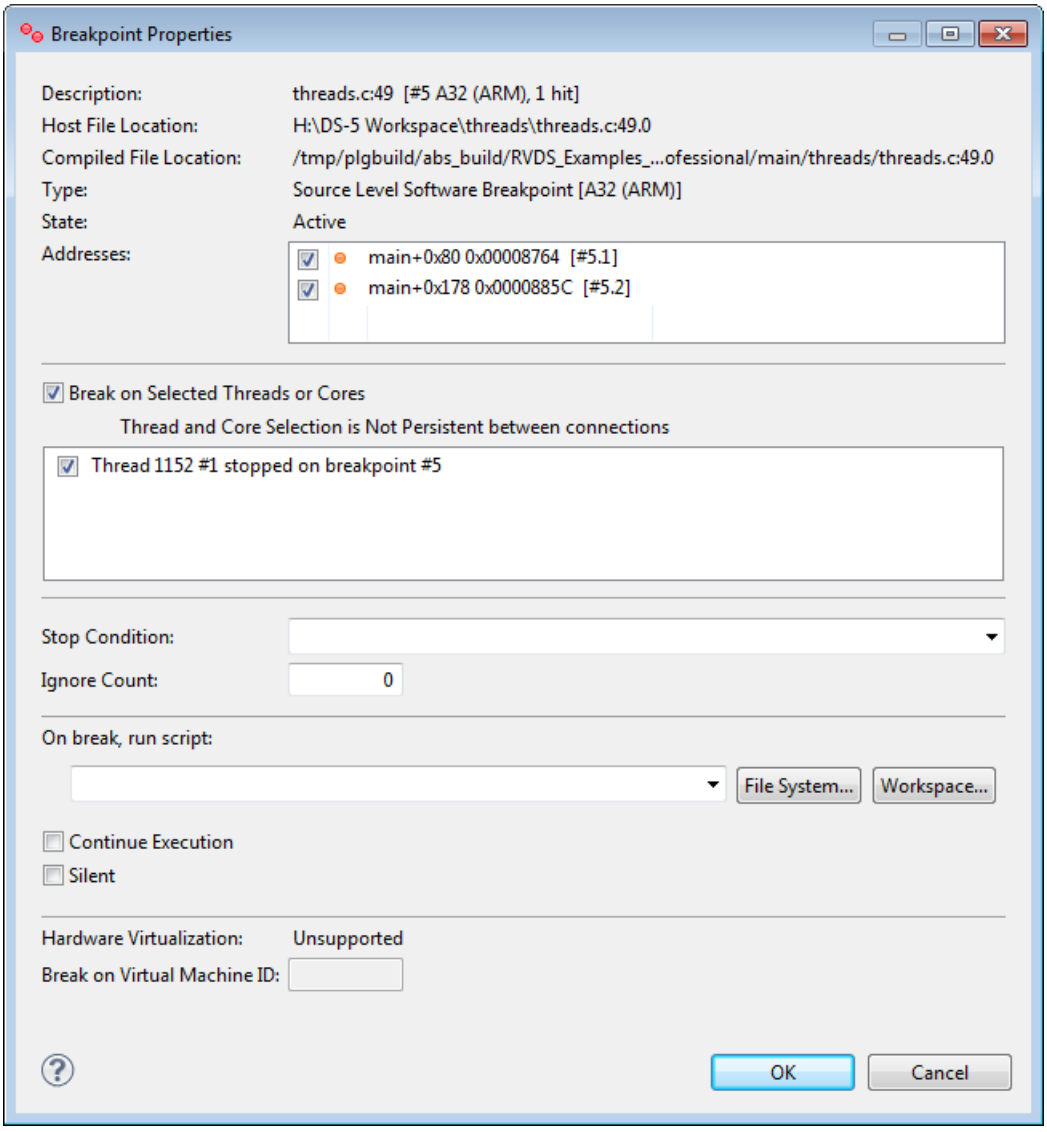


Figure 3-7 Breakpoint Properties dialog

3. Breakpoints apply to all threads by default, but you can modify the properties for a breakpoint to restrict it to a specific thread.
   a. Select the **Break on Selected Threads** option to view and select individual threads.
   b. Select the checkbox for each thread that you want to assign the breakpoint to.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Note

If you set a breakpoint for a specific thread, then any conditions you set for the breakpoint are checked only for that thread.

4. If you want to set a conditional expression for a specific breakpoint, then:
   a. In the **Stop Condition** field, enter a C-style expression. For example, if your application code has a variable `x`, then you can specify: `x == 10`

   Tip

   See the *`break`* command to see how it is used to specify conditional breakpoints.

5. If you want the debugger to delay hitting the breakpoint until a specific number of passes has occurred, then:
   a. In the **Ignore Count** field, enter the number of passes. For example, if you have a loop that performs 100 iterations, and you want a breakpoint in that loop to be hit after 50 passes, then enter `50`.
6. If you want to run a script when the selected breakpoint is triggered, then:
   a. In the **On break, run script** field, specify the script file.

   Click **File System...** to locate the file in an external directory from the workspace or click **Workspace...** to locate the file within the workspace.

   Note

   Take care with commands used in a script file that is attached to a breakpoint. For example, if the script file contains the `quit` command, the debugger disconnects from the target when the breakpoint is hit.

7. Select **Continue Execution** if you want to enable the debugger to automatically continue running the application on completion of all the breakpoint actions. Alternatively, you can enter the `continue` command as the last command in a script file, that is attached to a breakpoint.
8. Select **Silent** if you want to hide breakpoint information in the **Commands** view.
9. If required, specify a *Virtual Machine ID (VMID)*.

   Note

   You can only specify a *Virtual Machine ID (VMID)* if hardware virtualization is supported by your target.

10. Once you have selected the required options, click **OK** to save your changes.

Related references

11.3 ARM assembler editor on page 11-266.
11.4 Breakpoints view on page 11-268.
11.5 C/C++ editor on page 11-272.
11.6 Commands view on page 11-275.
11.9 Disassembly view on page 11-285.
11.12 Expressions view on page 11-294.
11.15 Memory view on page 11-302.
11.18 Registers view on page 11-314.
11.28 Variables view on page 11-337.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.10 Conditional watchpoints

Conditional watchpoints have properties that are assigned to test for conditions that must be satisfied to trigger the watchpoint. When the conditional watchpoint is hit, the specified condition is checked and if it evaluates to true, the watchpoint is triggered, and the target stops.

For example, using conditional watchpoints you can:

- Set a watchpoint to stop when accessing data from a memory region, but only when a variable evaluates to a given value.
- On processors that implement virtualization extensions, you can set a watchpoint to trigger only when running within a specific virtual machine (determined through its *Virtual Machine ID (VMID)*).
- On all ARMv7 and ARMv8 processors, you can set a watchpoint to trigger only when a specific process is running, as defined by the current *Context ID*.

Note

- Conditional watchpoints are not supported on *gdbserver* connections currently.
- You can create several conditional watchpoints, but when a conditional watchpoint is enabled, no other watchpoints (regardless of whether they are conditional) can be enabled.
- Conditional watchpoints can be intrusive and lower performance if they are hit frequently since the debugger stops the target every time the watchpoint triggers.

See *3.4 Working with watchpoints* on page 3-75 for details about assigning a condition to watchpoint when creating it. See *3.11 Assigning conditions to an existing watchpoint* on page 3-85 for details about assigning conditions to an existing watchpoint.

You can also use the `awatch`, `rwatch`, and `watch` commands to assign conditions to a watchpoint.

Considerations when creating conditional watchpoints

- If the instruction causing the trap occurred synchronously, then to evaluate a condition after any state has changed (for example, a store to an address), the debugger steps the instruction that caused the trap. The debugger then proceeds to evaluate the condition to see whether to stop on the watchpoint. This is required so that a specific address can be watched and trap immediately after a specific value is written to that address.
- Ignore count or core/thread specific watchpoints are not supported.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.11 Assigning conditions to an existing watchpoint

Using the options available on the **Watchpoint Properties** dialog, you can specify different conditions for a specific watchpoint.

To specify the condition which must evaluate to true at the time the watchpoint is triggered for the target to stop, use the **Stop Condition** field.

Note

You can create several conditional watchpoints, but when a conditional watchpoint is enabled, no other watchpoints (regardless of whether they are conditional) can be enabled.

Procedure

1. In the **Breakpoints** view, select the watchpoint that you want to modify and right-click to display the context menu.
2. Select **Properties...** to display the **Watchpoint Properties** dialog.
3. If not selected, select **Enabled**.
4. Specify the width to watch at the given address, in bits. Accepted values are: 8, 16, 32, and 64 if supported by the target.

   This parameter is optional. The width defaults to:
   - 32 bits for an address.
   - The width corresponding to the type of the symbol or expression, if entered.
5. Expand **Stop Condition** and in the **Expression** field, enter a C-style expression. For example, if your application code has a variable *x*, then you can specify: `x == 10`.

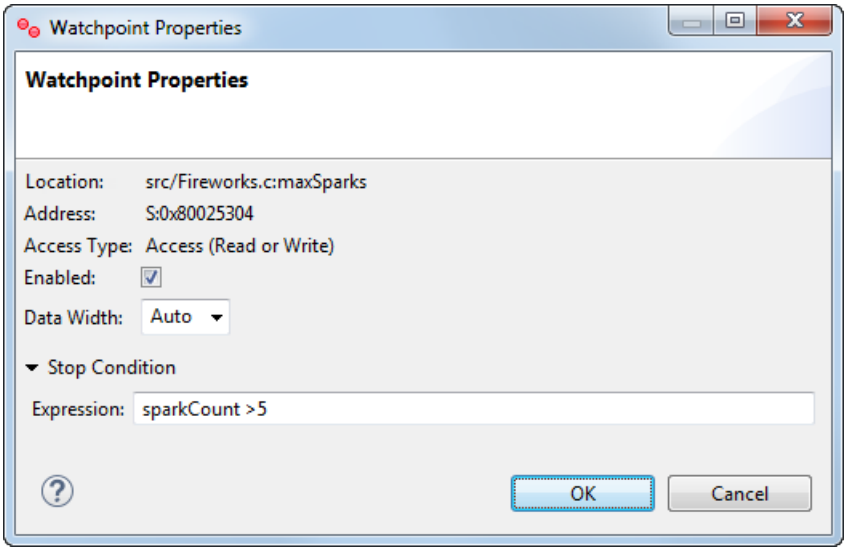


Figure 3-8 Watchpoint Properties dialog

6. Click **OK**, to apply the condition to the watchpoint.

Related tasks

3.4 Working with watchpoints on page 3-75.

Related references

11.35 Watchpoint Properties dialog box on page 11-352.

Related information

DS-5 Debugger command: awatch.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

DS-5 Debugger command: rwatch.
DS-5 Debugger command: watch.
DS-5 Debugger command: watch.
DS-5 Debugger command: watch-set-property.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.12 Pending breakpoints and watchpoints

A pending breakpoint or watchpoint is one that exists in the debugger but is not active on the target until some precondition is met, such as a shared library being loaded.

Breakpoints and watchpoints are typically set when debug information is available. Pending breakpoints and watchpoints, however, enable you to set breakpoints and watchpoints before the associated debug information is available.

When a new shared library is loaded, the debugger re-evaluates all pending breakpoints and watchpoints. Breakpoints or watchpoints with addresses that can be resolved are set as standard execution breakpoints or watchpoints and those with unresolved addresses remain pending. The debugger automatically changes any breakpoints or watchpoints in a shared library to a pending one when the library is unloaded by your application.

Manually setting a pending breakpoint or watchpoint

To manually set a pending breakpoint or watchpoint, you can use the `-p` option with any of these commands:

`advance`

`break`

`hbreak`

`tbreak`

`thbreak`

`watch`

`awatch`

`rwatch`

Tip

You can enter debugger commands in the **Commands** view. See ***Commands** view* on page 11-275 for more information.

Example 3-2 Pending breakpoint/watchpoint example

```
break -p lib.c:20          # Sets a pending breakpoint at line 20 in lib.c
awatch -p *0x80D4          # Sets a pending read/write watchpoint on address 0x80D4
```

Resolving a pending breakpoint or watchpoint

You can force the resolution of a pending breakpoint or watchpoint. This might be useful, for example, if you have manually modified the shared library search paths.

To resolve a pending breakpoint or watchpoint:

- If using the user interface, right-click on the pending breakpoint or watchpoint that you want to resolve, and select **Resolve**.
- If using the command-line, use the *`resolve`* command.

Related references

11.3 ARM assembler editor on page 11-266.

11.4 Breakpoints view on page 11-268.

11.5 C/C++ editor on page 11-272.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.6 Commands view on page 11-275.
11.9 Disassembly view on page 11-285.
11.12 Expressions view on page 11-294.
11.15 Memory view on page 11-302.
11.18 Registers view on page 11-314.
11.28 Variables view on page 11-337.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.13 Setting a tracepoint

Tracepoints are memory locations that are used to trigger behavior in a trace capture device when running an application. A tracepoint is hit when the processor executes an instruction at a specific address. Depending on the tracepoint type, trace capture is either enabled or disabled.

Tracepoints can be set from the following:

- **ARM Assembler** editor.
- **C/C++** editor.
- **Disassembly** view.
- **Functions** view.
- **Memory** view.
- The instruction execution history panel in the **Trace** view.

To set a tracepoint, right-click in the left-hand marker bar at the position where you want to set the tracepoint and select either **Toggle Trace Start Point**, **Toggle Trace Stop Point**, or **Toggle Trace Trigger Point** from the context menu. To remove a tracepoint, repeat this procedure on the same tracepoint or delete it from the **Breakpoints** view. See *About trace support* on page 5-138 for more information about Trace Start, Stop, and Trigger Point.

Tracepoints are stored on a per connection basis. If the active connection is disconnected then tracepoints can only be created from the source editor.

All tracepoints are visible in the **Breakpoints** view.

Related references

11.3 ARM assembler editor on page 11-266.

11.4 Breakpoints view on page 11-268.

11.5 C/C++ editor on page 11-272.

11.6 Commands view on page 11-275.

11.9 Disassembly view on page 11-285.

11.12 Expressions view on page 11-294.

11.15 Memory view on page 11-302.

11.18 Registers view on page 11-314.

11.28 Variables view on page 11-337.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.14 Handling UNIX signals

When debugging a Linux application you can configure the debugger to stop or report when a UNIX signal is raised.

To manage UNIX signals in the debugger, either:

- Select **Manage Signals** from the **Breakpoints** toolbar or the view menu.

  Select the individual **Signal** you want to **Stop** or **Print** information, and click **OK**. The results are displayed in the **Command** view.
- Use the `handle` command and view the results in the **Command** view.

Tip

You can also use the `info signals` command to display the current signal handler settings.

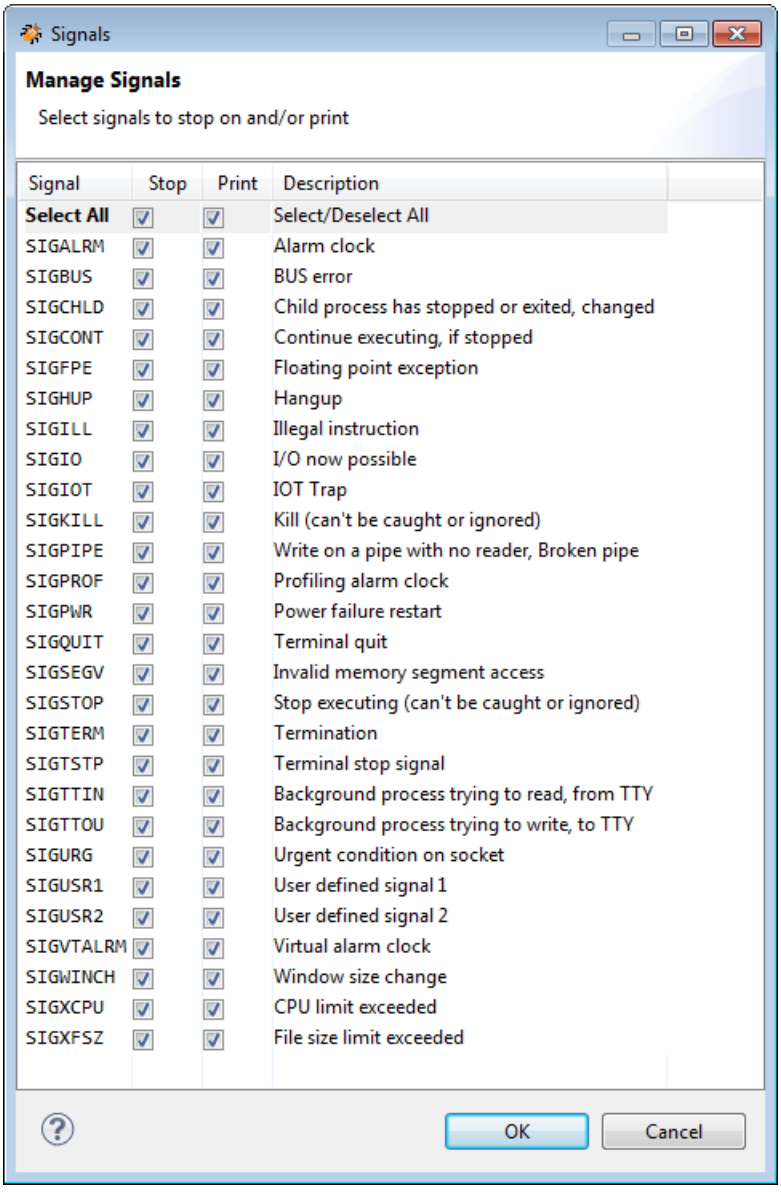


Figure 3-9 Manage signals dialog (UNIX signals)

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Note

UNIX signals `SIGINT` and `SIGTRAP` cannot be debugged in the same way as other signals because they are used internally by the debugger for asynchronous stopping of the process and breakpoints respectively.

Example 3-3 Managing signals

If you want the application to ignore a signal, but log the event when it is triggered, then you must enable stopping on a signal.

Ignoring a `SIGHUP` signal

In the following example, a SIGHUP signal occurs causing the debugger to stop and print a message. No signal handler is invoked when using this setting and the debugged application ignores the signal and continues to operate.

```
handle SIGHUP stop print                # Enable stop and print on SIGHUP signal
```

Debugging a `SIGHUP` signal

The following example shows how to debug a signal handler.

To do this you must disable stopping on a signal and then set a breakpoint in the signal handler. This is because if stopping on a signal is disabled then the handling of that signal is performed by the process that passes signal to the registered handler. If no handler is registered then the default handler runs and the application generally exits.

```
handle SIGHUP nostop noprint             # Disable stop and print on SIGHUP signal
```

Related concepts

6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.

Related references

3.2 Running, stopping, and stepping through an application on page 3-72.
5.1 Examining the target execution environment on page 5-136.
5.2 Examining the call stack on page 5-137.
3.15 Handling processor exceptions on page 3-92.
11.4 Breakpoints view on page 11-268.
11.6 Commands view on page 11-275.
11.37 Manage Signals dialog box on page 11-354.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.15 Handling processor exceptions

ARM processors handle exceptions by jumping to one of a set of fixed addresses known as exception vectors.

Except for a *Supervisor Call* (SVC) or *Secure Monitor Call* (SMC), these events are not part of normal program flow. The events can happen unexpectedly, perhaps because of a software bug. For this reason, most ARM processors include a vector catch feature to trap these exceptions. This is most useful for bare-metal projects, or projects at an early stage of development. When an OS is running, it might use these exceptions for legitimate purposes, for example virtual memory handling.

When vector catch is enabled, the effect is similar to placing a breakpoint on the selected vector table entry. But in this case, vector catches use dedicated hardware in the processor and do not use up valuable breakpoint resources.

Note

The available vector catch events are dependent on the exact processor that you are connected to.

To manage vector catch in the debugger, either:

- Select **Manage Signals** from the **Breakpoints** toolbar or the view menu to display the **Manage Signals** dialog box.

  For each individual signal that you want information, select either the **Stop** or **Print** option. The **Stop** option stops the execution and prints a message. The **Print** option prints a message, but continues execution. You can view these messages in the **Commands** view.

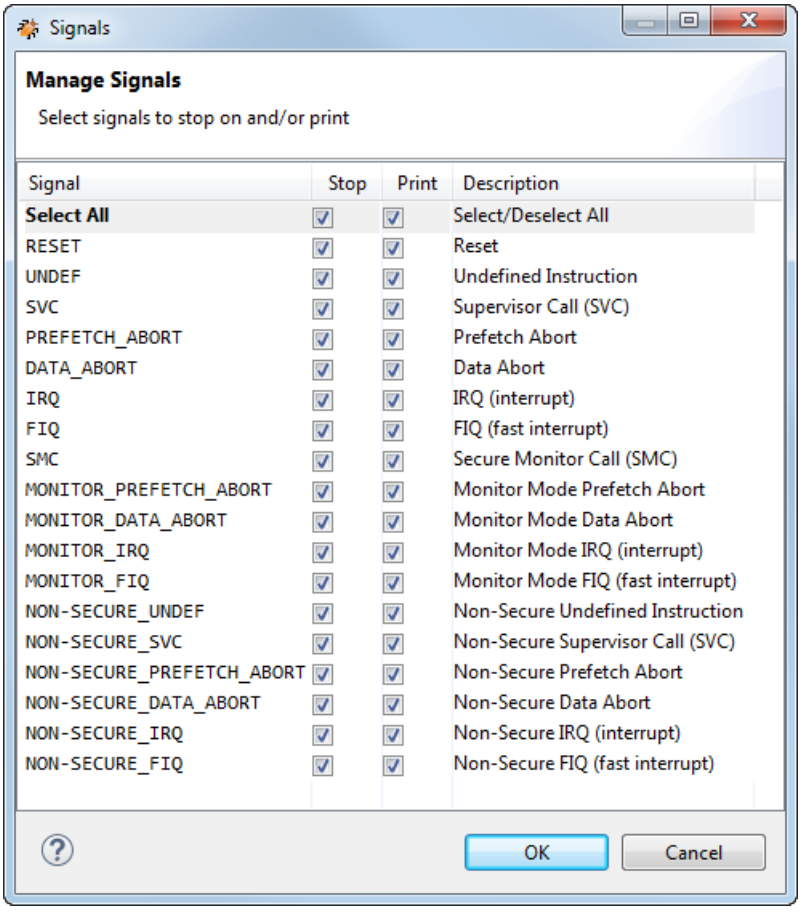


Figure 3-10 Manage Signals dialog

- Use the `handle` command and view the results in the **Command** view.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Tip

You can also use the `info signals` command to display the current handler settings.

Example 3-4 Examples

Debugging an exception handler

If you want the debugger to catch the exception, log the event, and stop the application when the exception occurs, then you must enable stopping on an exception. In the following example, a `NON-SECURE_FIQ` exception occurs causing the debugger to stop and print a message in the **Commands** view. You can then step or run to the handler, if present.

```
handle NON-SECURE_FIQ stop        # Enable stop and print on a NON-SECURE_FIQ exception
```

Ignoring an exception

If you want the exception to invoke the handler without stopping, then you must disable stopping on an exception.

```
handle NON-SECURE_FIQ nostop      # Disable stop on a NON-SECURE_FIQ exception
```

Related concepts

6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.

Related references

3.2 Running, stopping, and stepping through an application on page 3-72.
5.1 Examining the target execution environment on page 5-136.
5.2 Examining the call stack on page 5-137.
3.14 Handling UNIX signals on page 3-90.
11.4 Breakpoints view on page 11-268.
11.6 Commands view on page 11-275.
11.37 Manage Signals dialog box on page 11-354.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.16 Cross-trigger configuration

In a multiprocessor system, when debug events from one processor are used to affect the debug sessions of other processors, it is called cross-triggering. It is sometimes useful to control all processors with a single debugger command. For example, stopping all cores when a single core hits a breakpoint.

- Hardware cross-triggering

  A hardware cross-triggering mechanism uses the cross-trigger network (composed of Cross Trigger Interface (CTI) and Cross Trigger Matrix (CTM) devices) present in a multiprocessor system. The advantage of using a hardware-based cross-triggering mechanism is low latency performance.
- Software cross-triggering

  In a software cross-triggering scenario, the mechanism is performed and managed by the debugger. Using a software cross-triggering mechanism results in increased latency.

In DS-5, the Platform Configuration Editor (PCE) generates support for CTI-synchronized SMP and big.LITTLE debug operations platforms provided that sufficient and appropriate cores, and CTI are available in the SoC. PCE also supports for transporting trace trigger notifications across the cross-trigger network between trace sources and trace sinks.

CTI interfaces need to be programmed using the Debug and Trace Services Layer (DTSL) capabilities in DS-5. See the *DTSL documentation* on page 15-439 or contact your support representative for more information.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.17 Using semihosting to access resources on the host computer

Semihosting is a mechanism for ARM targets to communicate input/output requests from application code to a host computer running a debugger.

You can use semihosting to enable the host computer to provide input and output facilities of the final system if your development hardware does not have the necessary facilities. For example, you can use this mechanism to enable functions in the C library, such as `printf()` and `scanf()`, to use the screen and keyboard of the host instead of having a screen and keyboard on the target system.

Semihosting implementation on an ARM® processor

Semihosting is implemented by a set of defined software instructions, for example, SVCs, that generate exceptions from program control. The application invokes the appropriate semihosting call and the debug agent then handles the exception. The debug agent provides the required communication with the host. Semihosting uses stack base and heap base addresses to determine the location and size of the stack and heap. The stack base, also known as the top of memory, is an address that is by default 64K from the end of the heap base. The heap base is by default contiguous to the application code.

The following figure shows a typical layout for an ARM target.

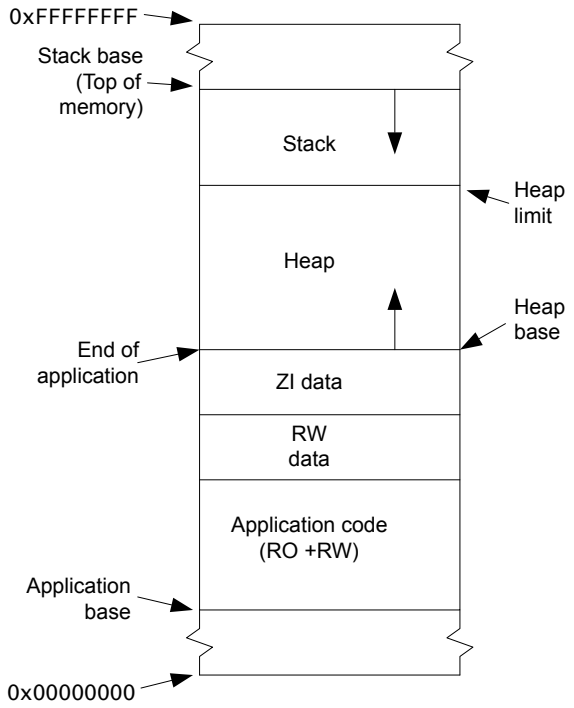


Figure 3-11 Typical layout between top of memory, stack, and heap

If you are compiling for the ARMv6-M or ARMv7-M architectures, the Thumb **BKPT** instruction is used instead of the Thumb **SVC** instruction. For more information, see: *The semihosting interface*.)

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Semihosting implementation on ARMv8-A and ARMv8-R architectures

DS-5 supports semihosting for both AArch64 and AArch32 states on both software models and real target hardware. DS-5 Debugger handles semihosting by intercepting instructions as per the following table:

Table 3-1 Semihosting trap instructions and encodings

Profile	Instruction Set	Instruction	Opcode
A+R Profile	A64	`HLT #0xF000`	`0xD45E0000`
	A32	`SVC #0x123456`	`0xEF123456`
		`HLT #0xF000`	`0xE10F0070`
	T32	`SVC #0xAB`	`0xDFAB`
		`HLT #0x3C`	`0xBABC`

- For AArch64 code running on real target hardware, the target halts on the **`HLT`** instruction and the debugger handles the semihosting automatically.
- For AArch32 code running on real target hardware using a semihosting library configured to use **`HLT`** instructions for semihosting traps, the debugger handles the semihosting automatically.
- For AArch32 code running on real target hardware using a semihosting library configured to use **`SVC`** instructions or when using a software model in either AArch32 or AArch64 states, you must explicitly set a semihosting trap. Otherwise the debugger reports this error:

  ```
  ERROR(TAB180): The semihosting breakpoint address has not been specified.
  ```

  This error is reported when the debugger tries to enable semihosting, either when an image is loaded that contains the special symbols **`__auto_semihosting`** or **`__semihosting_library_function`**, or if you explicitly try to enable semihosting using `set semihosting enabled on`.

You can set a semihosting trap in the debugger by executing the CLI command: `set semihosting vector <trap_address>`

This instructs the debugger to set a breakpoint at this address, and when this breakpoint is hit, the debugger takes control to perform the semihosting operation.

For AArch32 state, how execution gets to this address from the **`SVC`** semihosting instruction depends on the program used, the Exception level the program is executing at, how exceptions are set up to propagate, and other settings.

It is your responsibility to ensure that execution reaches this address. This is typically done by setting the semihosting vector address to an appropriate offset in the appropriate vector table, or by creating an explicit entry in the vector table that, perhaps conditionally, branches to a known offset.

Related references

16.5 About passing arguments to main() on page 16-501.
3.18 Working with semihosting on page 3-97.
11.44 Debug Configurations - Arguments tab on page 11-368.
11.1 App Console view on page 11-263.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.18 Working with semihosting

Semihosting is supported by the debugger in both the command-line console and from the user interface.

Enabling semihosting support

By default, semihosting support is disabled in the debugger. However, DS-5 Debugger enables semihosting automatically if either **`__auto_semihosting`** or **`__semihosting_library_function`** ELF symbols are present in an image. Also, if the image is compiled with ARM Compiler 5.0 and later, the linker automatically adds **`__semihosting_library_function`** to an image if it uses functions that require semihosting.

In C code, you can create the ELF symbol by defining a function with the name **`__auto_semihosting`**. To prevent this function generating any additional code or data in your image, you can define it as an alias of another function. This places the required ELF symbol in the debug information, but does not affect the code and data in the application image.

Example 3-5 Create a special semihosting ELF symbol with an alias to main()

```
#include <stdio.h>
void __auto_semihosting(void) __attribute__((alias("main")));
                                    //mark as alias for main() to declare
                                    //semihosting ELF symbol in debug information only
int main(void)
{
    printf("Hello world\n");
    return 0;
}
```

Using semihosting from the command-line console

The input/output requests from application code to a host workstation running the debugger are called semihosting messages. By default, all semihosting messages (*`stdout`* and *`stderr`*) are output to the console. When using this console interactively with *debugger commands*, you must use the *`stdin`* option to send input messages to the application.

By default, all messages are output to the command-line console, but you can choose to redirect them when launching the debugger by using one or more of the following options:

`--disable_semihosting`
: Disables all semihosting operations.

`--disable_semihosting_console`
: Disables all semihosting operations to the debugger console.

`--semihosting_error=filename`
: Specifies a file to write `stderr` for semihosting operations.

`--semihosting_input=filename`
: Specifies a file to read `stdin` for semihosting operations.

`--semihosting_output=filename`
: Specifies a file to write `stdout` for semihosting operations.

Note

Alternatively, you can disable semihosting in the console and use a separate telnet session to interact directly with the application. During start up, the debugger creates a semihosting server socket and displays the port number to use for the telnet session.

See *Command-line debugger options* on page 8-204 for more information.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Using semihosting from the user interface

The **App Console** view in the DS-5 Debug perspective controls all the semihosting input/output requests (`stdin`, `stdout`, and `stderr`) between the application code and the debugger.

Related references

16.5 About passing arguments to main() on page 16-501.
3.17 Using semihosting to access resources on the host computer on page 3-95.
11.44 Debug Configurations - Arguments tab on page 11-368.
11.1 App Console view on page 11-263.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.19 Configuring the debugger path substitution rules

During the debugging process, the debugger attempts to open the corresponding source file when execution stops at an address in the image or shared object.

The debugger might not be able to locate the source file when debug information is loaded because:

- The path that is specified in the debug information is not present on your workstation, or that path does not contain the required source file.
- The source file is not in the same location on your workstation as the image containing the debug information. The debugger attempts to use the same path as this image by default.

Therefore, you must modify the search paths used by the debugger when it executes any of the commands that look up and display source code.

To modify the search paths:

Procedure

1. Open the **Path Substitution** dialog box.
   - If a source file cannot be located, a warning is displayed in the C/C++ editor. Click the **Set Path Substitution** option.
   - In the **Debug Control** view, select **Path Substitution** from the view menu.

     Note

     You must be connected to your target to access the **Path Substitution** menu option.

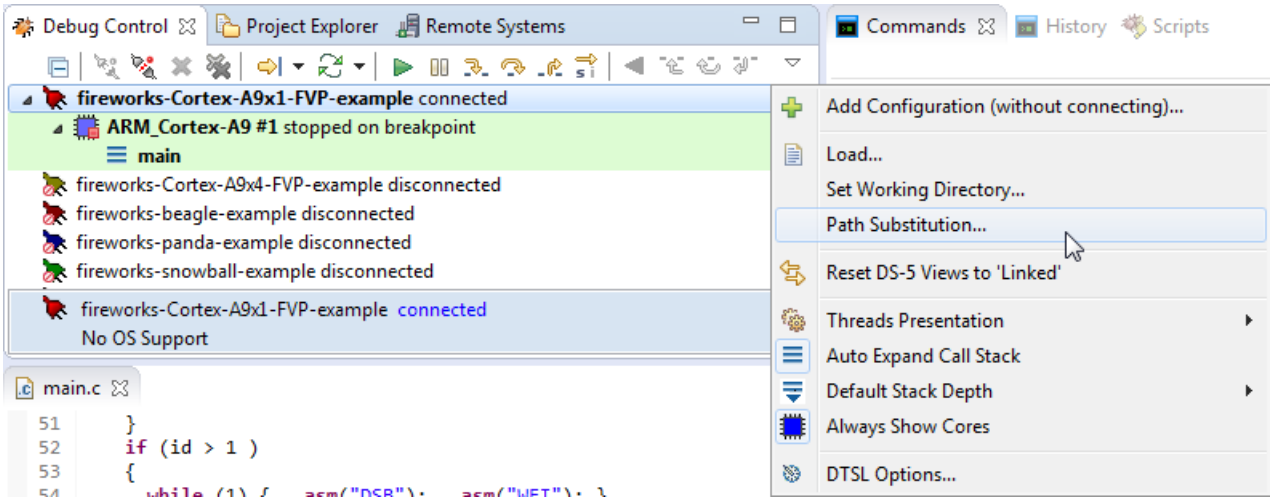


Figure 3-12 Set Path Substitution

2. Click on the required toolbar icons in the **Path Substitution** dialog box:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

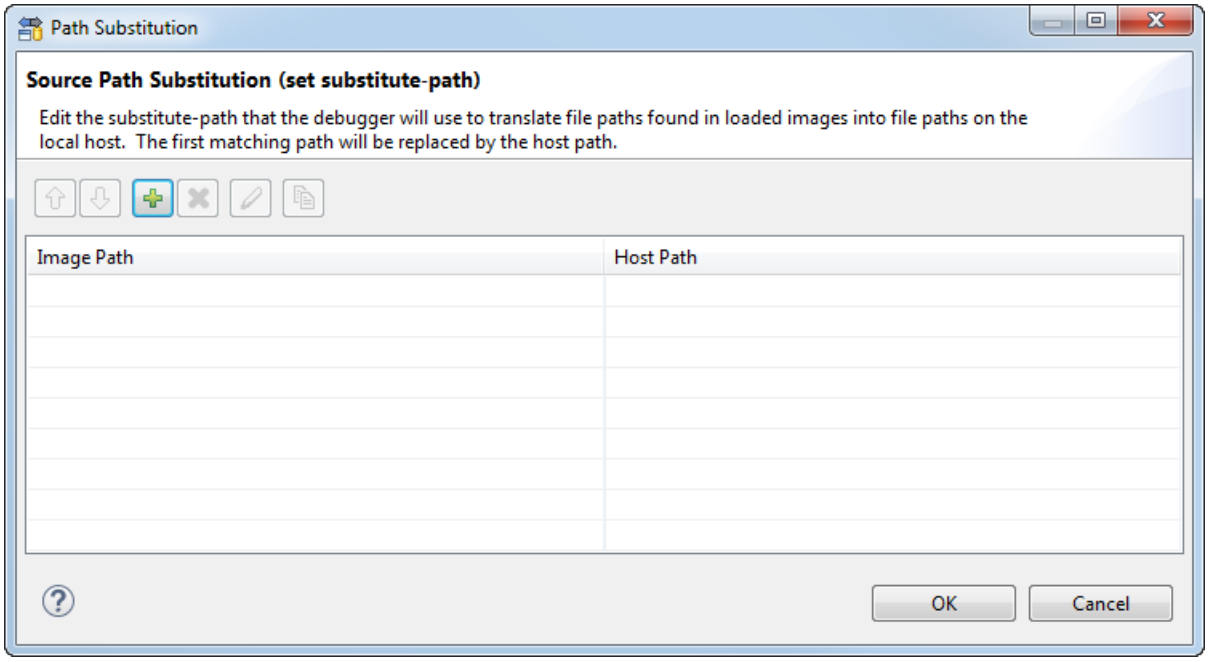


Figure 3-13 Path Substitution dialog box

- - Add a path using the **Edit Substitute Path** dialog box.

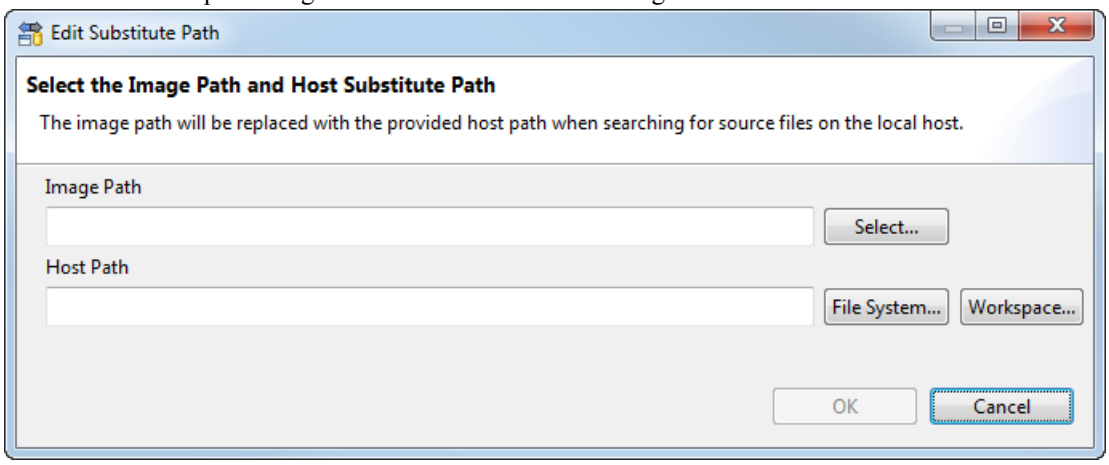


Figure 3-14 Edit Substitute Path dialog box

1. **Image Path** - Enter the original path for the source files or **Select...** a compilation path.
2. **Host Path** - Enter the current location of the sources. Click **File System...** to locate the source files in an external folder or click **Workspace...** to locate the source files in a workspace project.
3. Click **OK** to accept the changes and close the dialog.

- - Delete an existing path.
  1. Select the path that you want to delete in the **Path Substitution** dialog box.
  2. Click to delete the selected path.
  3. Click **OK** to accept the changes and close the dialog box.
- - Edit an existing path.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

1. Select the path that you want to edit in the **Path Substitution** dialog box.
2. Click to edit the path in the **Edit Substitute Path** dialog box.
3. Make your changes and click **OK** to accept the changes and close the dialog box.

- - Duplicate substitution rules.
  1. Select the path that you want to duplicate in the **Path Substitution** dialog box.
  2. Click to display the **Edit Substitute Path** dialog box.
  3. Make your changes and click **OK** to accept the changes and close the dialog box.
- If required, you can change the order of the substitution rules.

3. Click **OK** to pass the substitution rules to the debugger and close the **Path Substitution** dialog box.

Related concepts

16.4 About loading debug information into the debugger on page 16-499.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 4
Working with the Target Configuration Editor

Describes how to use the editor when developing a project for an ARM target.

It contains the following sections:

- *4.1 About the Target Configuration Editor* on page 4-103.
- *4.2 Target configuration editor - Overview tab* on page 4-104.
- *4.3 Target configuration editor - Memory tab* on page 4-106.
- *4.4 Target configuration editor - Peripherals tab* on page 4-108.
- *4.5 Target configuration editor - Registers tab* on page 4-110.
- *4.6 Target configuration editor - Group View tab* on page 4-112.
- *4.7 Target configuration editor - Enumerations tab* on page 4-114.
- *4.8 Target configuration editor - Configurations tab* on page 4-115.
- *4.9 Scenario demonstrating how to create a new target configuration file* on page 4-117.
- *4.10 Creating a power domain for a target* on page 4-128.
- *4.11 Creating a Group list* on page 4-129.
- *4.12 Importing an existing target configuration file* on page 4-131.
- *4.13 Exporting a target configuration file* on page 4-133.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.1 About the Target Configuration Editor

The target configuration editor provides forms and graphical views to easily create and edit *Target Configuration Files* (TCF) describing memory mapped peripheral registers present on a device. It also provides import and export wizards for compatibility with the file formats used in µVision System Viewer.

TCF files must have the file extension `.tcf` to invoke this editor.

If this is not the default editor, right-click on your source file in the **Project Explorer** view and select **Open With** > **Target Configuration Editor** from the context menu.

The target configuration editor also provides a hierarchical tree using the **Outline** view. Click on an entry in the **Outline** view to move the focus of the editor to the relevant tab and selected field. If this view is not visible, select **Window** > **Show View** > **Outline** from the main menu.

To configure the target peripherals, you must provide the TCF files to DS-5 Debugger before connecting to the target. You can specify directories containing TCF files in the **Debug Configurations** window by selecting **Add peripheral description files from directory** in the **Files** tab.

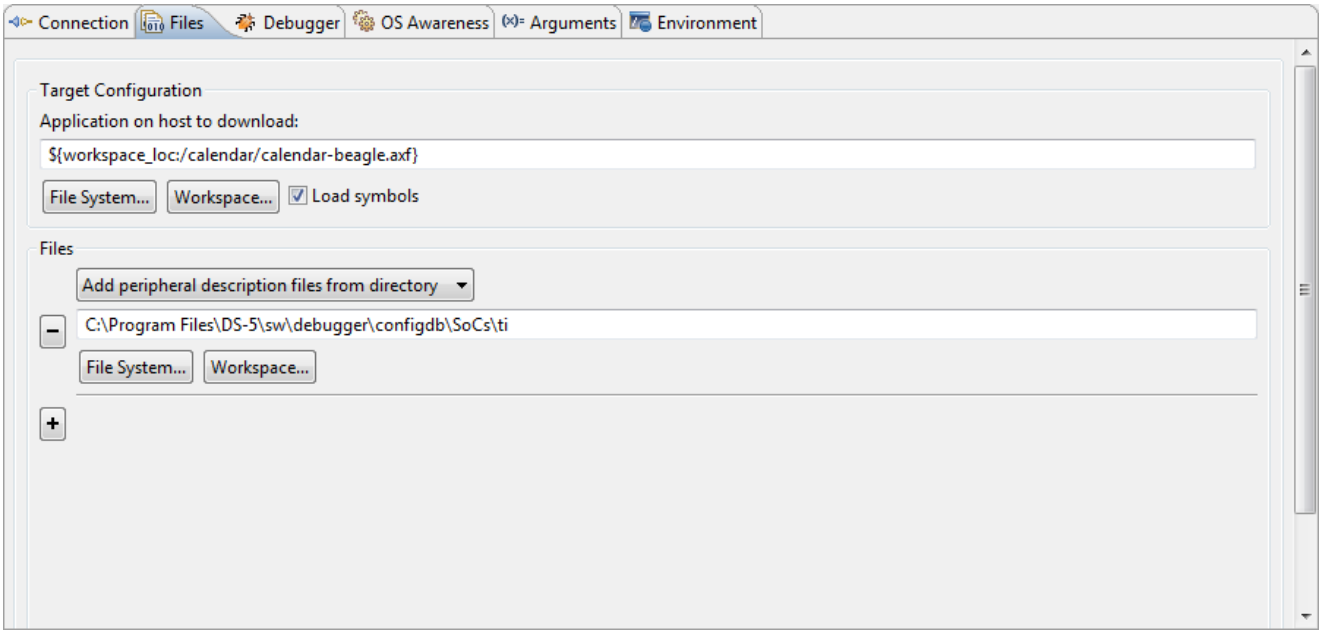


Figure 4-1 Specifying TCF files in the Debug Configurations window

Related references

4.2 Target configuration editor - Overview tab on page 4-104.
4.3 Target configuration editor - Memory tab on page 4-106.
4.4 Target configuration editor - Peripherals tab on page 4-108.
4.5 Target configuration editor - Registers tab on page 4-110.
4.6 Target configuration editor - Group View tab on page 4-112.
4.7 Target configuration editor - Enumerations tab on page 4-114.
4.8 Target configuration editor - Configurations tab on page 4-115.
11.41 Debug Configurations - Files tab on page 11-361.
4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.2 Target configuration editor - Overview tab

A graphical view showing general information about the current target and summary information for all the tabs.

General Information

Unique Name
Unique board name (mandatory).

Category
Name of the manufacturer.

Inherits
Name of the board, memory region or peripheral to inherit data from. You must use the **Includes** panel to populate this drop-down menu.

Endianness
Byte order of the target.

TrustZone
TrustZone support for the target. If supported, the **Memory** and **Peripheral** tabs are displayed with a TrustZone **Address Type** field.

Power Domain
Power Domain support for the target. If supported, the **Memory** and **Peripheral** tabs are displayed with a Power Domain **Address Type** field. Also, the **Configurations** tab includes an additional **Power Domain Configurations** group.

Description
Board description.

Includes
Include files for use when inheriting target data that is defined in an external file. Populates the **Inherits** drop-down menu.

The **Overview** tab also provides a summary of the other tabs available in this view, together with the total number of items defined in that view.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

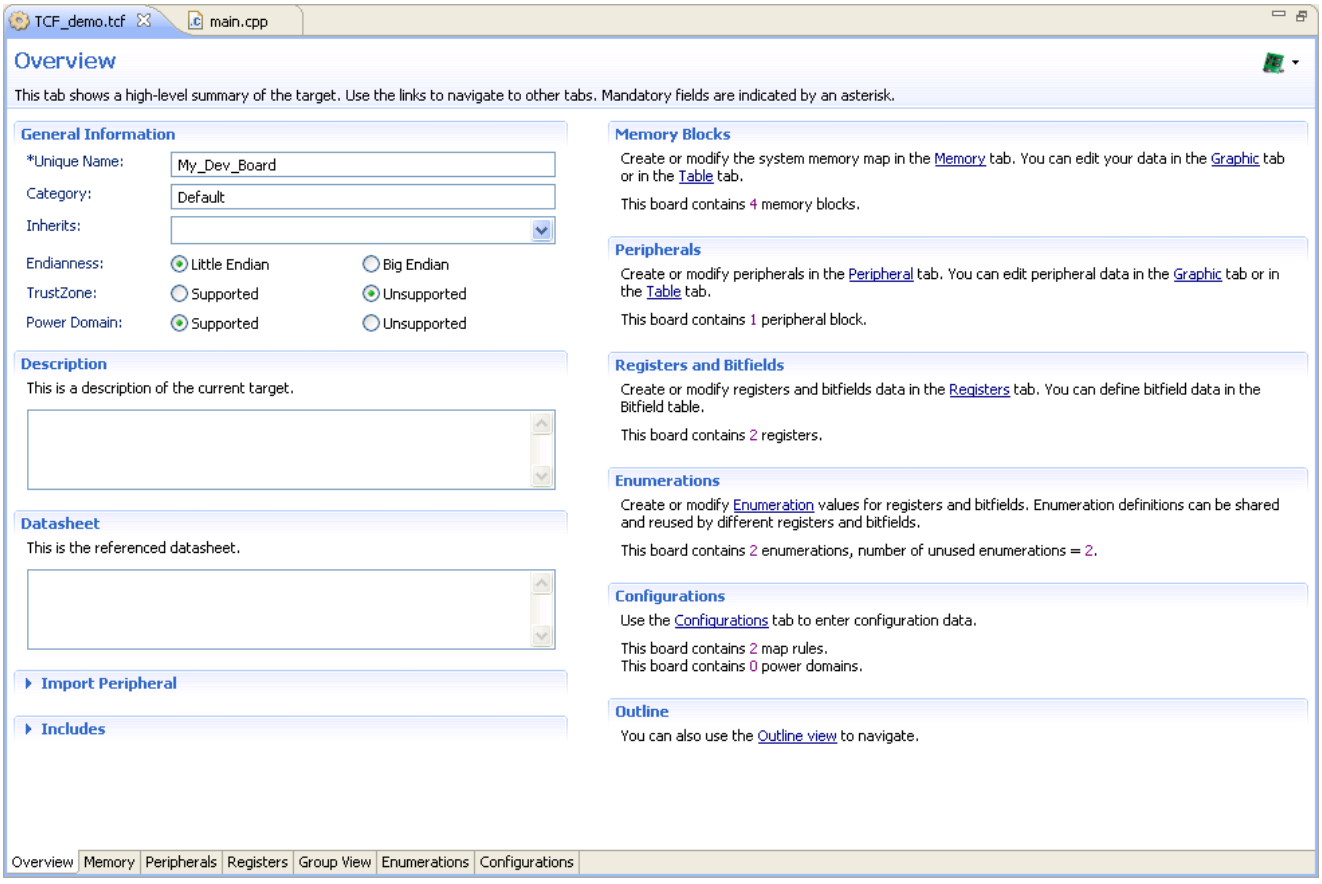


Figure 4-2 Target configuration editor - Overview tab

Mandatory fields are indicated by an asterisk. Toolbar buttons and error messages are displayed in the header panel as appropriate.

Related concepts

4.1 About the Target Configuration Editor on page 4-103.

Related tasks

4.10 Creating a power domain for a target on page 4-128.

Related references

4.3 Target configuration editor - Memory tab on page 4-106.
4.4 Target configuration editor - Peripherals tab on page 4-108.
4.5 Target configuration editor - Registers tab on page 4-110.
4.6 Target configuration editor - Group View tab on page 4-112.
4.7 Target configuration editor - Enumerations tab on page 4-114.
4.8 Target configuration editor - Configurations tab on page 4-115.
4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.3 Target configuration editor - Memory tab

A graphical view or tabular view that enables you to define the attributes for each of the block of memory on your target. These memory blocks are used to ensure that your debugger accesses the memory on your target in the right way.

Graphical view

In the graphical view, the following options are available:

View by Map Rule
Filter the graphical view based on the selected rule.

View by Address Type
Filter the graphical view based on secure or non-secure addresses. Available only when TrustZone is supported. You can select TrustZone support in the **Overview** tab.

View by Power Domain
Filter the graphical view based on the power domain. Available only when Power Domain is supported. You can select Power Domain support in the **Overview** tab.

Add button
Add a new memory region.

Remove button
Remove the selected memory region.

Graphical and tabular views

In both the graphical view and the tabular view, the following settings are available:

Unique Name
Name of the selected memory region (mandatory).

Name
User-friendly name for the selected memory region.

Description
Detailed description of the selected memory region.

Base Address
Absolute address or the Name of the memory region to use as a base address. The default is an absolute starting address of `0x0`.

Offset
Offset that is added to the base address (mandatory).

Size
Size of the selected memory region in bytes (mandatory).

Width
Access width of the selected memory region.

Access
Access mode for the selected memory region.

Apply Map Rule (graphical view) Map Rule (tabular view)
Mapping rule to be applied to the selected memory region. You can use the **Map Rules** tab to create and modify rules for control registers.

More... (tabular view)
In the tabular view, the **...** button is displayed when you select **More...** cell. Click the **...** button to display the Context and Parameters dialog box.

Context
Debugger plug-in. If you want to pass parameters to a specific debugger, select a plug-in and enter the associated parameters.

Parameters
Parameters associated with the selected debugger plug-in. Select the required debugger plug-in from the **Context** drop-down menu to enter parameters for that debugger plug-in.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

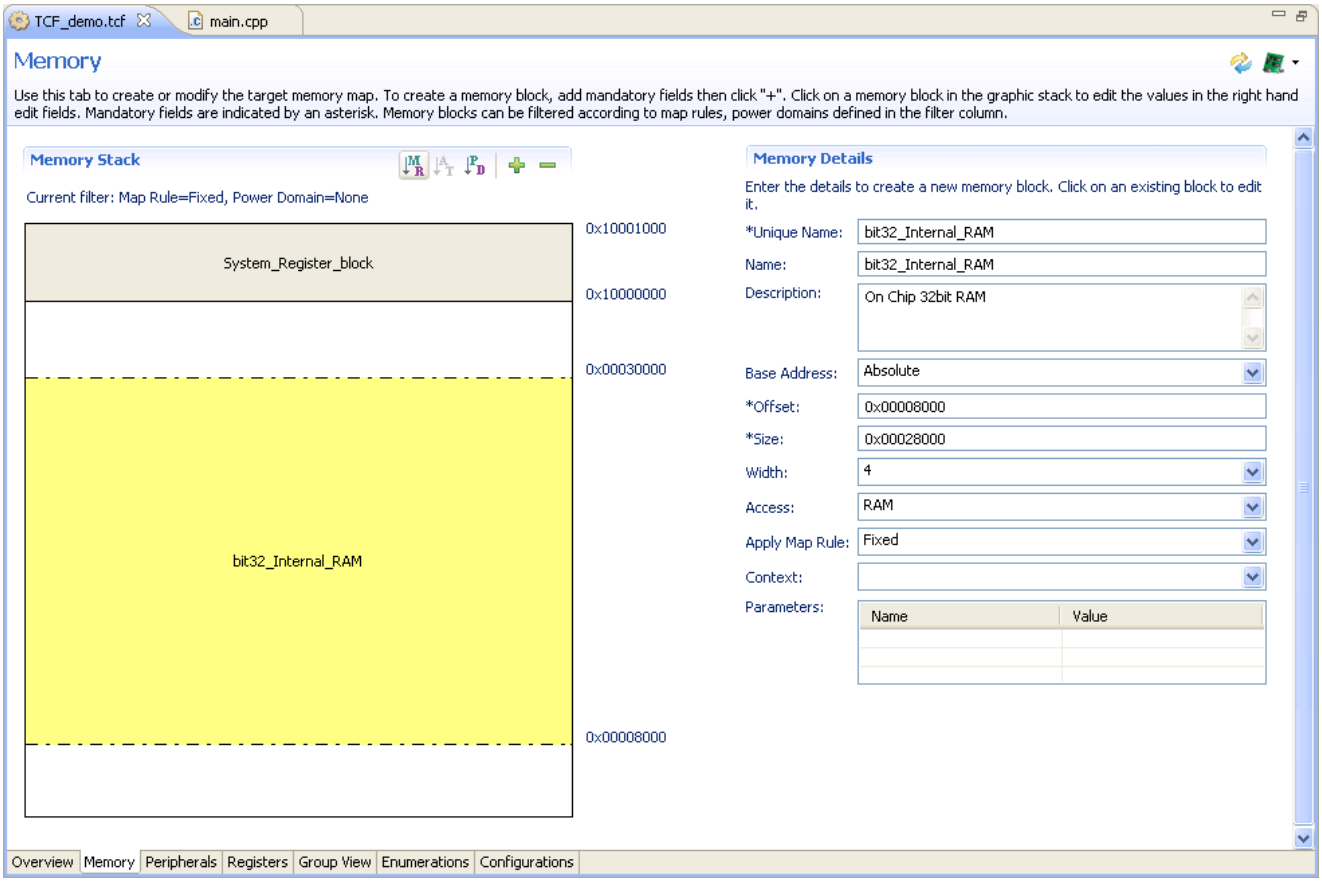


Figure 4-3 Target configuration editor - Memory tab

Mandatory fields are indicated by an asterisk. Toolbar buttons and error messages are displayed in the header panel as appropriate.

Related concepts

4.1 About the Target Configuration Editor on page 4-103.

Related tasks

4.9.1 Creating a memory map on page 4-118.
4.9.8 Creating a memory region for remapping by a control register on page 4-124.
4.9.9 Applying the map rules to the overlapping memory regions on page 4-125.

Related references

4.2 Target configuration editor - Overview tab on page 4-104.
4.4 Target configuration editor - Peripherals tab on page 4-108.
4.5 Target configuration editor - Registers tab on page 4-110.
4.6 Target configuration editor - Group View tab on page 4-112.
4.7 Target configuration editor - Enumerations tab on page 4-114.
4.8 Target configuration editor - Configurations tab on page 4-115.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.4 Target configuration editor - Peripherals tab

A graphical view or tabular view that enables you to define peripherals on your target. They can then be mapped in memory, for display and control, and accessed for block data, when available. You define the peripheral in terms of the area of memory it occupies.

Graphical view

In the graphical view, the following options are available:

View by Address Type
Filter the graphical view based on secure or non-secure addresses. Available only when TrustZone is supported. You can select TrustZone support in the **Overview** tab.

View by Power Domain
Filter the graphical view based on the power domain. Available only when Power Domain is supported. You can select Power Domain support in the **Overview** tab.

Add button
Add a new peripheral.

Remove button
Remove the selected peripheral and, if required, the associated registers.

Graphical and tabular views

In both the graphical view and the tabular view, the following settings are available:

Unique Name
Name of the selected peripheral (mandatory).

Name
User-friendly name for the selected peripheral.

Description
Detailed description of the selected peripheral.

Base Address
Absolute address or the Name of the memory region to use as a base address. The default is an absolute starting address of `0x0`.

Offset
Offset that is added to the base address (mandatory).

Size
Size of the selected peripheral in bytes.

Width
Access width of the selected peripheral in bytes.

Access
Access mode for the selected peripheral.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

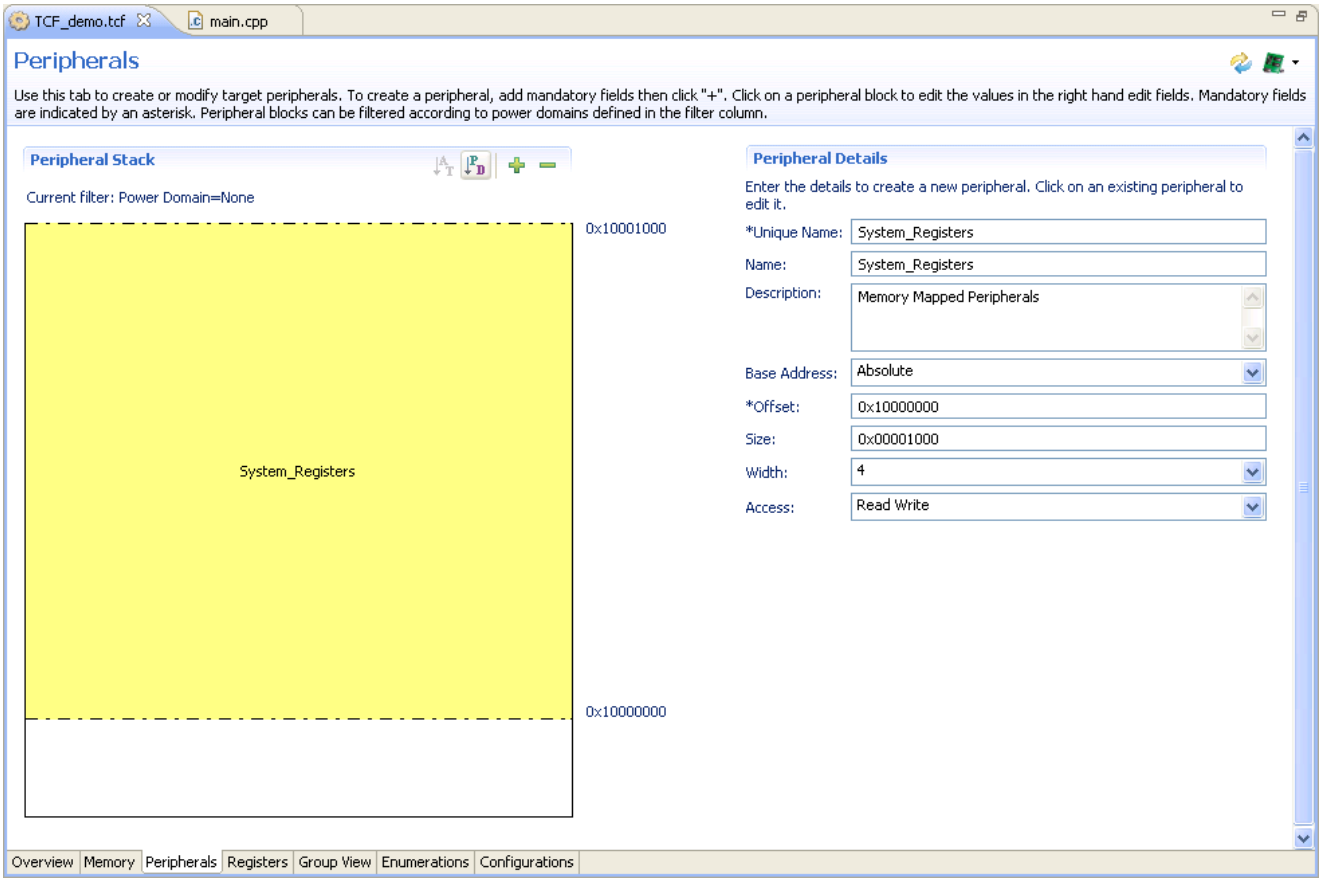


Figure 4-4 Target configuration editor - Peripherals tab

Mandatory fields are indicated by an asterisk. Toolbar buttons and error messages are displayed in the header panel as appropriate.

Related concepts

4.1 About the Target Configuration Editor on page 4-103.

Related tasks

4.9.2 Creating a peripheral on page 4-119.

Related references

4.2 Target configuration editor - Overview tab on page 4-104.
4.3 Target configuration editor - Memory tab on page 4-106.
4.5 Target configuration editor - Registers tab on page 4-110.
4.6 Target configuration editor - Group View tab on page 4-112.
4.7 Target configuration editor - Enumerations tab on page 4-114.
4.8 Target configuration editor - Configurations tab on page 4-115.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.5 Target configuration editor - Registers tab

A tabular view that enables you to define memory mapped registers for your target. Each register is named and typed and can be subdivided into bit fields (any number of bits) which act as subregisters.

Unique Name
Name of the register (mandatory).

Name
User-friendly name for the register.

Base Address
Absolute address or the Name of the memory region to use as a base address. The default is an absolute starting address of `0x0`.

Offset
Offset that is added to the base address (mandatory).

Size
Size of the register in bytes (mandatory).

Access size
Access width of the register in bytes.

Access
Access mode for the selected register.

Description
Detailed description of the register.

Peripheral
Associated peripheral, if applicable.

The **Bitfield** button opens a table displaying the following information:

Unique Name
Name of the selected bitfield (mandatory).

Name
User-friendly name for the selected bitfield.

Low Bit
Zero indexed low bit number for the selected bitfield (mandatory).

High Bit
Zero indexed high bit number for the selected bitfield (mandatory).

Access
Access mode for the selected bitfield.

Description
Detailed description of the selected bitfield.

Enumeration
Associated enumeration for the selected bitfield, if applicable.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

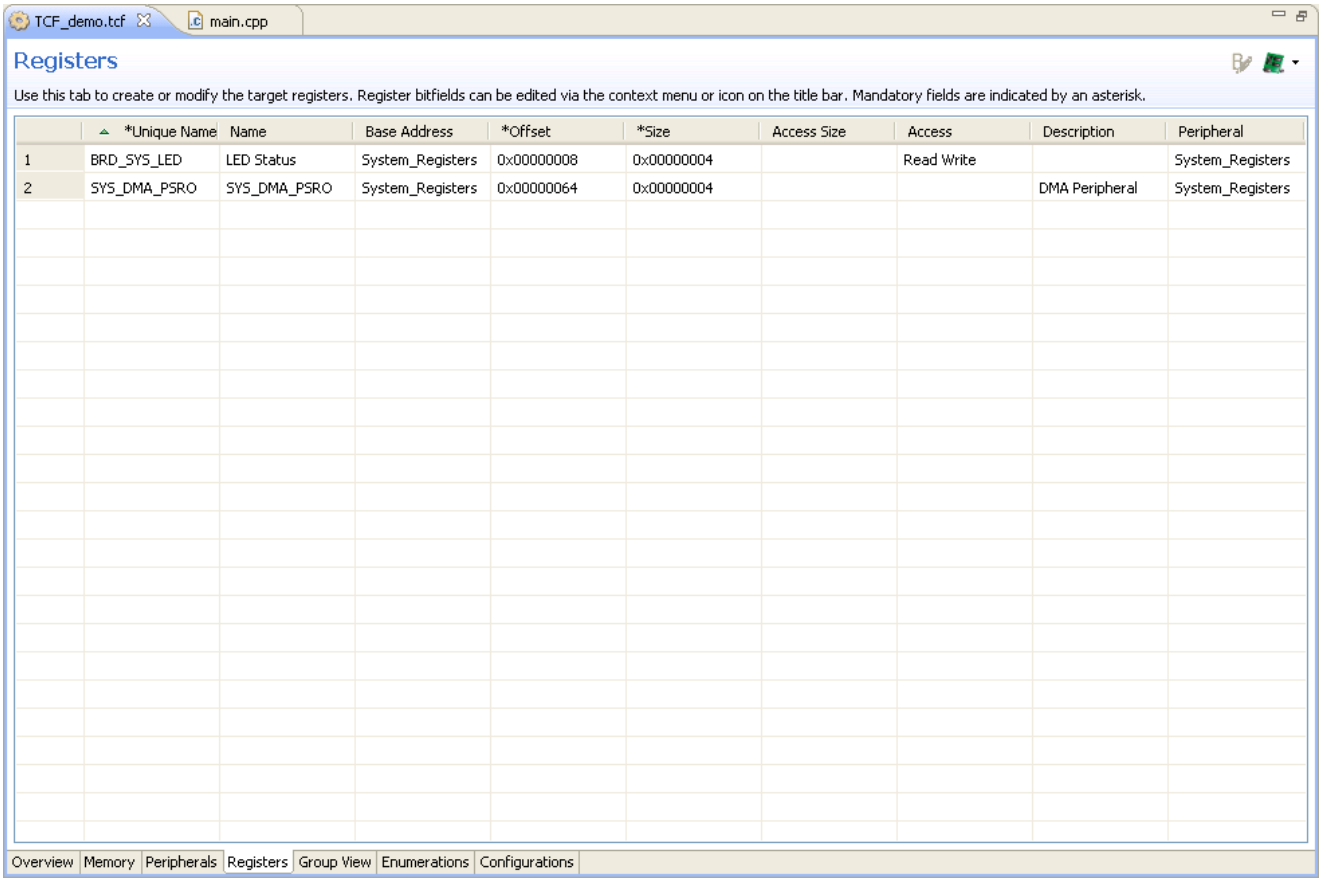


Figure 4-5 Target configuration editor - Registers tab

Mandatory fields are indicated by an asterisk. Toolbar buttons and error messages are displayed in the header panel as appropriate.

Related concepts

4.1 About the Target Configuration Editor on page 4-103.

Related tasks

4.9.3 Creating a standalone register on page 4-120.
4.9.4 Creating a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.
4.9.5 Creating enumerations for use with a peripheral register on page 4-121.

Related references

4.2 Target configuration editor - Overview tab on page 4-104.
4.3 Target configuration editor - Memory tab on page 4-106.
4.4 Target configuration editor - Peripherals tab on page 4-108.
4.6 Target configuration editor - Group View tab on page 4-112.
4.7 Target configuration editor - Enumerations tab on page 4-114.
4.8 Target configuration editor - Configurations tab on page 4-115.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.6 Target configuration editor - Group View tab

A list view that enables you to select peripherals for use by the debugger.

Group View List

Empty list that enables you to add frequently used peripherals to the debugger.

Add a new group

Creates a group that you can personalize with peripherals.

Remove the selected group

Removes a group from the list.

Available Peripheral List

A list of the available peripherals. You can select peripherals from this view to add to the **Group View List**.

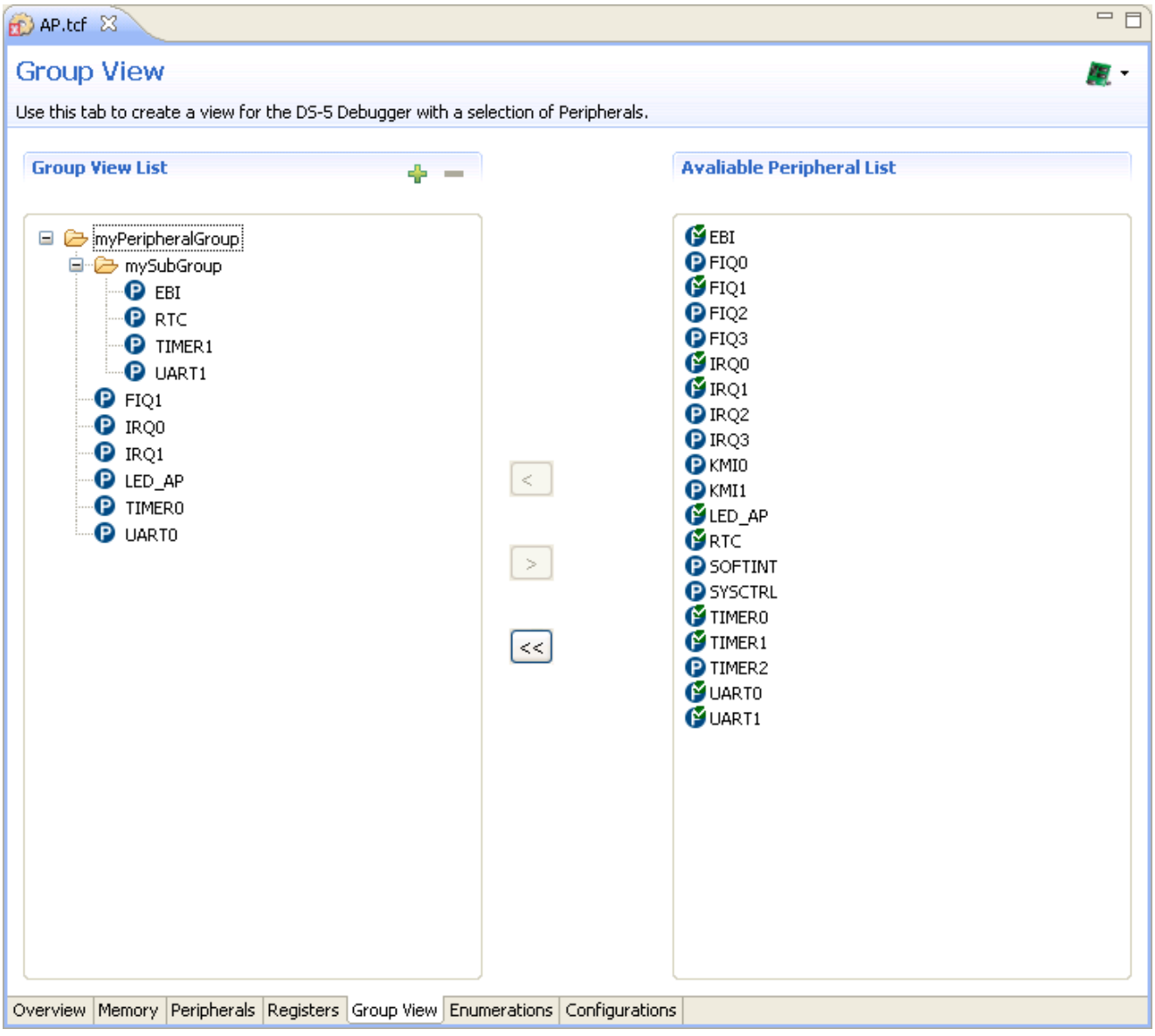


Figure 4-6 Target configuration editor - Group View tab

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Mandatory fields are indicated by an asterisk. Toolbar buttons and error messages are displayed in the header panel as appropriate.

Related concepts

4.1 About the Target Configuration Editor on page 4-103.

Related tasks

4.11 Creating a Group list on page 4-129.

Related references

4.2 Target configuration editor - Overview tab on page 4-104.
4.3 Target configuration editor - Memory tab on page 4-106.
4.4 Target configuration editor - Peripherals tab on page 4-108.
4.5 Target configuration editor - Registers tab on page 4-110.
4.7 Target configuration editor - Enumerations tab on page 4-114.
4.8 Target configuration editor - Configurations tab on page 4-115.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.7 Target configuration editor - Enumerations tab

A tabular view that enables you to assign values to meaningful names for use by registers you have defined. Enumerations can be used, instead of values, when a register is displayed in the **Registers** view. This setting enables you to define the names associated with different values. Names defined in this group are displayed in the **Registers** view, and can be used to change register values.

Register bit fields are numbered 0, 1, 2,... regardless of their position in the register.

For example, you might want to define `ENABLED` as `1` and `DISABLED` as `0`.

The following settings are available:

Unique Name
: Name of the selected enumeration (mandatory).

Value
: Definitions specified as comma separated values for selection in the **Registers** tab (mandatory).

Description
: Detailed description of the selected enumeration.

Mandatory fields are indicated by an asterisk. Toolbar buttons and error messages are displayed in the header panel as appropriate.

Related concepts

4.1 About the Target Configuration Editor on page 4-103.

Related tasks

4.9.5 Creating enumerations for use with a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.

Related references

4.2 Target configuration editor - Overview tab on page 4-104.
4.3 Target configuration editor - Memory tab on page 4-106.
4.4 Target configuration editor - Peripherals tab on page 4-108.
4.5 Target configuration editor - Registers tab on page 4-110.
4.6 Target configuration editor - Group View tab on page 4-112.
4.8 Target configuration editor - Configurations tab on page 4-115.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.8 Target configuration editor - Configurations tab

A tabular view that enables you to:

- Define rules to control the enabling and disabling of memory blocks using target registers. You specify a register to be monitored, and when the contents match a given value, a set of memory blocks is enabled. You can define several map rules, one for each of several memory blocks.
- Define power domains that are supported on your target.

Memory Map Configurations group

The following settings are available in the **Memory Map Configurations** group:

Unique Name
: Name of the rule (mandatory).

Name
: User-friendly name for the rule.

Register
: Associated control register (mandatory).

Mask
: Mask value (mandatory).

Value
: Value for a condition (mandatory).

Trigger
: Condition that changes the control register mapping (mandatory).

Power Domain Configurations group

The **Power Domain Configurations** group

The following settings are available in this group, and all are mandatory:

Unique Name
: Name of the power domain.

Wake-up Conditions
: User-friendly name for the rule:

  Register
  : An associated control register that you have previously created.

  Mask
  : Mask value.

  Value
  : Value for a condition.

  Power State
  : The power state of the power domain:

    - Active.
    - Inactive.
    - Retention.
    - Off.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

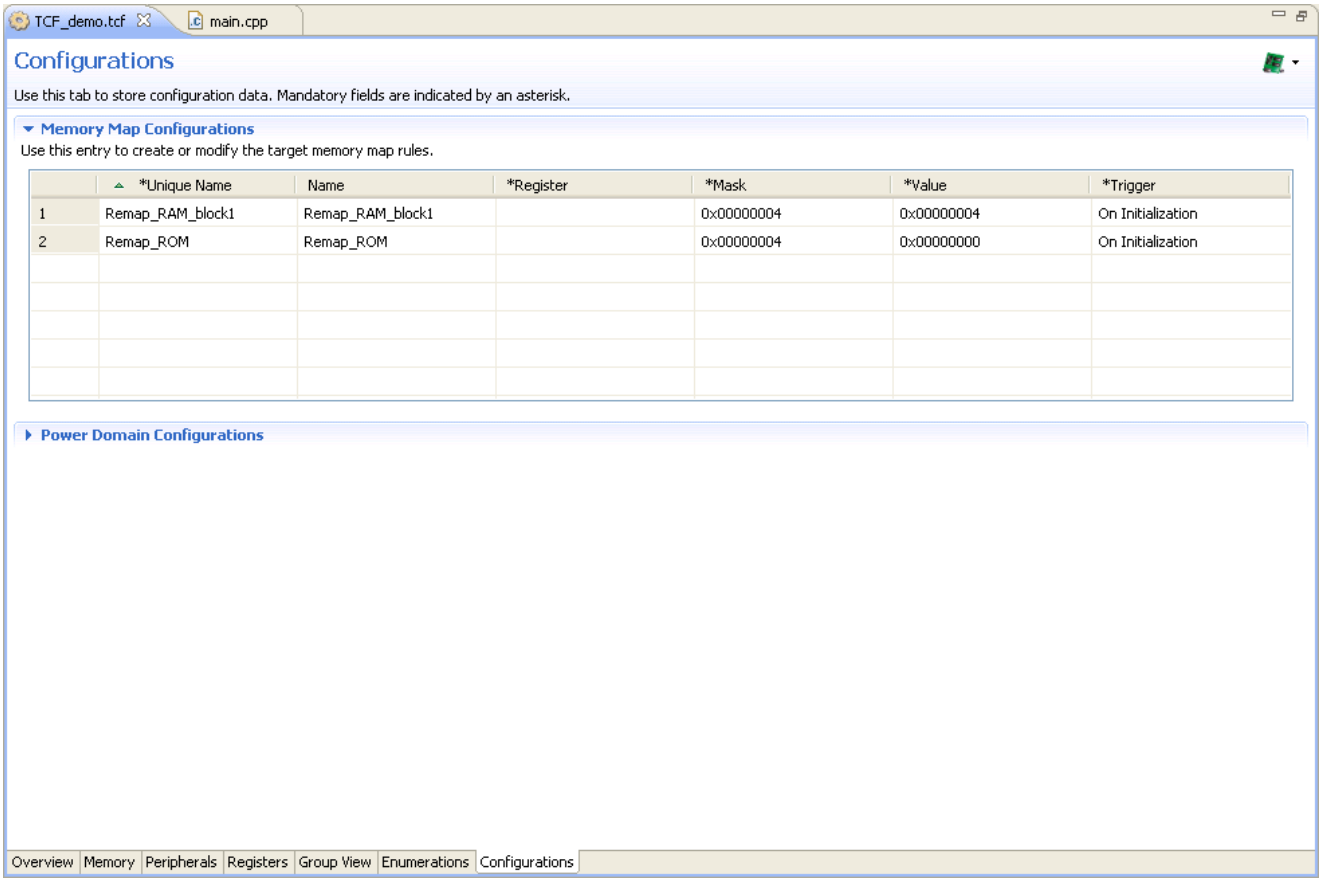


Figure 4-7 Target configuration editor - Configuration tab

Mandatory fields are indicated by an asterisk. Toolbar buttons and error messages are displayed in the header panel as appropriate.

Related concepts

4.1 About the Target Configuration Editor on page 4-103.

Related tasks

4.9.3 Creating a standalone register on page 4-120.
4.9.7 Creating remapping rules for a control register on page 4-123.
4.10 Creating a power domain for a target on page 4-128.

Related references

4.2 Target configuration editor - Overview tab on page 4-104.
4.3 Target configuration editor - Memory tab on page 4-106.
4.4 Target configuration editor - Peripherals tab on page 4-108.
4.5 Target configuration editor - Registers tab on page 4-110.
4.6 Target configuration editor - Group View tab on page 4-112.
4.7 Target configuration editor - Enumerations tab on page 4-114.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.9 Scenario demonstrating how to create a new target configuration file

This is a fictitious scenario to demonstrate how to create a new Target Configuration File (TCF) containing the following memory map and register definitions. The individual tasks required to complete each step of this tutorial are listed below.

- Boot ROM: `0x0 - 0x8000`
- SRAM: `0x0 - 0x8000`
- Internal RAM: `0x8000 - 0x28000`
- System Registers that contain memory mapped peripherals:

  ```
  0x10000000 - 0x10001000.
  ```

  — A basic standalone LED register. This register is located at `0x10000008` and is used to write a hexadecimal value that sets the corresponding bits to 1 to illuminate the respective LEDs.

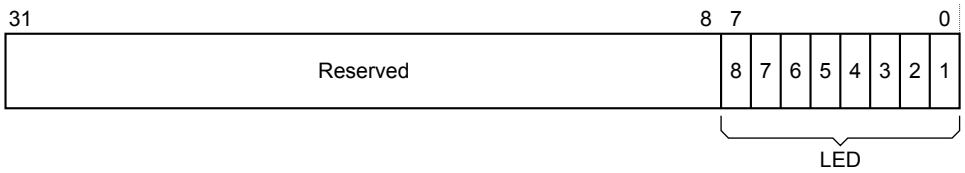


Figure 4-8 LED register and bitfields

  — DMA map register. This register is located at `0x10000064` and controls the mapping of external peripheral DMA request and acknowledge signals to DMA channel 0.

Table 4-1 DMA map register SYS_DMAPSR0

Bits [31:8]	-	Reserved. Use read-modify-write to preserve value
Bit [7]	Read/Write	Set to 1 to enable mapping of external peripheral DMA signals to the DMA controller channel.
Bits [6:5]	-	Reserved. Use read-modify-write to preserve value

Bits [4:0]	Read/Write	FPGA peripheral mapped to this channel
		`b00000 = AACI Tx`
		`b00001 = AACI Rx`
		`b00010 = USB A`
		`b00011 = USB B`
		`b00100 = MCI 0`

  — The core module and LCD control register. This register is located at `0x1000000C` and controls a number of user-configurable features of the core module and the display interface on the baseboard.

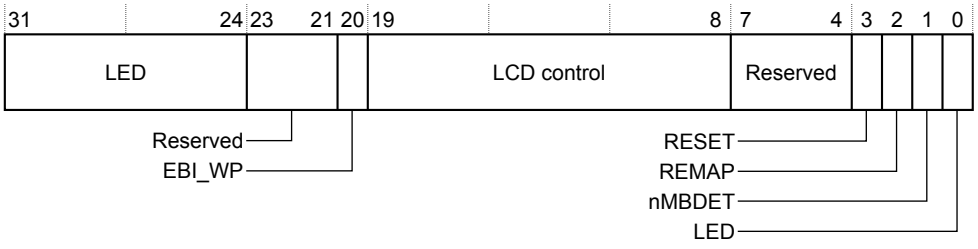


Figure 4-9 Core module and LCD control register

This register uses bit 2 to control the remapping of an area of memory as shown in the following table.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Table 4-2 Control bit that remaps an area of memory

Bits	Name	Access	Function
[2]	REMAP	Read/Write	0 = Flash ROM at address 0 1 = SRAM at address 0.

- Clearing bit 2 (CM_CTRL = 0) generates the following memory map:
  - `0x0000 - 0x8000 Boot_ROM`
  - `0x8000 - 0x28000 32bit_RAM`
- Setting bit 2 (CM_CTRL = 1) generates the following memory map:
  - `0x0000 - 0x8000 32bit_RAM_block1_alias`
  - `0x8000 - 0x28000 32bit_RAM`

This section contains the following subsections:

- *4.9.1 Creating a memory map* on page 4-118.
- *4.9.2 Creating a peripheral* on page 4-119.
- *4.9.3 Creating a standalone register* on page 4-120.
- *4.9.4 Creating a peripheral register* on page 4-121.
- *4.9.5 Creating enumerations for use with a peripheral register* on page 4-121.
- *4.9.6 Assigning enumerations to a peripheral register* on page 4-122.
- *4.9.7 Creating remapping rules for a control register* on page 4-123.
- *4.9.8 Creating a memory region for remapping by a control register* on page 4-124.
- *4.9.9 Applying the map rules to the overlapping memory regions* on page 4-125.

4.9.1 Creating a memory map

Describes how to create a new memory map.

Procedure

1. Add a new file with the `.tcf` file extension to an open project.
   The editor opens with the **Overview** tab activated.
2. Click on the **Overview** tab, enter a unique board name, for example: `My-Dev-Board`.
3. Click on the **Memory** tab.
4. Click the **Switch to table** button in the top right of the view.
5. Enter the data as shown in the following figure.

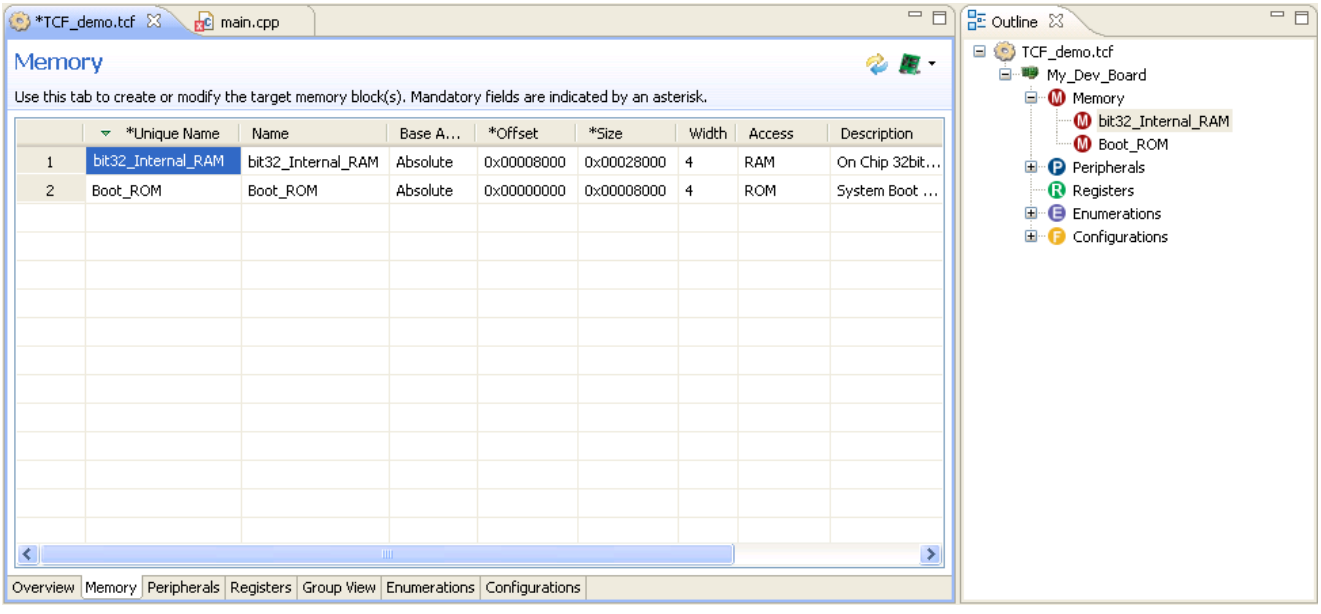


Figure 4-10 Creating a Memory map

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

On completion, you can switch back to the graphical view to see the color coded stack of memory regions.

Related tasks

4.9.2 Creating a peripheral on page 4-119.
4.9.3 Creating a standalone register on page 4-120.
4.9.4 Creating a peripheral register on page 4-121.
4.9.5 Creating enumerations for use with a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.
4.9.7 Creating remapping rules for a control register on page 4-123.
4.9.8 Creating a memory region for remapping by a control register on page 4-124.
4.9.9 Applying the map rules to the overlapping memory regions on page 4-125.

Related references

4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.
4.3 Target configuration editor - Memory tab on page 4-106.

4.9.2 Creating a peripheral

Describes how to create a peripheral.

Procedure

1. Click on the **Peripherals** tab.
2. Click the **Switch to table** button in the top right of the view.
3. Enter the data as shown in the following figure.

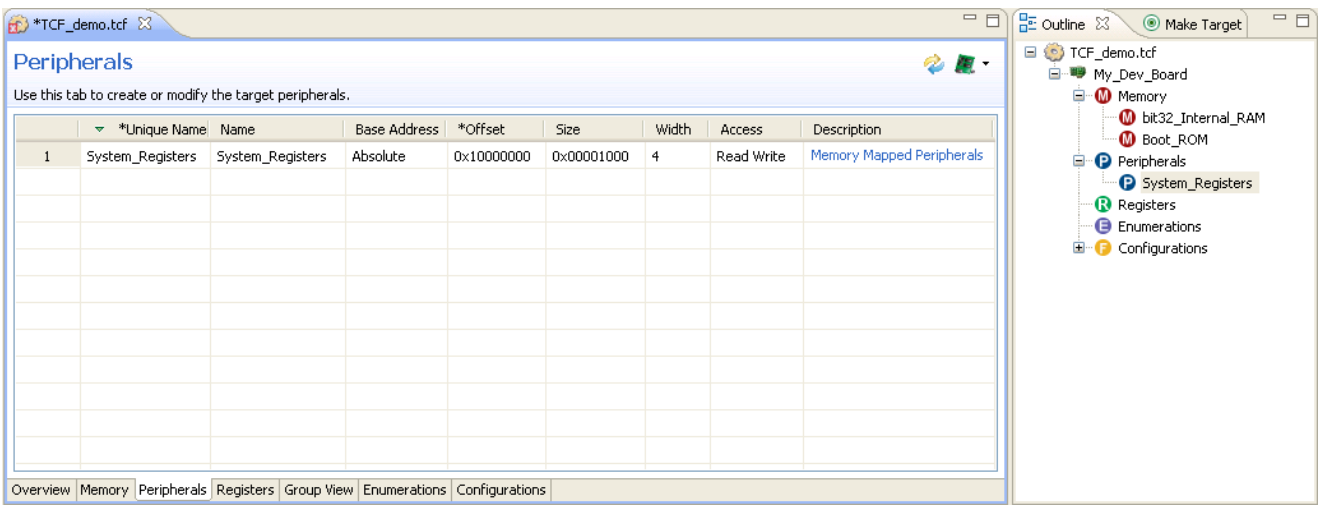


Figure 4-11 Creating a peripheral

On completion, you can switch back to the graphical view to see the color coded stack of peripherals.

Related tasks

4.9.1 Creating a memory map on page 4-118.
4.9.3 Creating a standalone register on page 4-120.
4.9.4 Creating a peripheral register on page 4-121.
4.9.5 Creating enumerations for use with a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.
4.9.7 Creating remapping rules for a control register on page 4-123.
4.9.8 Creating a memory region for remapping by a control register on page 4-124.
4.9.9 Applying the map rules to the overlapping memory regions on page 4-125.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related references

4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.
4.4 Target configuration editor - Peripherals tab on page 4-108.

4.9.3 Creating a standalone register

Describes how to create a basic standalone register.

Procedure

1. Click on the **Registers** tab.
2. Enter the register data as shown in the following figure.
3. Bitfield data is entered in a floating table associated with the selected register. Select the Unique name field containing the register name, `BRD_SYS_LED`.
4. Click on the **Edit Bitfield** button in the top right corner of the view.
5. In the floating Bitfield table, enter the data as shown in the following figure. If required, you can dock this table below the register table by clicking on the title bar of the Bitfield table and dragging it to the base of the register table.

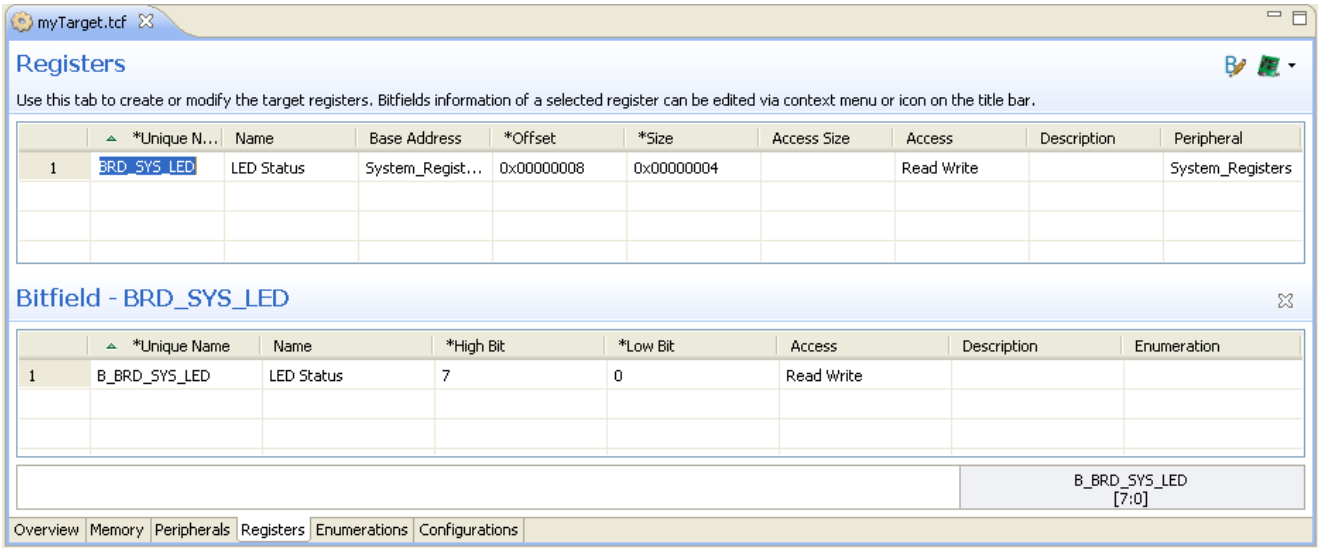


Figure 4-12 Creating a standalone register

On completion, close the floating table.

Related tasks

4.9.1 Creating a memory map on page 4-118.
4.9.2 Creating a peripheral on page 4-119.
4.9.4 Creating a peripheral register on page 4-121.
4.9.5 Creating enumerations for use with a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.
4.9.7 Creating remapping rules for a control register on page 4-123.
4.9.8 Creating a memory region for remapping by a control register on page 4-124.
4.9.9 Applying the map rules to the overlapping memory regions on page 4-125.

Related references

4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.
4.5 Target configuration editor - Registers tab on page 4-110.
4.8 Target configuration editor - Configurations tab on page 4-115.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.9.4 Creating a peripheral register

Describes how to create a peripheral register.

Procedure

1. Click on the **Registers** tab, if it is not already active.
2. Enter the peripheral register and associated bitfield data as shown in the following figure.

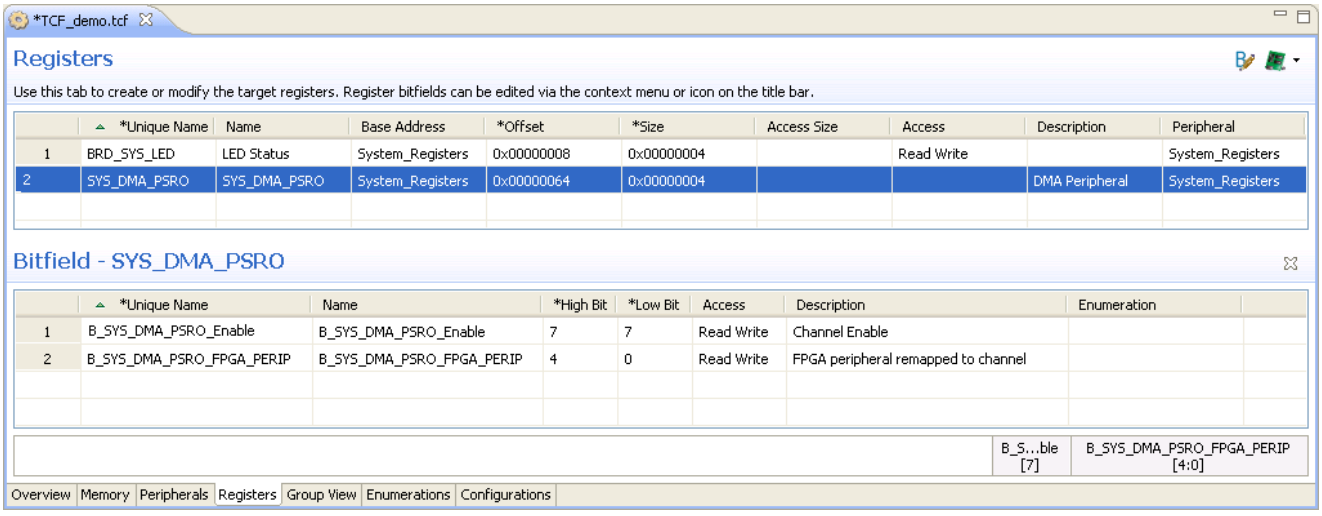


Figure 4-13 Creating a peripheral register

Related tasks

4.9.1 Creating a memory map on page 4-118.
4.9.2 Creating a peripheral on page 4-119.
4.9.3 Creating a standalone register on page 4-120.
4.9.5 Creating enumerations for use with a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.
4.9.7 Creating remapping rules for a control register on page 4-123.
4.9.8 Creating a memory region for remapping by a control register on page 4-124.
4.9.9 Applying the map rules to the overlapping memory regions on page 4-125.

Related references

4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.
4.5 Target configuration editor - Registers tab on page 4-110.

4.9.5 Creating enumerations for use with a peripheral register

Describes how to create enumerations for use with a peripheral.

With more complex peripherals it can be useful to create and assign enumerations to particular peripheral bit patterns so that you can select from a list of enumerated values rather than write the equivalent hexadecimal value. (For example: Enabled/Disabled, On/Off).

Procedure

1. Click on the **Enumerations** tab.
2. Enter the data as shown in the following figure.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

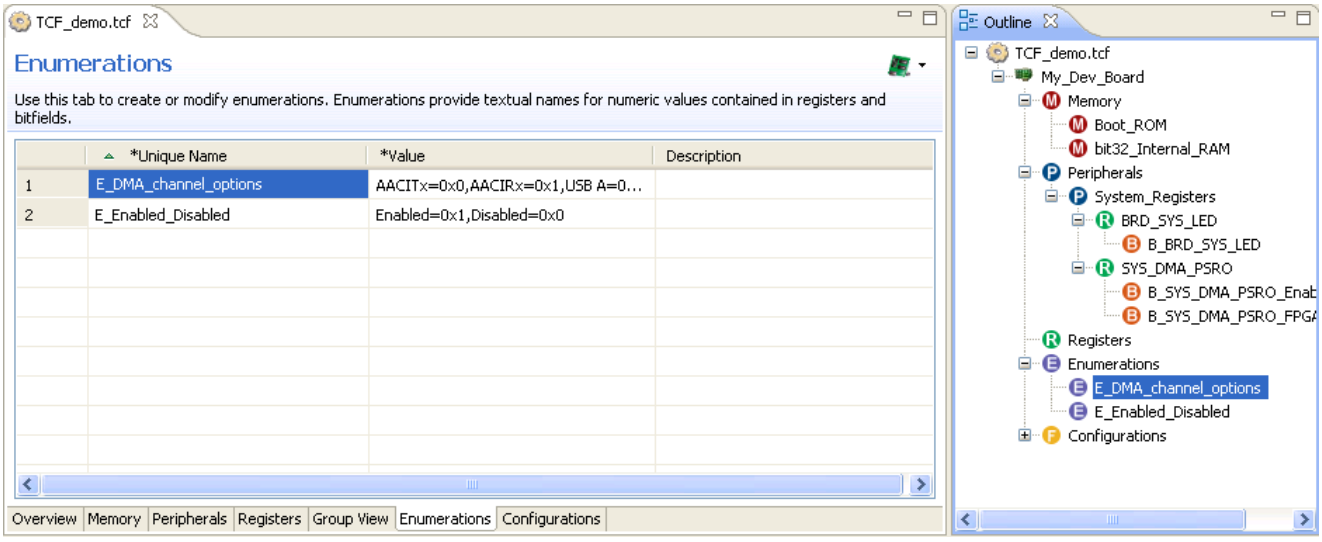


Figure 4-14 Creating enumerations

Related tasks

4.9.1 Creating a memory map on page 4-118.
4.9.2 Creating a peripheral on page 4-119.
4.9.3 Creating a standalone register on page 4-120.
4.9.4 Creating a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.
4.9.7 Creating remapping rules for a control register on page 4-123.
4.9.8 Creating a memory region for remapping by a control register on page 4-124.
4.9.9 Applying the map rules to the overlapping memory regions on page 4-125.

Related references

4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.
4.5 Target configuration editor - Registers tab on page 4-110.
4.7 Target configuration editor - Enumerations tab on page 4-114.

4.9.6 Assigning enumerations to a peripheral register

Describes how to assign enumerations to a peripheral register.

Procedure

1. Click on the **Registers** tab
2. Open the relevant Bitfield table for the DMA peripheral.
3. Assign enumerations as shown in the following figure.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

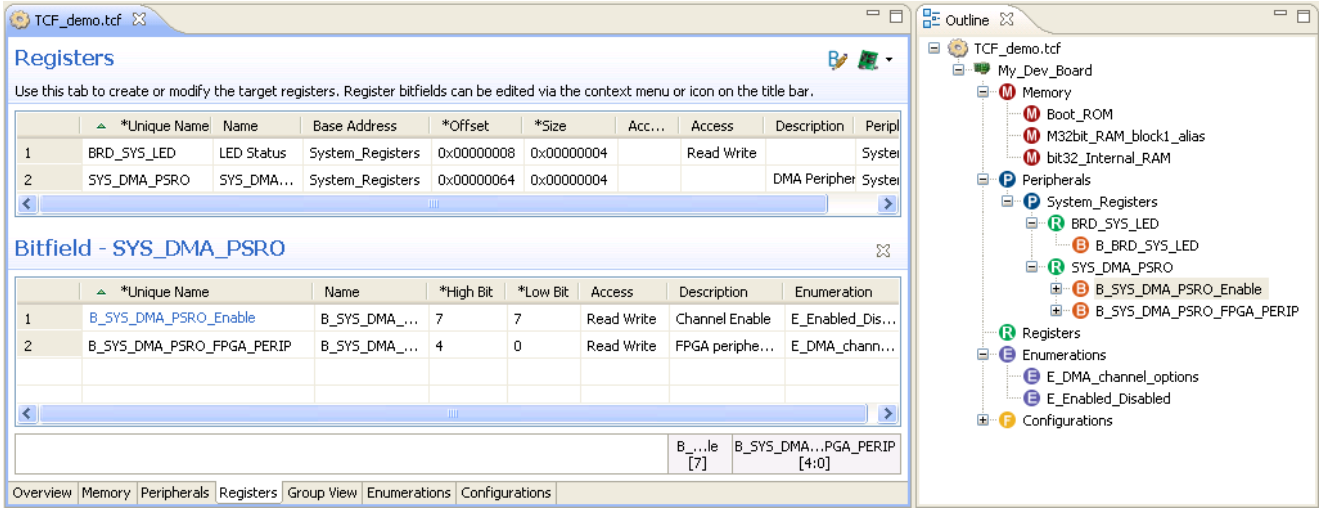


Figure 4-15 Assigning enumerations

Related tasks

4.9.1 Creating a memory map on page 4-118.
4.9.2 Creating a peripheral on page 4-119.
4.9.3 Creating a standalone register on page 4-120.
4.9.4 Creating a peripheral register on page 4-121.
4.9.5 Creating enumerations for use with a peripheral register on page 4-121.
4.9.7 Creating remapping rules for a control register on page 4-123.
4.9.8 Creating a memory region for remapping by a control register on page 4-124.
4.9.9 Applying the map rules to the overlapping memory regions on page 4-125.

Related references

4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.
4.5 Target configuration editor - Registers tab on page 4-110.
4.7 Target configuration editor - Enumerations tab on page 4-114.

4.9.7 Creating remapping rules for a control register

Describes how to create remapping rules for the core module and LCD control register.

Procedure

1. Click on the **Configurations** tab.
2. Enter the data as shown in the following figure.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

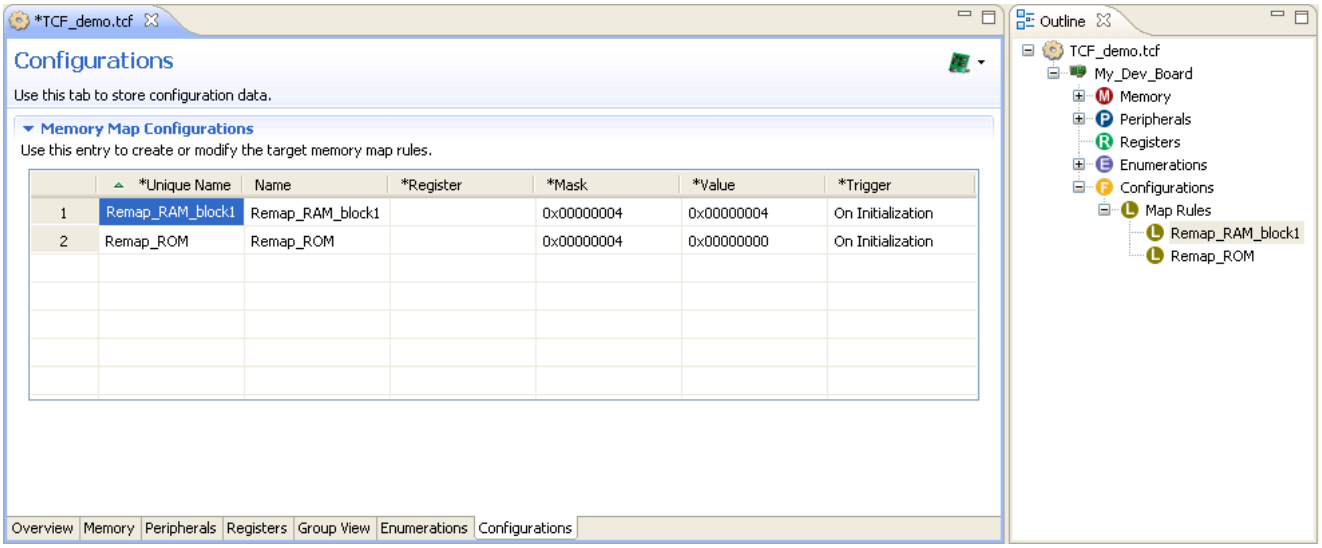


Figure 4-16 Creating remapping rules

Related tasks

4.9.1 Creating a memory map on page 4-118.
4.9.2 Creating a peripheral on page 4-119.
4.9.3 Creating a standalone register on page 4-120.
4.9.4 Creating a peripheral register on page 4-121.
4.9.5 Creating enumerations for use with a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.
4.9.8 Creating a memory region for remapping by a control register on page 4-124.
4.9.9 Applying the map rules to the overlapping memory regions on page 4-125.

Related references

4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.
4.8 Target configuration editor - Configurations tab on page 4-115.

4.9.8 Creating a memory region for remapping by a control register

Describes how to create a new memory region that can be used for remapping when bit 2 of the control register is set.

Procedure

1. Click on the **Memory** tab.
2. Switch to the table view by clicking on the relevant button in the top corner.
3. Enter the data as shown in the following figure.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

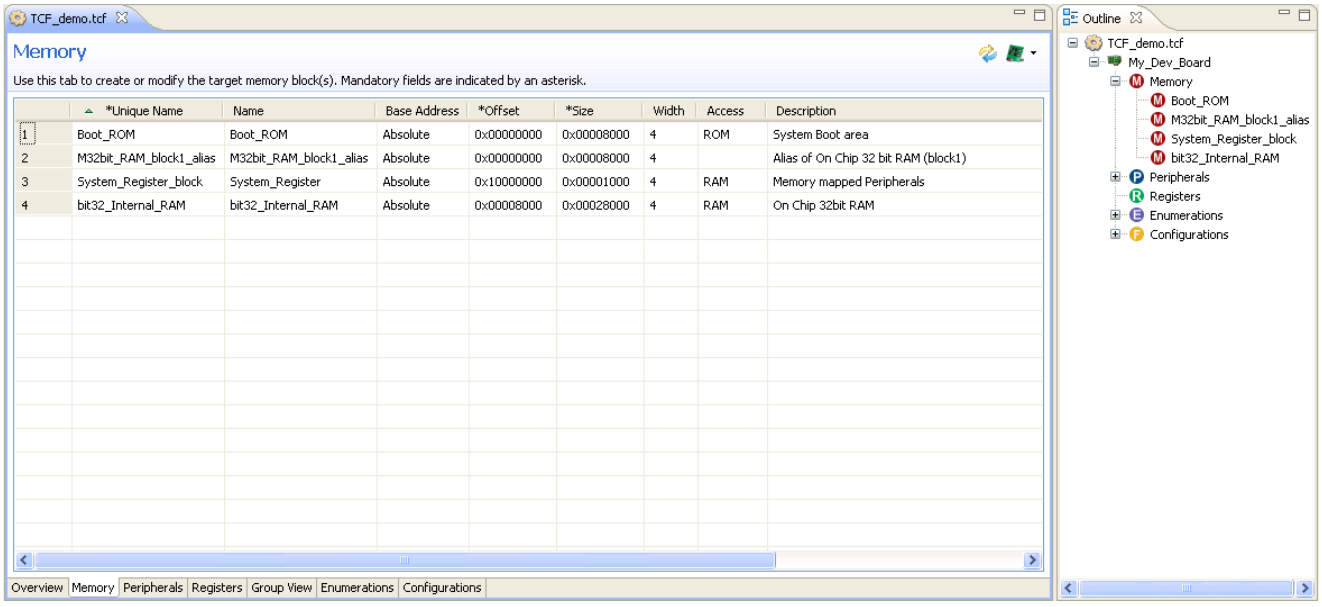


Figure 4-17 Creating a memory region for remapping by a control register

Related tasks

4.9.1 Creating a memory map on page 4-118.
4.9.2 Creating a peripheral on page 4-119.
4.9.3 Creating a standalone register on page 4-120.
4.9.4 Creating a peripheral register on page 4-121.
4.9.5 Creating enumerations for use with a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.
4.9.7 Creating remapping rules for a control register on page 4-123.
4.9.9 Applying the map rules to the overlapping memory regions on page 4-125.

Related references

4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.
4.3 Target configuration editor - Memory tab on page 4-106.

4.9.9 Applying the map rules to the overlapping memory regions

Describes how to apply the map rules to the overlapping memory regions.

Procedure

1. Switch back to the graphic view by clicking on the relevant button in the top corner.
2. Select the overlapping memory region **M32bit_RAM_block1_alias** and then select **Remap_RAM_block1** from the **Apply Map Rule** drop-down menu as shown in the following figure.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

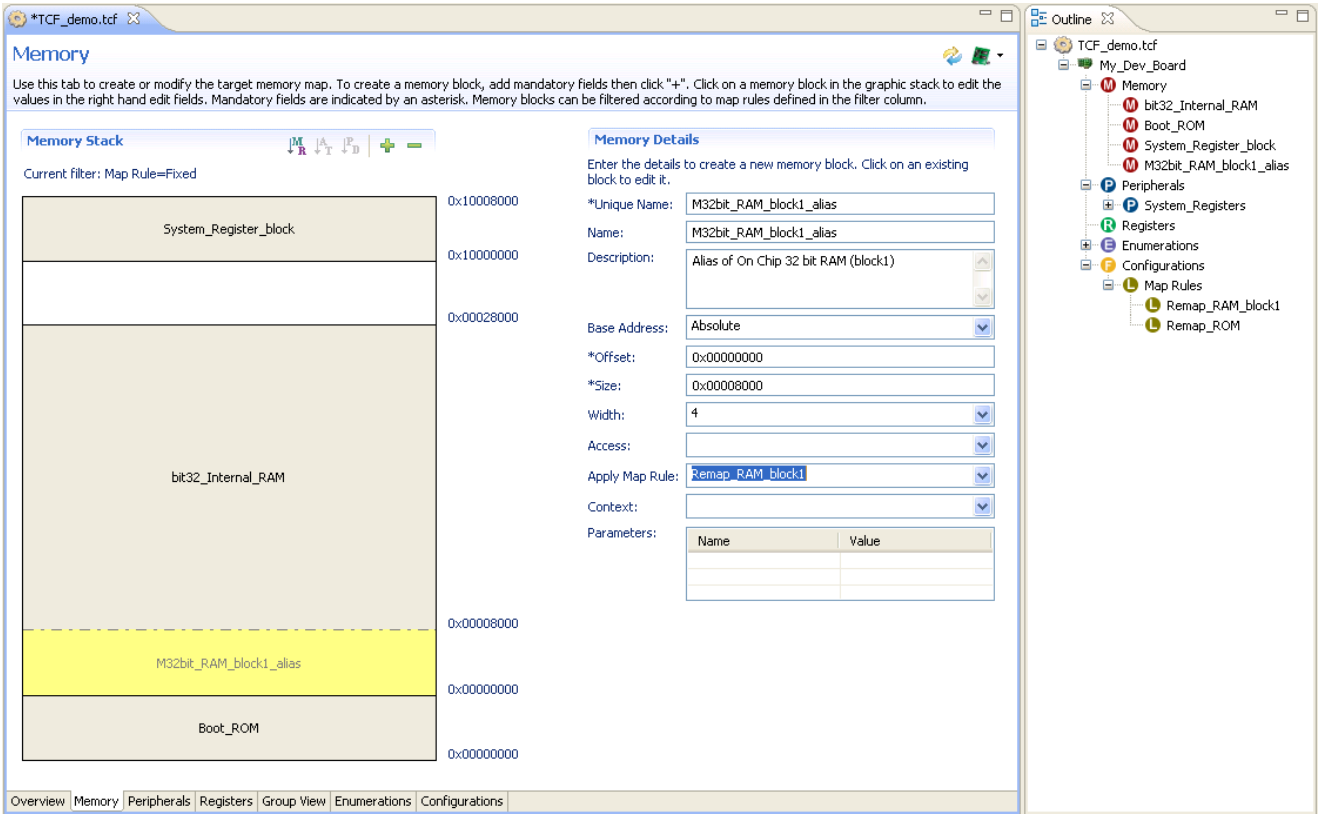


Figure 4-18 Applying the Remap_RAM_block1 map rule

3. To apply the other map rule, you must select **Remap_ROM** in the **View by Map Rule** drop-down menu at the top of the stack view.
4. Select the overlapping memory region **Boot_ROM** and then select **Remap_ROM** from the **Apply Map Rule** drop-down menu as shown in the following figure.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

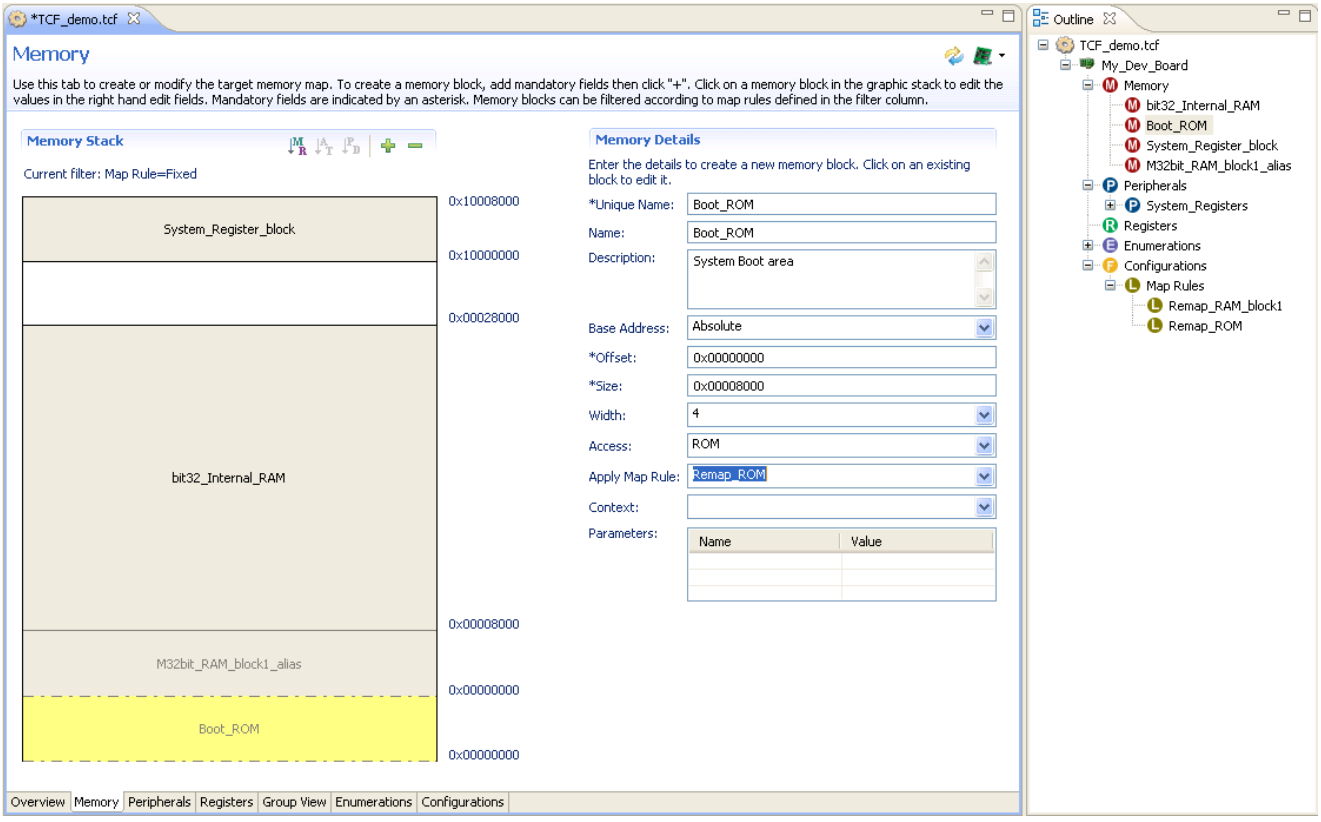


Figure 4-19 Applying the Remap_ROM map rule

5. Save the file.

Related tasks

4.9.1 Creating a memory map on page 4-118.
4.9.2 Creating a peripheral on page 4-119.
4.9.3 Creating a standalone register on page 4-120.
4.9.4 Creating a peripheral register on page 4-121.
4.9.5 Creating enumerations for use with a peripheral register on page 4-121.
4.9.6 Assigning enumerations to a peripheral register on page 4-122.
4.9.7 Creating remapping rules for a control register on page 4-123.
4.9.8 Creating a memory region for remapping by a control register on page 4-124.

Related references

4.9 Scenario demonstrating how to create a new target configuration file on page 4-117.
4.3 Target configuration editor - Memory tab on page 4-106.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.10 Creating a power domain for a target

Describes how to create a power domain configuration for your target.

Prerequisites

Before you create a power domain configuration, you must first create a control register.

Procedure

1. Click on the **Overview** tab.
2. Select **Supported** for the Power Domain setting.
3. Click on the **Configurations** tab.
4. Expand the **Power Domain Configurations** group.

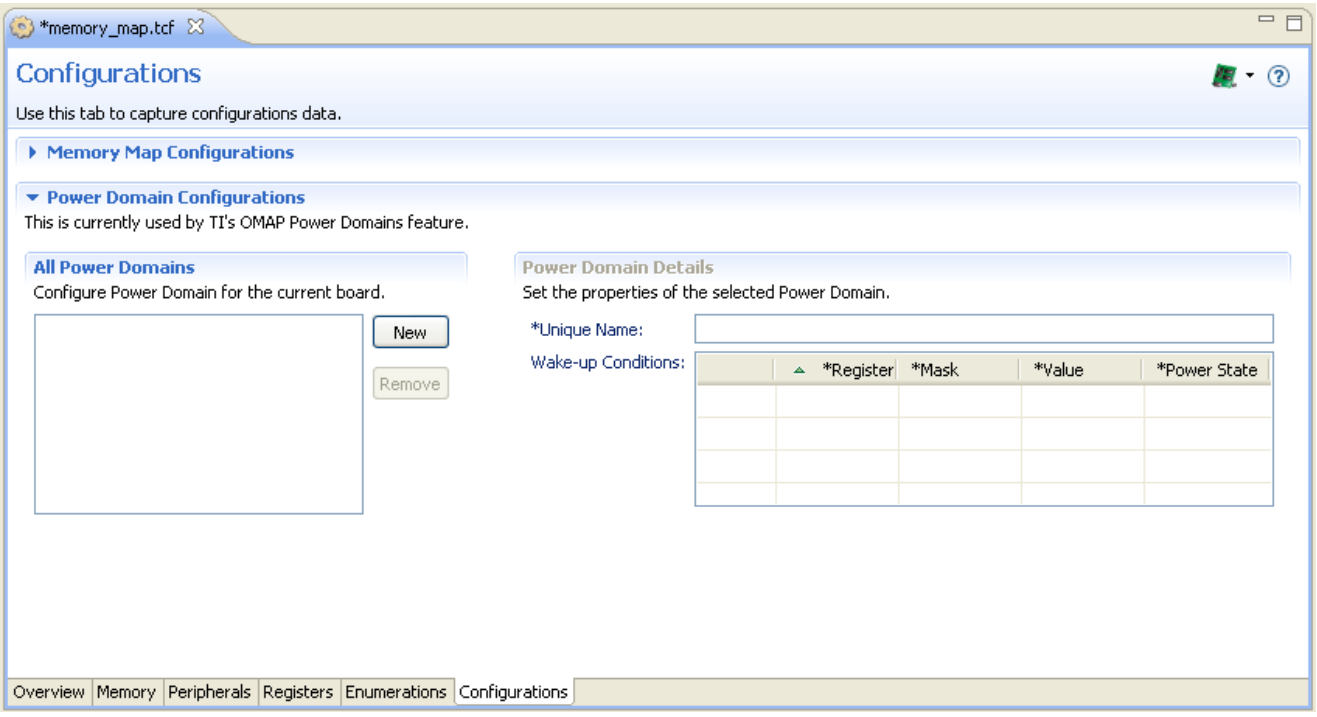


Figure 4-20 Power Domain Configurations

5. Click **New** to create a new power domain.
6. Enter a name in the **Unique Name** field.
7. Set the following **Wake-up Conditions** for the power domain:
   - **Register** - a list of registers you have previously created
   - **Mask**
   - **Value**
   - **Power State**.

   All settings are mandatory.

Related tasks

4.9.3 Creating a standalone register on page 4-120.

Related references

4.2 Target configuration editor - Overview tab on page 4-104.
4.8 Target configuration editor - Configurations tab on page 4-115.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.11 Creating a Group list

Describes how to create a new group list.

Procedure

1. Click on the **Group View** tab.
2. Click **Add a new group** in the **Group View List**.
3. Select the new group.

   Note

   You can create a subgroup by selecting a group and clicking **Add**.

4. Select peripherals and registers from the **Available Peripheral List**.
5. Press the **<< Add** button to add the selected peripherals to the **Group View List**.
6. Click the **Save** icon in the toolbar.

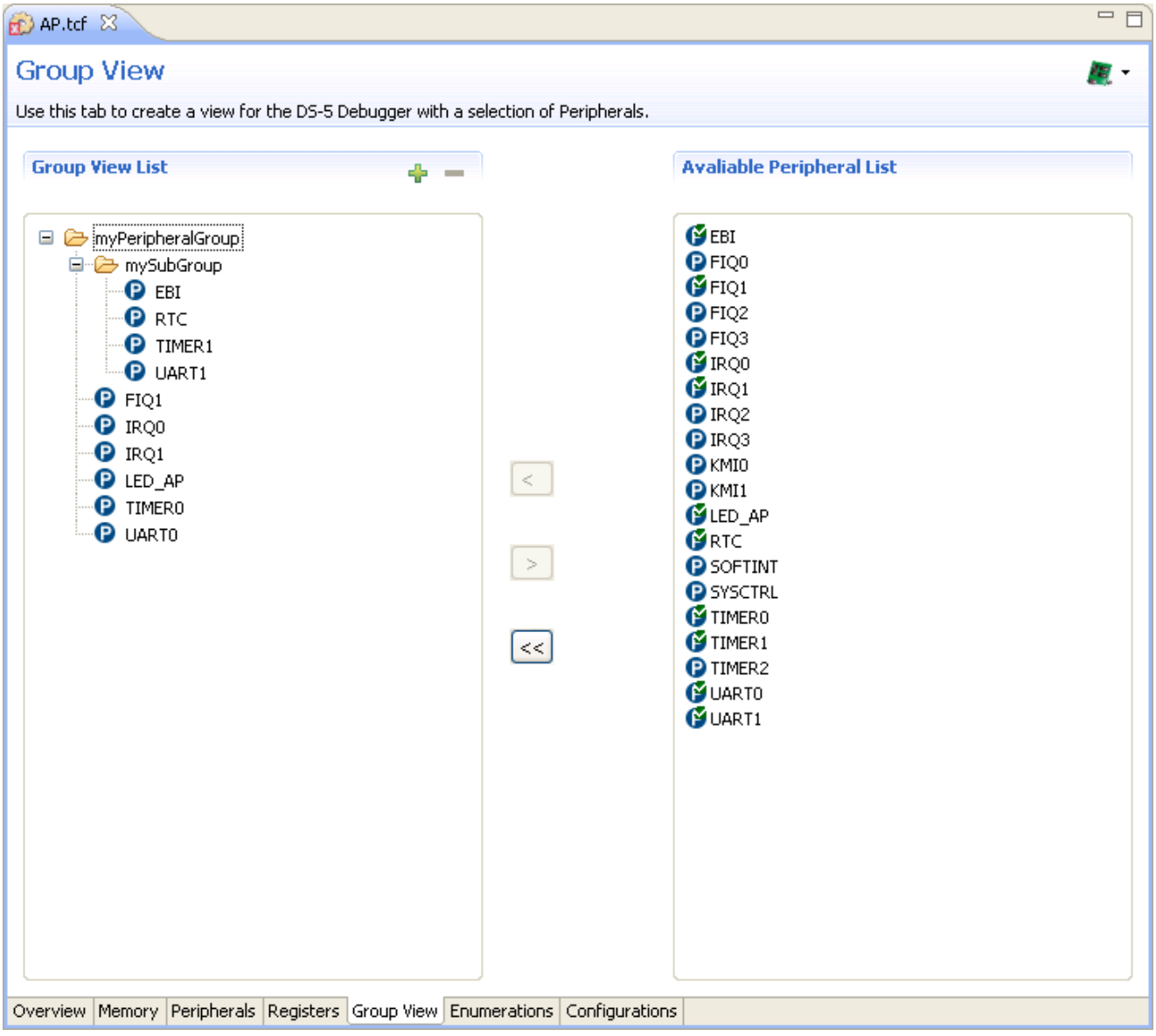


Figure 4-21 Creating a group list

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related references

4.6 Target configuration editor - Group View tab on page 4-112.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.12 Importing an existing target configuration file

Describes how to import an existing target configuration file into the workspace.

Procedure

1. Select **Import** from the **File** menu.
2. Expand the **Target Configuration Editor** group.
3. Select the required file type.

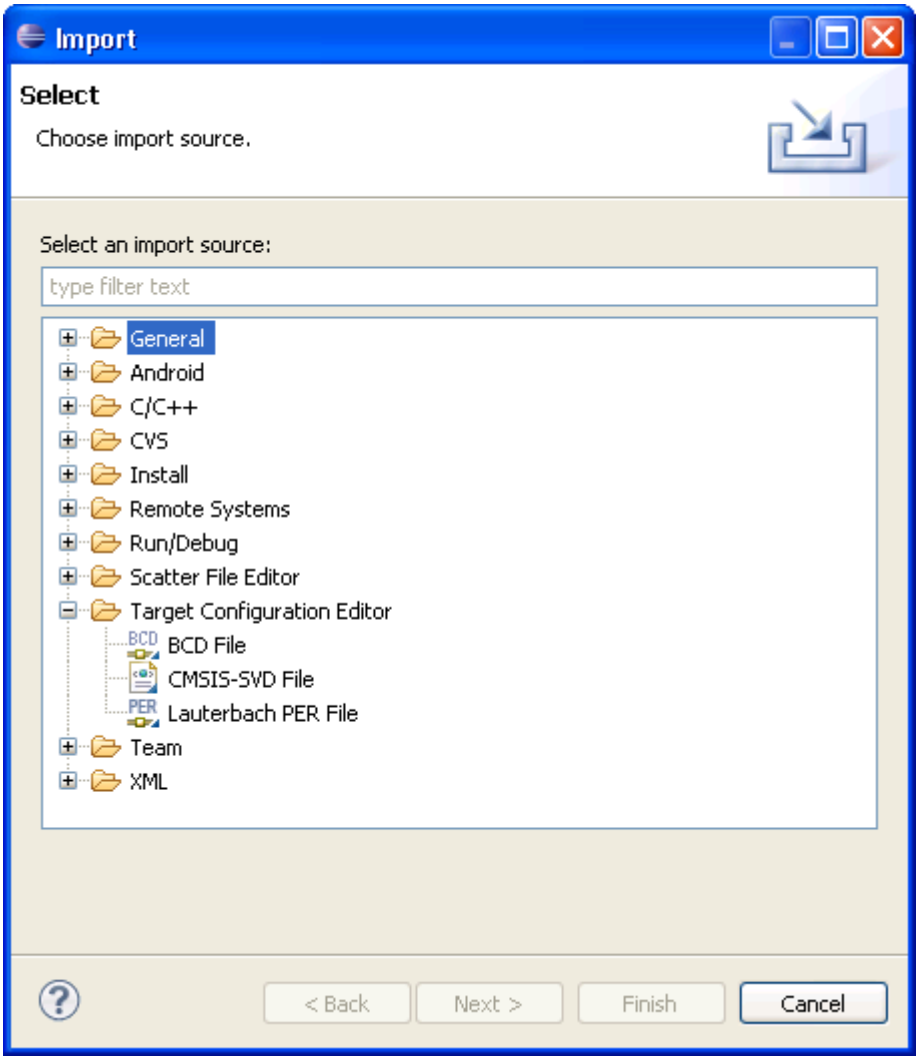


Figure 4-22 Selecting an existing target configuration file

4. Click on **Next**.
5. In the Import dialog box, click **Browse...** to select the folder containing the file.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

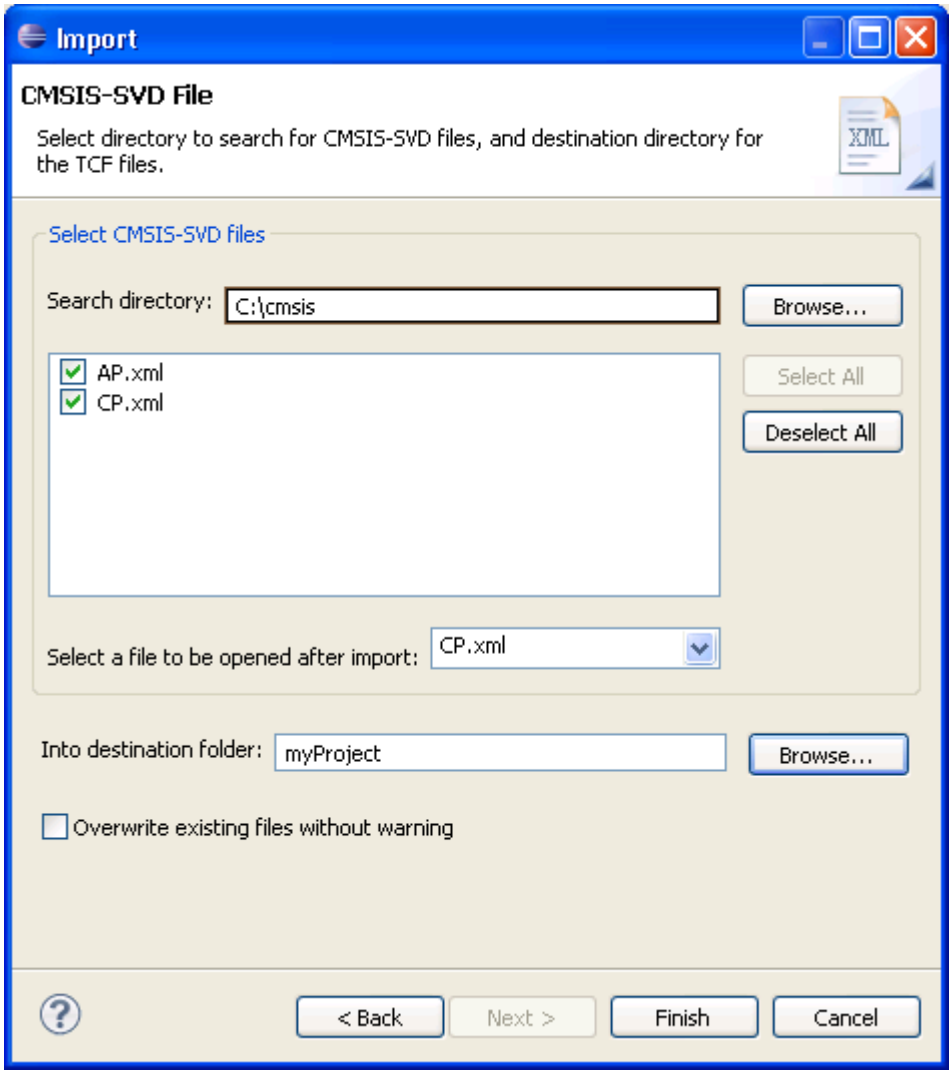


Figure 4-23 Importing the target configuration file

6. By default, all the files that can be imported are displayed. If the selection panel shows more than one file, select the files that you want to import.
7. Select the file that you want to automatically open in the editor.
8. In the Into destination folder field, click **Browse...** to select an existing project.
9. Click **Finish**.

The new *Target Configuration Files* (TCF) is visible in the **Project Explorer** view.

Related tasks

4.13 Exporting a target configuration file on page 4-133.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4.13 Exporting a target configuration file

Describes how to export a target configuration file from a project in the workspace to a C header file.

Note

Before using the export wizard, you must ensure that the Target Configuration File (TCF) is open in the editor view.

Procedure

1. Select **Export** from the **File** menu.
2. Expand the **Target Configuration Editor** group.
3. Select **C Header file**.

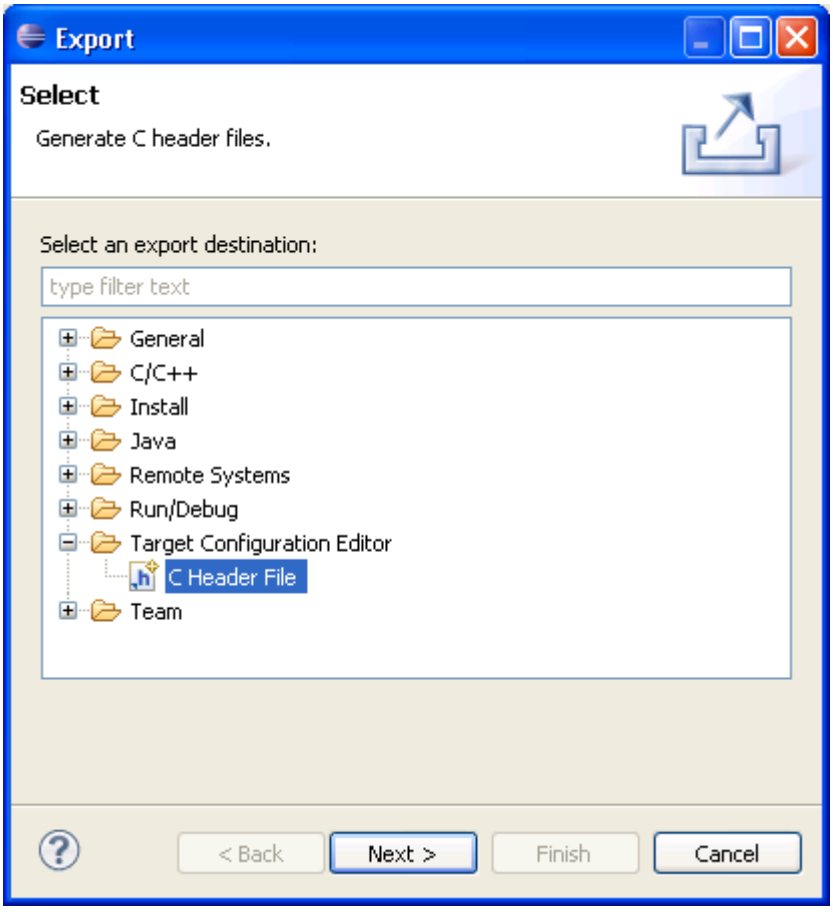


Figure 4-24 Exporting to C header file

4. Click on **Next**.
5. By default, the active files that are open in the editor are displayed. If the selection panel shows more than one file, select the files that you want to export.
6. Click **Browse...** to select a destination path.
7. If required, select **Overwrite existing files without warning**.
8. Click on **Next**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

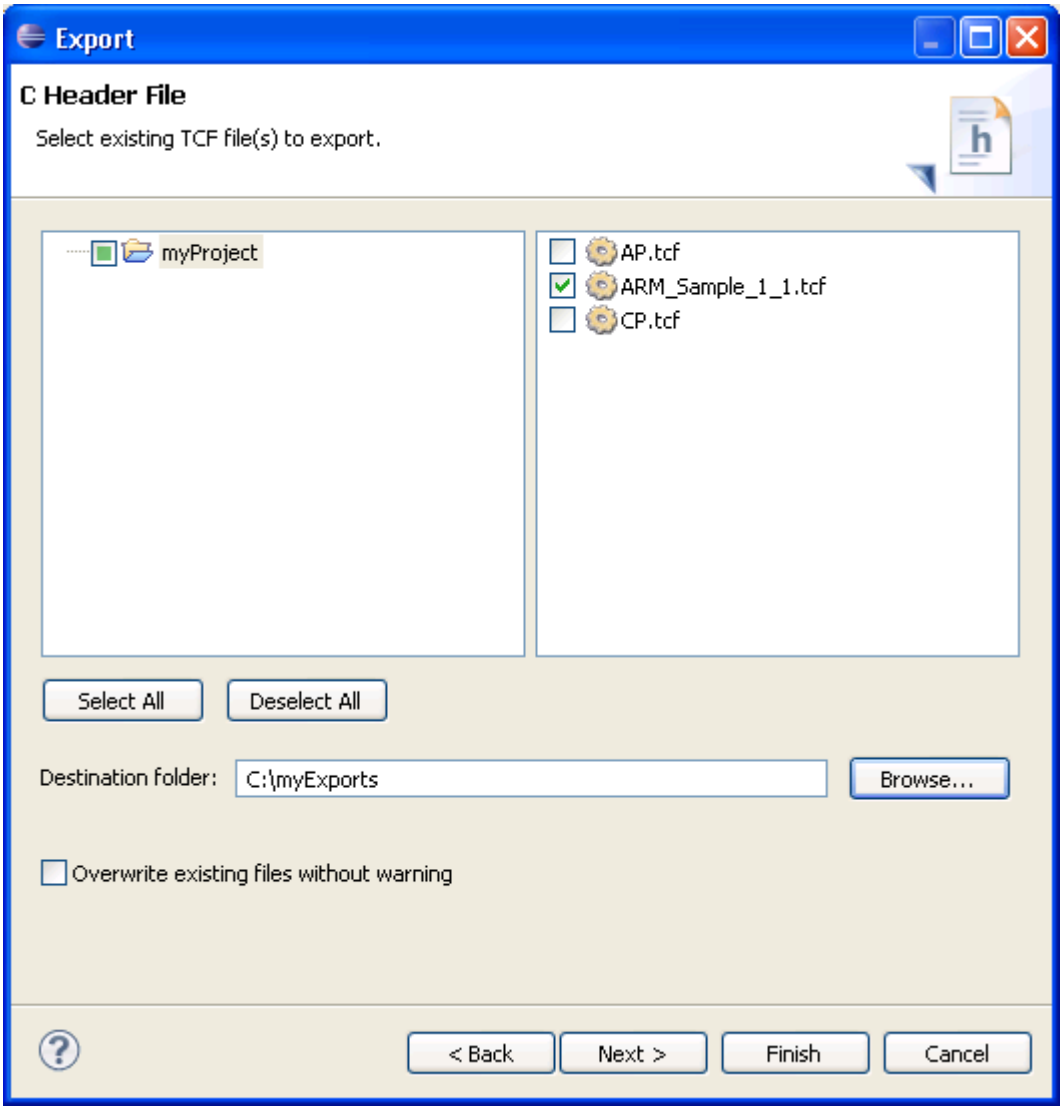


Figure 4-25 Selecting the files

9. If the TCF file has multiple boards, select the board that you want to configure the data for.
10. Select the data that you want to export.
11. Select required export options.
12. Click **Finish** to create the C header file.

Related tasks

4.12 Importing an existing target configuration file on page 4-131.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 5
Examining the Target

This chapter describes how to examine registers, variables, memory, and the call stack.

It contains the following sections:

- *5.1 Examining the target execution environment* on page 5-136.
- *5.2 Examining the call stack* on page 5-137.
- *5.3 About trace support* on page 5-138.
- *5.4 About post-mortem debugging of trace data* on page 5-141.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

5.1 Examining the target execution environment

During a debug session, you might want to display the value of a register or variable, the address of a symbol, the data type of a variable, or the content of memory. The DS-5 Debug perspective provides essential debugger views showing the current values.

As you step through the application, all the views associated with the active connection are updated. In the perspective, you can move any of the views to a different position by clicking on the tab and dragging the view to a new position. You can also double-click on a tab to maximize or reset a view for closer analysis of the contents in the view.

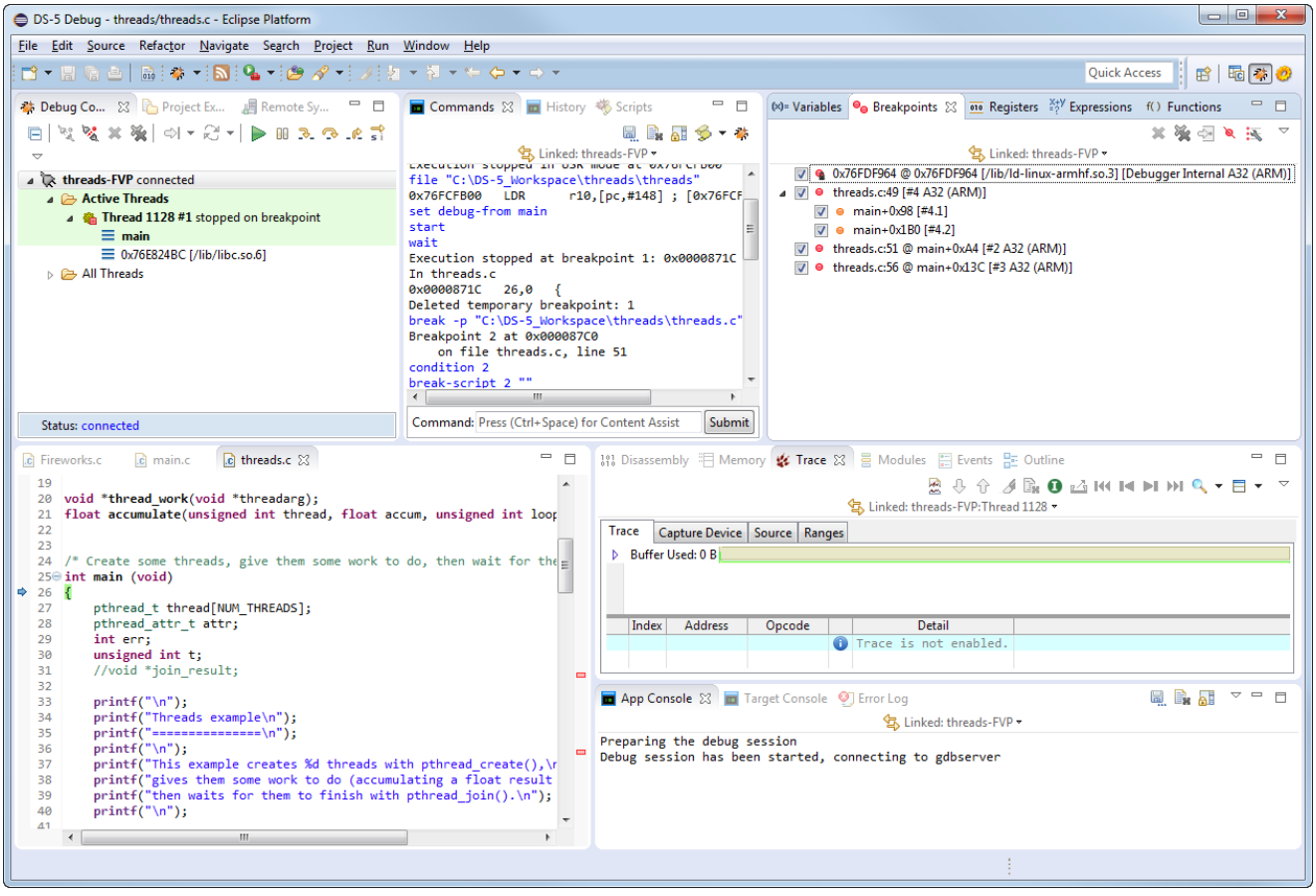


Figure 5-1 Target execution environment

Alternatively, you can use debugger commands to display the required information. In the Commands view, you can execute individual commands or you can execute a sequence of commands by using a script file.

Related concepts

6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.

Related references

3.2 Running, stopping, and stepping through an application on page 3-72.
5.2 Examining the call stack on page 5-137.
3.14 Handling UNIX signals on page 3-90.
3.15 Handling processor exceptions on page 3-92.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

5.2 Examining the call stack

The call stack, or runtime stack, is an area of memory used to store function return information and local variables. As each function is called, a record is created on the call stack. This record is commonly known as a stack frame.

The debugger can display the calling sequence of any functions that are still in the execution path because their calling addresses are still on the call stack. However:

- When a function completes execution the associated stack frame is removed from the call stack and the information is no longer available to the debugger.
- If the call stack contains a function for which there is no debug information, the debugger might not be able to trace back up the calling stack frames. Therefore you must compile all your code with debug information to successfully view the full call stack.

If you are debugging multi-threaded applications, a separate call stack is maintained for each thread.

Use the **Stack** view to display stack information for the currently active connection in the **Debug Control** view. All the views in the DS-5 Debug perspective are associated with the current stack frame and are updated when you select another frame. See *11.8 Stack view* on page 11-282 for more information.

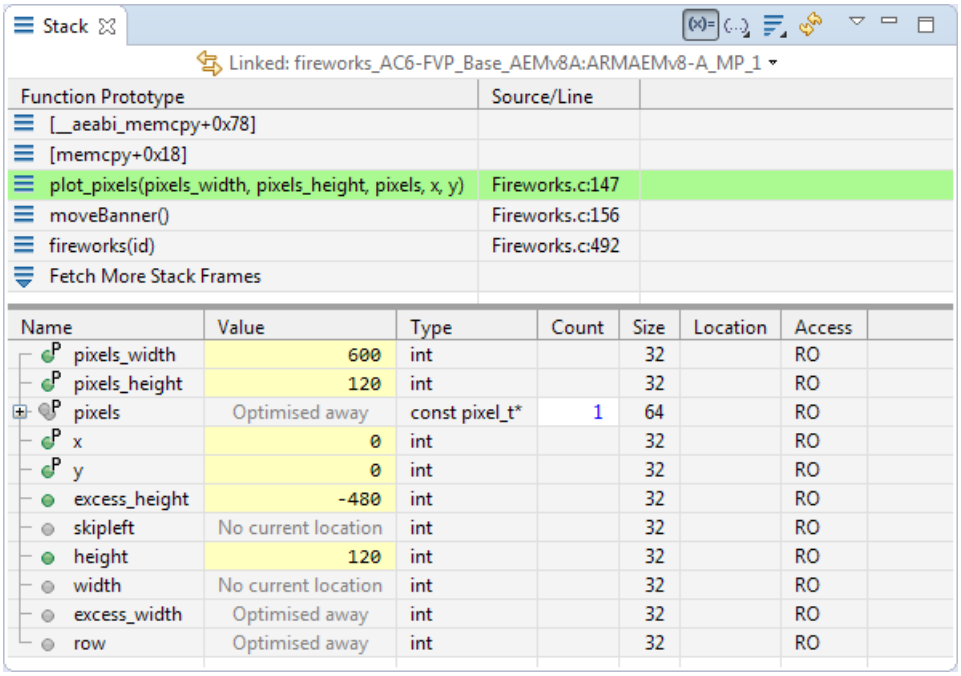


Figure 5-2 Stack view showing information for a selected core

Related concepts

6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.

Related references

3.2 Running, stopping, and stepping through an application on page 3-72.
5.1 Examining the target execution environment on page 5-136.
3.14 Handling UNIX signals on page 3-90.
3.15 Handling processor exceptions on page 3-92.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

5.3 About trace support

ARM DS-5 enables you to perform tracing on your application or system. Tracing enables you to non-invasively capture, in real-time, the instructions and data accesses that were executed. It is a powerful tool that enables you to investigate problems while the system runs at full speed. These problems can be intermittent, and are difficult to identify through traditional debugging methods that require starting and stopping the processor. Tracing is also useful when trying to identify potential bottlenecks or to improve performance-critical areas of your application.

When a program fails, and the trace buffer is enabled, you can see the program history associated with the captured trace. With this program history, it is easier to walk back through your program to see what happened just before the point of failure. This is particularly useful for investigating intermittent and real-time failures, which can be difficult to identify through traditional debug methods that require stopping and starting the processor. The use of hardware tracing can significantly reduce the amount of time required to find these failures, because the trace shows exactly what was executed.

Before the debugger can trace your platform, you must ensure that:

- you have a debug hardware agent, such as an ARM DSTREAM unit or a software debug agent such as ARM VSTREAM, with a connection to a trace stream.
- the debugger is connected to the debug hardware agent.

Trace hardware

Trace is typically provided by an external hardware block connected to the processor. This is known as an *Embedded Trace Macrocell* (ETM) or *Program Trace Macrocell* (PTM) and is an optional part of an ARM architecture-based system. System-on-chip designers might omit this block from their silicon to reduce costs. These blocks observe (but do not affect) the processor behavior and are able to monitor instruction execution and data accesses.

There are two main problems with capturing trace. The first is that with very high processor clock speeds, even a few seconds of operation can mean billions of cycles of execution. Clearly, to look at this volume of information would be extremely difficult. The second problem is that data trace requires very high bandwidth as every load or store operation generates trace information. This is a problem because typically only a few pins are provided on the chip and these outputs might be able to be switched at significantly lower rates than the processor can be clocked at. It is very easy to exceed the capacity of the trace port. To solve this latter problem, the trace macrocell tries to compress information to reduce the bandwidth required. However, the main method to deal with these issues is to control the trace block so that only selected trace information is gathered. For example, trace only execution, without recording data values, or trace only data accesses to a particular peripheral or during execution of a particular function.

In addition, it is common to store trace information in an on-chip memory buffer, the *Embedded Trace Buffer* (ETB). This alleviates the problem of getting information off-chip at speed, but has an additional cost in terms of silicon area and also provides a fixed limit on the amount of trace that can be captured.

The ETB stores the compressed trace information in a circular fashion, continuously capturing trace information until stopped. The size of the ETB varies between chip implementations, but a buffer of 8 or 16kB is typically enough to hold a several thousand lines of program trace.

Trace Ranges

Trace ranges enable you to restrict the capture of trace to a linear range of memory. A trace range has a start and end address in virtual memory, and any execution within this address range is captured. In contrast to trace start and end points, any function calls made within a trace range are only captured if the target of the function call is also within the specified address range. The number of trace ranges that can be enabled is determined by the debug hardware in your processor.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Trace capture is enabled by default when no trace ranges are set. Trace capture is disabled by default when any trace ranges are set, and is only enabled when within the defined ranges.

You can configure trace ranges using the **Ranges** tab in the Trace view. The start and end address for each range can either be an absolute address or an expression, such as the name of a function. Be aware that optimizing compilers might rearrange or minimize code in memory from that in the associated source code. This can lead to code being unexpectedly included or excluded from the trace capture.

Trace Points

Trace points enable you to control precisely where in your program trace is captured. Trace points are non-intrusive and do not require stopping the system to process. The maximum number of trace points that can be set is determined by the debug hardware in your processor. The following types of trace points are available:To set trace points in the source view, right-click in the margin and select the required option from the **DS-5 Breakpoints** context menu. To set trace points in the Disassembly view, right-click on an instruction and select the required option from the **DS-5 Breakpoints** context menu. Trace points are listed in the Breakpoints view.

Trace Start Point
: Enables trace capture when execution reaches the selected address.

Trace Stop Point
: Disables trace capture when execution reaches the selected address

Trace Trigger Point
: Marks this point in your source code so that you can more easily locate it in the Trace view.

Trace Start Points and Trace Stop Points enable and disable capture of trace respectively. Trace points do not take account of nesting. For example, if you hit two Trace Start Points in a row, followed by two Trace Stop Points, then the trace is disabled immediately when the first Trace Stop Point is reached, not the second. With no Trace Start Points set then trace is enabled all the time by default. If you have any Trace Start Points set, then trace is disabled by default and is only enabled when the first Trace Start Point is hit.

Trace trigger points enable you to mark interesting locations in your source code so that you can easily find them later in the Trace view. The first time a Trigger Point is hit a Trace Trigger Event record is inserted into the trace buffer. Only the first Trigger Point to be hit inserts the trigger event record. To configure the debugger so that it stops collecting trace when a trace trigger point is hit, use the **Stop Trace Capture On Trigger** checkbox in the **Properties** tab of the Trace view.

Note

This does not stop the target. It only stops the trace capture. The target continues running normally until it hits a breakpoint or until you click the **Interrupt** icon in the Debug Control view.

When this is set you can configure the amount of trace that is captured before and after a trace trigger point using the Post-Trigger Capture Size field in the **Properties** tab of the Trace view. If you set this field to:

0%
: The trace capture stops as soon as possible after the first trigger point is hit. The trigger event record can be found towards the end of the trace buffer.

50%
: The trace capture stops after the first trigger point is hit and an additional 50% of the buffer is filled. The trigger event record can be found towards the middle of the trace buffer.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

99%

The trace capture stops after the first trigger point is hit and an additional 99% of the buffer is filled. The trigger event record can be found towards the beginning of the trace buffer.

Note

Due to target timing constraints the trigger event record might get pushed out of the trace buffer.

Being able to limit trace capture to the precise areas of interest is especially helpful when using a capture device such as an ETB, where the quantity of trace that can be captured is very small.

Select the **Find Trigger Event record** option in the view menu to locate Trigger Event record in the trace buffer.

Note

Trace trigger functionality is dependent on the target platform being able to signal to the trace capture hardware, such as ETB or DSTREAM, that a trigger condition has occurred. If this hardware signal is not present or not configured correctly then it might not be possible to automatically stop trace capture around trigger points.

Related concepts

5.4 About post-mortem debugging of trace data on page 5-141.
8.1 Overview: Running DS-5 Debugger from the command-line or from a script on page 8-203.

Related tasks

8.4 Specifying a custom configuration database using the command-line on page 8-211.

Related references

8.2 Command-line debugger options on page 8-204.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

5.4 About post-mortem debugging of trace data

You can decode previously captured trace data. You must have files available containing the captured trace, as well as any other files, such as configuration and images, that are needed to process and decode that trace data.

Once the trace data and other files are ready, you configure the headless command-line debugger to connect to the post-mortem debug configuration from the configuration database.

You can then inspect the state of the data at the time of the trace capture.

Note

- The memory and registers are read-only.
- You can add more debug information using additional files.
- You can also decode trace and dump the output to files.

The basic steps for post-mortem debugging using the headless command-line debugger are:

1. Generate trace data files.
2. Use `--cdb-list` to list the platforms and parameters available in the configuration database.
3. Use `--cdb-entry` to specify a platform entry in the configuration database.
4. If you need to specify additional parameters, use the `--cdb-entry-param` option to specify the parameters.

   Note

   At the DS-5 command prompt, enter `debugger --help` to view the list of available options.

Related concepts

5.3 About trace support on page 5-138.

8.1 Overview: Running DS-5 Debugger from the command-line or from a script on page 8-203.

Related tasks

8.4 Specifying a custom configuration database using the command-line on page 8-211.

Related references

8.2 Command-line debugger options on page 8-204.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 6
Debugging Embedded Systems

Gives an introduction to debugging embedded systems.

It contains the following sections:

- *6.1 About endianness* on page 6-143.
- *6.2 About accessing AHB, APB, and AXI buses* on page 6-144.
- *6.3 About virtual and physical memory* on page 6-145.
- *6.4 About address spaces* on page 6-146.
- *6.5 About debugging hypervisors* on page 6-148.
- *6.6 About debugging big.LITTLE systems* on page 6-149.
- *6.7 About debugging bare-metal symmetric multiprocessing systems* on page 6-150.
- *6.8 About debugging multi-threaded applications* on page 6-152.
- *6.9 About debugging shared libraries* on page 6-153.
- *6.10 About OS awareness* on page 6-155.
- *6.11 About debugging TrustZone enabled targets* on page 6-160.
- *6.12 About debugging a Unified Extensible Firmware Interface (UEFI)* on page 6-162.
- *6.13 About debugging MMUs* on page 6-163.
- *6.14 About Debug and Trace Services Layer (DTSL)* on page 6-165.
- *6.15 About CoreSight™ Target Access Library* on page 6-166.
- *6.16 About debugging caches* on page 6-167.
- *6.17 About DS-5 Debugger support for overlays* on page 6-170.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.1 About endianness

The term endianness is used to describe the ordering of individually addressable quantities, which means bytes and halfwords in the ARM architecture. The term byte-ordering can also be used rather than endian.

If an image is loaded to the target on connection, the debugger automatically selects the endianness of the image otherwise it selects the current endianness of the target. If the debugger detects a conflict then a warning message is generated.

You can use the `set endian` command to modify the default debugger setting.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.2 About accessing AHB, APB, and AXI buses

ARM-based systems connect the processors, memories and peripherals using buses. Examples of common bus types include AMBA High-performance Bus (AHB), Advanced Peripheral Bus (APB), and Advanced eXtensible Interface (AXI).

In some systems, these buses are accessible from the debug interface. Where this is the case, then DS-5 Debugger provides access to these buses when performing bare-metal or kernel debugging. Buses are exposed within the debugger as additional address spaces. Accesses to these buses are available irrespective of whether the processor is running or halted.

Within a debug session in DS-5 Debugger you can discover which buses are available using the `info memory` command. The address and description columns in the output of this command explain what each address space represents and how the debugger accesses it.

You can use `AHB:`, `APB:`, and `AXI:` address prefixes for these buses anywhere in the debugger where you normally enter an address or expression. For example, assuming that the debugger provides an APB address space, then you can print the contents of address zero using the following command:

```
x/1 APB:0x0
```

Each address space has a size, which is the number of bits that comprise the address. Common address space size on embedded and low-end devices is 32-bits, higher-end devices that require more memory might use > 32-bits. As an example, some devices based around ARM architecture ARMv7 make use of LPAE (Large Physical Address Extensions) to extend physical addresses on the AXI bus to 40-bits, even though virtual addresses within the processor are 32-bits.

The exact topology of the buses and their connection to the debug interface is dependent on your system. See the CoreSight specifications for your hardware for more information. Typically, the debug access to these buses bypass the processor, and so does not take into account memory mappings or caches within the processor itself. It is implementation dependent on whether accesses to the buses occur before or after any other caches in the system, such as L2 or L3 caches. The debugger does not attempt to achieve coherency between caches in your system when accessing these buses and it is your responsibility to take this into account and manually perform any clean or flush operations as required.

For example, to achieve cache coherency when debugging an image with the processors level 1 cache enabled, you must clean and invalidate portions of the L1 cache prior to modifying any of your application code or data using the AHB address space. This ensures that any existing changes in the cache are written out to memory before writing to that address space, and that the processor correctly reads your modification when execution resumes.

The behavior when accessing unallocated addresses is undefined, and depending on your system can lead to locking up the buses. It is recommended that you only access those specific addresses that are defined in your system. You can use the `memory` command to redefine the memory regions within the debugger and modifying access rights to control the addresses. You can use the `x` command with the *`count`* option to limit the amount of memory that is read.

Related references

11.6 Commands view on page 11-275.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.3 About virtual and physical memory

Processors that contain a Memory Management Unit (MMU) provide two views of memory, virtual and physical. The virtual address is the address prior to address translation in the MMU and the physical address is the address after translation.

Normally when the debugger accesses memory, it uses virtual addresses. However, if the MMU is disabled, then the mapping is flat and the virtual address is the same as the physical address.

To force the debugger to use physical addresses, prefix the addresses with `P:`.

For example:

```
P:0x8000
P:0+main creates a physical address with the address offset of main()
```

If your processor also contains TrustZone technology, then you have access to Secure and Normal worlds, each with their own separate virtual and physical address mappings. In this case, the address prefix `P:` is not available, and instead you must use `NP:` for normal physical and `SP:` for secure physical.

Note

- Processors that are compliant with ARM Architectures prior to ARMv6 do not support physical addressing in this manner. This includes the ARM7 and ARM9 family of processors.
- Physical address access is not enabled for all operations. For example, the ARM hardware does not support setting breakpoints via a physical address.

  When memory is accessed via a physical address, the caches are not flushed. Hence, results might differ depending on whether you view memory through the physical or virtual addresses (assuming they are addressing the same memory addresses).

Related references

11.6 Commands view on page 11-275.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.4 About address spaces

You can use address space prefixes in DS-5 Debugger to refer to different addresses spaces. You can use these address space prefixes for various debugging activities such as to:

- set breakpoint in a specific memory space
- read or write memory
- load symbols associated with a specific memory space.

DS-5 Debugger also uses these prefixes when reporting the current memory space where the execution stopped.

Note

The address spaces can be different on different targets. The availability of an address space depends on what architecture features are implemented, such as security extensions.

Address spaces in ARMv7 based processors

The following address space prefixes might be available for ARMv7 based processors:

- `S:` This corresponds to the secure address space.
- `H:` This corresponds to the hypervisor address space.
- `N:` This corresponds to the non-secure address space.
- `SP:` This corresponds to secure world physical memory.
- `NP:` This corresponds to non-secure world physical memory.

The following are examples of DS-5 Debugger commands with address spaces for ARMv7 based processors:

- `break S:main`
- `x N:0x80000000`
- `add-symbol-file foo.axf SP:0`.

When execution stops, DS-5 Debugger reports the current memory space, for example:

- `Execution stopped in SVC mode at S:0x80000000`
- `Execution stopped in SYS mode at breakpoint 1: S:0x80000BA8`.

Address spaces in ARMv8 based processors

The following address space prefixes might be available for ARMv8 based processors when in the AArch64 execution state:

- `EL3:` This corresponds to the EL3 translation regime. This is a secure address space.
- `EL2:` This corresponds to the EL2 translation regime. This is a non-secure address space.
- `EL1S:` This corresponds to the Secure EL1 and Secure EL0 translation regimes.
- `EL1N:` This corresponds to the Non-secure EL1 and Non-secure EL0 translation regimes.
- `SP:` This corresponds to Secure world physical memory.
- `NP:` This corresponds to Non-secure world physical memory.

The following address space prefixes might be available for ARMv8 based processors when in the AArch32 execution state:

- `S:` This corresponds to the EL3, Secure EL1, and Secure EL0 translation regimes.
- `H:` This corresponds to the EL2 translation regime. This is a Non-secure address space.
- `N:` This corresponds to the Non-secure EL1 and Non-secure EL0 translation regimes.
- `SP:` This corresponds to Secure world physical memory.
- `NP:` This corresponds to Non-secure world physical memory.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

The following are examples of DS-5 Debugger commands with address spaces for ARMv8 based processors:

- `break EL1N:main`
- `x EL1S:0x80000000`
- `add-symbol-file foo.axf SP:0`.

When execution stops, DS-5 Debugger reports the current memory space, for example:

- `Execution stopped in EL3h mode at: EL3:0x0000000080001500`
- `Execution stopped in EL1h mode at breakpoint 2.2: EL1N:0x0000000080000F6C`

If the core is stopped in exception level EL3, the debugger cannot reliably determine whether the translation regime at EL1/EL0 is configured for secure or non-secure access. This is because the secure monitor can change this at run-time when switching between secure and non-secure worlds. Memory accesses from EL3, such as setting software breakpoints at EL1S: or EL1N: addresses, might cause corruption or the target to lockup.

The memory spaces for the EL1 and EL0 exception levels have the same prefix because the same translation tables are used for both EL0 and EL1. These translation tables are used for either Secure EL1/EL0 or Non-secure EL1/EL0. The consequence of this is that if the core, in AArch64 state, is stopped in EL0 in secure state, then the debugger reports: `Execution stopped in EL0h mode at: EL1S:0x0000000000000000`.

Note

The reported `EL1S:` here refers to the memory space that is common to EL0 and EL1. It does not refer to the exception level.

Related concepts

6.2 About accessing AHB, APB, and AXI buses on page 6-144.
6.3 About virtual and physical memory on page 6-145.
6.5 About debugging hypervisors on page 6-148.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.5 About debugging hypervisors

ARM processors that support virtualization extensions have the ability to run multiple guest operating systems beneath a hypervisor. The hypervisor is the software that arbitrates amongst the guest operating systems and controls access to the hardware.

DS-5 Debugger provides basic support for bare-metal hypervisor debugging. When connected to a processor that supports virtualization extensions, the debugger enables you to distinguish between hypervisor and guest memory, and to set breakpoints that only apply when in hypervisor mode or within a specific guest operating system.

A hypervisor typically provides separate address spaces for itself as well as for each guest operating system. Unless informed otherwise, all memory accesses by the debugger occur in the current context. If you are stopped in hypervisor mode then memory accesses use the hypervisor memory space, and if stopped in a guest operating system then memory accesses use the address space of the guest operating system. To force access to a particular address space, you must prefix the address with either `H:` for hypervisor or `N:` for guest operating system.

Note

It is only possible to access the address space of the guest operating system that is currently scheduled to run within the hypervisor. It is not possible to specify a different guest operating system.

Similarly, hardware and software breakpoints can be configured to match on hypervisor or guest operating systems using the same address prefixes. If no address prefix is used then the breakpoint applies to the address space that is current when the breakpoint is first set. For example, if a software breakpoint is set in memory that is shared between hypervisor and a guest operating system, then the possibility exists for the breakpoint to be hit from the wrong mode, and in this case the debugger may not recognize your breakpoint as the reason for stopping.

For hardware breakpoints only, not software breakpoints, you can additionally configure them to match only within a specific guest operating system. This feature uses the architecturally defined Virtual Machine ID (VMID) register to spot when a specific guest operating system is executing. The hypervisor is responsible for assigning unique VMIDs to each guest operating system setting this in the VMID register when that guest operating system executes. In using this feature, it is your responsibility to understand which VMID is associated with each guest operating system that you want to debug. Assuming a VMID is known, you can apply a breakpoint to it within the **Breakpoints** view or by using the `break-stop-on-vmid` command.

When debugging a system that is running multiple guest operating systems, you can optionally enable the `set print current-vmid` setting to receive notifications in the console when the debugger stops and the current VMID changes. You can also obtain the VMID within DS-5 scripts using the `$vmid` debugger variable.

Related references

11.6 Commands view on page 11-275.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.6 About debugging big.LITTLE systems

A big.LITTLE system is designed to optimize both high performance and low power consumption over a wide variety of workloads. It achieves this by including one or more high performance processors alongside one or more low power processors. The system transitions the workload between the processors as necessary to achieve this goal.

big.LITTLE systems are typically configured in a *Symmetric MultiProcessing* (SMP) configuration. An operating system or hypervisor controls which processors are powered up or down at any given time and assists in migrating tasks between them.

For bare-metal debugging on big.LITTLE systems, you can establish an SMP connection within DS-5 Debugger. In this case all the processors in the system are brought under the control of the debugger. The debugger monitors the power state of each processor as it runs and displays it in the **Debug Control** view and on the command -line. Processors that are powered-down are visible to the debugger but cannot be accessed.

For Linux application debugging on big.LITTLE systems, you can establish a `gdbserver` connection within DS-5 Debugger. Linux applications are typically unaware of whether they are running on a big processor or a little processor because this is hidden by the operating system. There is therefore no difference within the debugger when debugging a Linux application on a big.LITTLE system as compared to application debug on any other system.

Related concepts

6.7 About debugging bare-metal symmetric multiprocessing systems on page 6-150.

Related references

11.6 Commands view on page 11-275.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.7 About debugging bare-metal symmetric multiprocessing systems

DS-5 Debugger supports debugging bare-metal *Symmetric MultiProcessing* (SMP) systems. The debugger expects an SMP system to meet the following requirements:

- The same ELF image running on all processors.
- All processors must have identical debug hardware. For example, the number of hardware breakpoint and watchpoint resources must be identical.
- Breakpoints and watchpoints must only be set in regions where all processors have identical memory maps, both physical and virtual. Processors with different instance of identical peripherals mapped at the same address are considered to meet this requirement, as in the case of the private peripherals of ARM multicore processors.

Configuring and connecting

To enable SMP support in the debugger you must first configure a debug session in the Debug Configurations dialog. Targets that support SMP debugging are identified by having SMP mentioned in the Debug operation drop-down list.

Configuring a single SMP connection is all you require to enable SMP support in the debugger. On connection, you can then debug all of the SMP processors in your system by selecting them in the **Debug Control** view.

Note

It is recommended to always use an SMP connection when debugging an SMP system. Using a single-core connection instead of an SMP connection might result in other cores halting on software breakpoints with no way to resume them.

Image and symbol loading

When debugging an SMP system, image and symbol loading operations apply to all the SMP processors. For image loading, this means that the image code and data are written to memory once through one of the processors, and are assumed to be accessible through the other processors at the same address because they share the same memory. For symbol loading, this means that debug information is loaded once and is available when debugging any of the processors.

Running, stopping and stepping

When debugging an SMP system, attempting to run one processor automatically starts running all the other processors in the system. Similarly, when one processor stops (either because you requested it or because of an event such as a breakpoint being hit), then all processors in the system stop.

For instruction level single-stepping (`stepi` and `nexti` commands), then the currently selected processor steps one instruction. The exception to this is when a `nexti` operation is required to step over a function call in which case the debugger sets a breakpoint and then runs all processors. All other stepping commands affect all processors.

Depending on your system, there might be a delay between one processor running or stopping and another processor running or stopping. This delay can be very large because the debugger must manually run and stop all the processors individually.

In rare cases, one processor might stop and one or more of the others fails to stop in response. This can occur, for example, when a processor running code in secure mode has temporarily disabled debug ability. When this occurs, the **Debug Control** view displays the individual state of each processor (running or stopped), so that you can see which ones have failed to stop. Subsequent run and step operations might not operate correctly until all the processors stop.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Breakpoints, watchpoints, and signals

By default, when debugging an SMP system, breakpoint, watchpoint, and signal (vector catch) operations apply to all processors. This means that you can set one breakpoint to trigger when any of the processors execute code that meets the criteria. When the debugger stops due to a breakpoint, watchpoint, or signal, then the processor that causes the event is listed in the **Commands** view.

Breakpoints or watchpoints can be configured for one or more processors by selecting the required processor in the relevant Properties dialog box. Alternatively, you can use the `break-stop-on-cores` command. This feature is not available for signals.

Examining target state

Views of the target state, including registers, call stack, memory, disassembly, expressions, and variables contain content that is specific to a processor.

Views such as breakpoints, signals and commands are shared by all the processors in the SMP system, and display the same contents regardless of which processor is currently selected.

Trace

When you are using a connection that enables trace support then you are able to view trace for each of the processors in your system. By default, the **Trace** view shows trace for the processor that is currently selected in the **Debug Control** view. Alternatively, you can choose to link a **Trace** view to a specific processor by using the **Linked:** ***context*** toolbar option for that **Trace** view. Creating multiple **Trace** views linked to specific processors enables you to view the trace from multiple processors at the same time. The indexes in the **Trace** views do not necessarily represent the same point in time for different processors.

Related concepts

6.6 About debugging big.LITTLE systems on page 6-149.
16.3 About loading an image on to the target on page 16-497.
16.4 About loading debug information into the debugger on page 16-499.

Related references

3.13 Setting a tracepoint on page 3-89.
3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.
3.12 Pending breakpoints and watchpoints on page 3-87.
3.2 Running, stopping, and stepping through an application on page 3-72.
11.4 Breakpoints view on page 11-268.
11.6 Commands view on page 11-275.
11.9 Disassembly view on page 11-285.
11.15 Memory view on page 11-302.
11.17 Modules view on page 11-312.
11.18 Registers view on page 11-314.
11.28 Variables view on page 11-337.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.8 About debugging multi-threaded applications

The debugger tracks the current thread using the debugger variable, `$thread`. You can use this variable in print commands or in expressions. Threads are displayed in the **Debug Control** view with a unique ID that is used by the debugger and a unique ID from the *Operating System* (OS) :

```
os_idle_demon #3 stopped (PID 255 was running)
```

where `#3` is the unique ID used by the debugger and `PID 255` is the ID from the OS.

A separate call stack is maintained for each thread and the selected stack frame is shown in bold text. All the views in the DS-5 Debug perspective are associated with the selected stack frame and are updated when you select another frame.

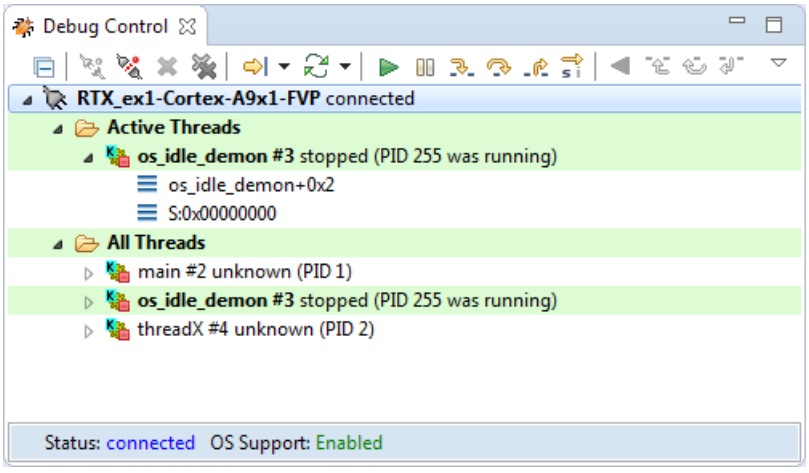


Figure 6-1 Threading call stacks in the Debug Control view

Related references

11.4 Breakpoints view on page 11-268.
11.6 Commands view on page 11-275.
11.9 Disassembly view on page 11-285.
11.15 Memory view on page 11-302.
11.17 Modules view on page 11-312.
11.18 Registers view on page 11-314.
11.28 Variables view on page 11-337.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.9 About debugging shared libraries

Shared libraries enable parts of your application to be dynamically loaded at runtime. You must ensure that the shared libraries on your target are the same as those on your host. The code layout must be identical, but the shared libraries on your target do not require debug information.

You can set standard execution breakpoints in a shared library but not until it is loaded by the application and the debug information is loaded into the debugger. Pending breakpoints however, enable you to set execution breakpoints in a shared library before it is loaded by the application.

When a new shared library is loaded the debugger re-evaluates all pending breakpoints, and those with addresses that it can resolve are set as standard execution breakpoints. Unresolved addresses remain as pending breakpoints.

The debugger automatically changes any breakpoints in a shared library to a pending breakpoint when the library is unloaded by your application.

You can load shared libraries in the Debug Configurations dialog box. If you have one library file then you can use the **Load symbols from file** option in the **Files** tab.

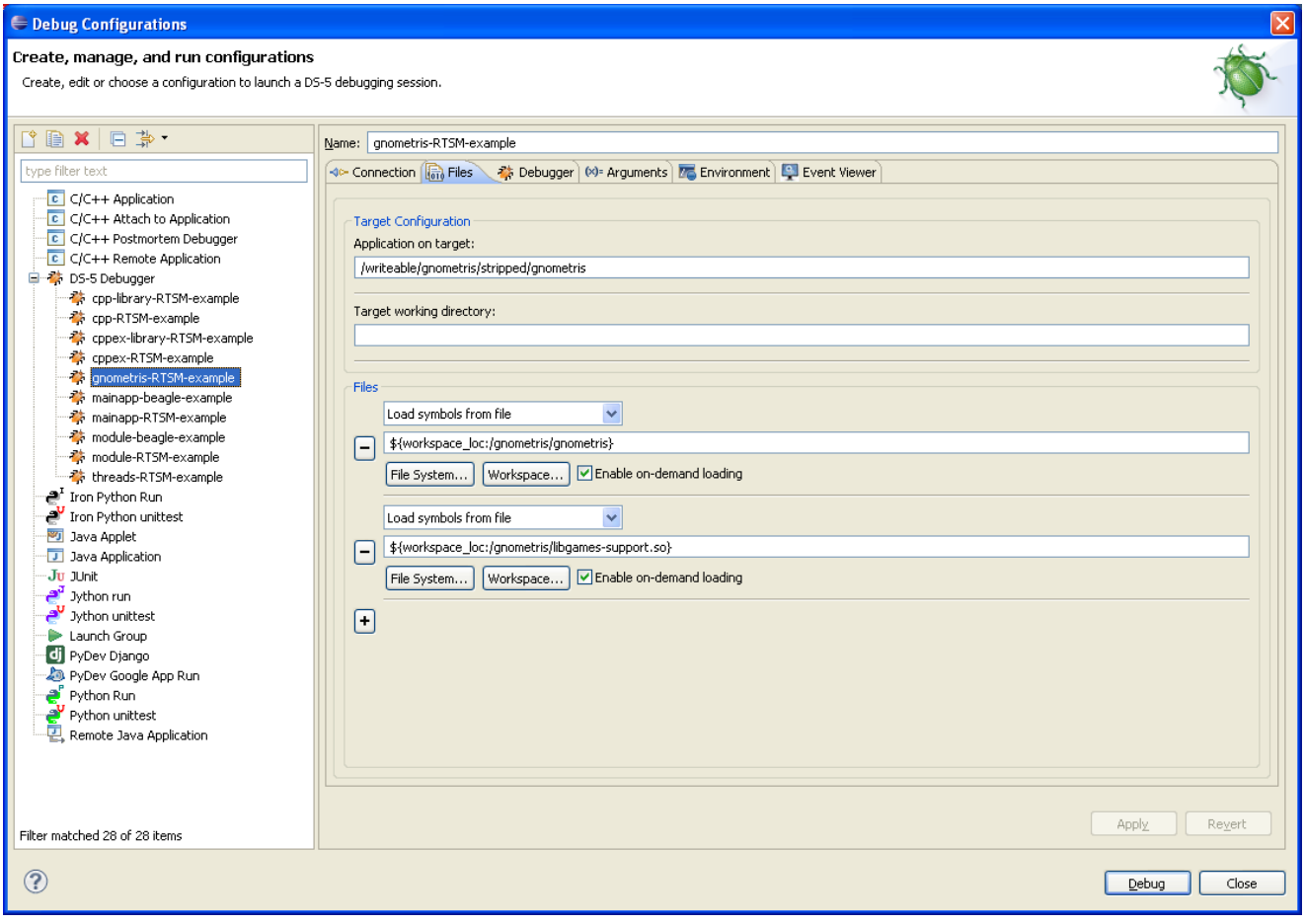


Figure 6-2 Adding individual shared library files

Alternatively if you have multiple library files then it is probably more efficient to modify the search paths in use by the debugger when searching for shared libraries. To do this you can use the **Shared library search directory** option in the Paths panel of the **Debugger** tab.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

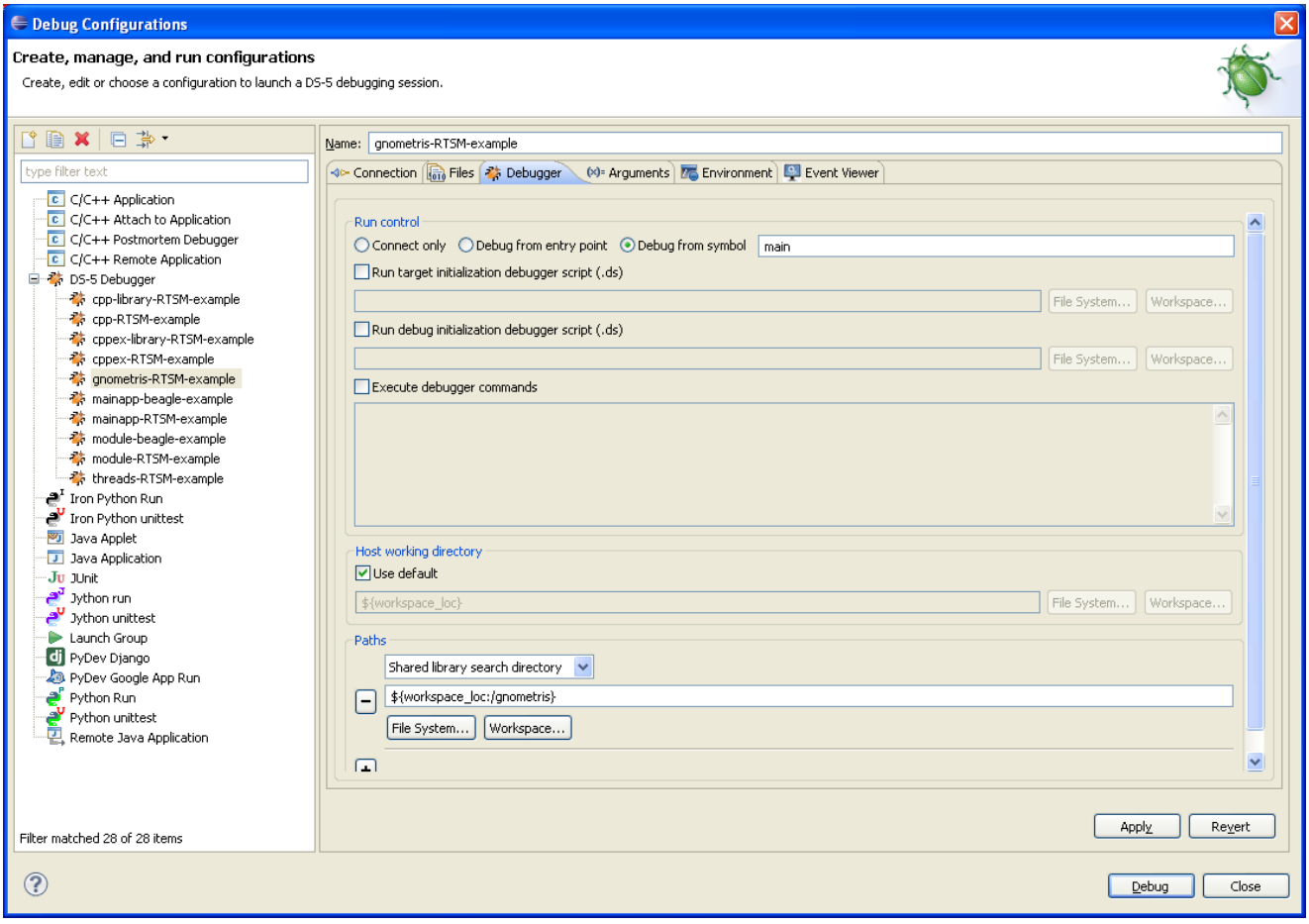


Figure 6-3 Modifying the shared library search paths

For more information on the options in the Debug Configurations dialog box, use the dynamic help.

Related references

3.2 Running, stopping, and stepping through an application on page 3-72.
5.1 Examining the target execution environment on page 5-136.
5.2 Examining the call stack on page 5-137.
3.14 Handling UNIX signals on page 3-90.
3.15 Handling processor exceptions on page 3-92.
11.4 Breakpoints view on page 11-268.
11.6 Commands view on page 11-275.
11.9 Disassembly view on page 11-285.
11.15 Memory view on page 11-302.
11.17 Modules view on page 11-312.
11.18 Registers view on page 11-314.
11.28 Variables view on page 11-337.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.10 About OS awareness

DS-5 provides support for a number of operating systems that can run on the target. This is called OS awareness and it provides a representation of the operating system threads and other relevant data structures.

The OS awareness support in DS-5 Debugger depends on the OS version and the processor architecture on the target.

DS-5 Debugger provides OS awareness for:

- ThreadX 5.6: ARMv5, ARMv5T, ARMv5TE, ARMv5TEJ, ARMv6M, ARMv7M, ARMv7R, ARMv7A
- µC/OS-II 2.92: ARMv6M, ARMv7M, ARMv7R, ARMv7A
- µC/OS-III 3.04: ARMv6M, ARMv7M, ARMv7R, ARMv7A
- embOS 3.88: ARMv5, ARMv5T, ARMv5TE, ARMv5TEJ, ARMv6M, ARMv7M, ARMv7R, ARMv7A
- Keil CMSIS-RTOS RTX 4.7: Cortex-M0, Cortex-M0+, Cortex-M1, Cortex-M3, Cortex-M4, and Cortex-A9 processors
- FreeRTOS 8.0: ARMv6M, ARMv7M, ARMv7R, ARMv7A
- Freescale MQX 4.0: Freescale-based Cortex-M4 and Cortex-A5 processors
- Quadros RTXC 1.0.2: ARMv5, ARMv5T, ARMv5TE, ARMv5TEJ, ARMv7M, ARMv7R, ARMv7A.
- Nucleus RTOS 2014.06: ARMv5, ARMv5T, ARMv5TE, ARMv5TEJ, ARMv6M, ARMv7M, ARMv7R, ARMv7A.
- µC3 Standard: ARMv7R, ARMv7A.
- µC3 Compact: ARMv6M, ARMv7M.

Note

- By default, OS awareness is not present for an architecture or processor that is not listed above.
- OS awareness support for newer versions of the OS depends on the scope of changes to their internal data structures.
- OS awareness in DS-5 Debugger does not support the original non-CMSIS Keil RTX.
- OS awareness for µC3 Standard requires you to set the `vfp-flag` parameter based on the `--fpu` option that the µC3 Standard kernel was compiled with. You can set this using the **OS Awareness** tab in the **Debug Configurations** dialog box, or using the command `set os vfp-flag`. You can set the value to `disabled`, `vfpv3_16`, or `vfpv3_32`.

The Linux kernels that DS-5 Debugger provides OS awareness for are:

- Linux 2.6.28, ARMv7A
- Linux 2.6.38: ARMv7A
- Linux 3.0: ARMv7A
- Linux 3.11.0-rc6: ARMv7A
- Linux 3.13.0-rc3: ARMv7A
- Linux 3.6.0-rc6: ARMv7A
- Linux 3.7.0: ARMv7A
- Linux 3.9.0-rc3: ARMv7A
- Linux 3.11.0-rc6: ARMv8A.

Note

Later versions of Linux are expected to work on ARMv7A and ARMv8A architectures.

This section contains the following subsections:

- *6.10.1 About debugging FreeRTOS ™* on page 6-156.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

- *6.10.2 About debugging a Linux kernel* on page 6-156.
- *6.10.3 About debugging Linux kernel modules* on page 6-158.
- *6.10.4 About debugging ThreadX* on page 6-159.

6.10.1 About debugging FreeRTOS ™

FreeRTOS is an open-source real-time operating system.

DS-5 Debugger provides the following support for debugging FreeRTOS:

- Supports FreeRTOS on Cortex-M cores.
- View FreeRTOS tasks in the **Debug Control** view.
- View FreeRTOS tasks and queues in the **RTOS Data** view.

To enable FreeRTOS support in DS-5™ Debugger, in the **Debug Configuration** dialog, select FreeRTOS in the **OS** tab. Debugger support is activated when FreeRTOS is initialized on the target device.

Note

Operating system support in the debugger is activated only when OS-specific debug symbols are loaded. Ensure that the debug symbols for the operating system are loaded before using any of the OS-specific views and commands.

When building your FreeRTOS image, ensure that the following compiler flags are set:

- -DportREMOVE_STATIC_QUALIFIER
- -DINCLUDE_xTaskGetIdleTaskHandle
- -DconfigQUEUE_REGISTRY_SIZE=n (where n >= 1)

If these flags are set incorrectly, FreeRTOS support might fail to activate in DS-5 Debugger. See the documentation supplied with FreeRTOS to view the details of these flags.

6.10.2 About debugging a Linux kernel

DS-5 supports source level debugging of a Linux kernel. The Linux kernel (and associated device drivers) can be debugged in the same way as a standard ELF format executable. For example, you can set breakpoints in the kernel code, step through the source, inspect the call stack, and watch variables.

Note

User space parameters (marked `__user`) that are not currently mapped in cannot be read by the debugger.

To debug the kernel:

1. Compile the kernel source using the following options:
   - `CONFIG_DEBUG_KERNEL=y`Enables the kernel debug options.
   - `CONFIG_DEBUG_INFO=y`Builds `vmlinux` with debugging information.
   - `CONFIG_DEBUG_INFO_REDUCED=n`Includes full debugging information when compiling the kernel.
   - `CONFIG_PERF_EVENTS=n`
     Disables the performance events subsystem. Some implementations of the performance events subsystem internally make use of hardware breakpoints, disrupting the use of hardware breakpoints set by the debugger. It is recommended to disable this option if you observe the debugger failing to hit hardware breakpoints or failing to report kernel module load and unload events.

     Note

     If you are working with Streamline, this option must be enabled.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Compiling the kernel source generates a Linux kernel image and symbol files which contain debug information.

Note

Be aware that:

- Other options might be required depending on the type of debugging you want to perform. Check the kernel documentation for details.
- A Linux kernel is always compiled with full optimizations and inlining enabled, therefore:
  - Stepping through code might not work as expected due to the possible reordering of some instructions.
  - Some variables might be optimized out by the compiler and therefore not be available for the debugger.

2. Load the Linux kernel on to the target.
3. Load kernel debug information into the debugger.

   Note

   If the Linux kernel you are debugging runs on multiple cores, then it is recommended to select an SMP connection type when connecting the debugger. Using a single-core connection instead of an SMP connection might result in other cores halting on software breakpoints with no way to resume them.

4. Debug the kernel as required.

Related concepts

6.10.3 About debugging Linux kernel modules on page 6-158.
6.7 About debugging bare-metal symmetric multiprocessing systems on page 6-150.

Related tasks

2.6 Configuring a connection to a Linux kernel on page 2-48.

Related references

3.2 Running, stopping, and stepping through an application on page 3-72.
5.1 Examining the target execution environment on page 5-136.
5.2 Examining the call stack on page 5-137.
3.14 Handling UNIX signals on page 3-90.
3.15 Handling processor exceptions on page 3-92.
11.41 Debug Configurations - Files tab on page 11-361.
11.42 Debug Configurations - Debugger tab on page 11-364.
11.4 Breakpoints view on page 11-268.
11.6 Commands view on page 11-275.
11.9 Disassembly view on page 11-285.
11.15 Memory view on page 11-302.
11.17 Modules view on page 11-312.
11.18 Registers view on page 11-314.
11.28 Variables view on page 11-337.

Related information

Debugging a loadable kernel module.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.10.3 About debugging Linux kernel modules

Linux kernel modules provide a way to extend the functionality of the kernel, and are typically used for things such as device and file system drivers. Modules can either be built into the kernel or can be compiled as a loadable module and then dynamically inserted and removed from a running kernel during development without having to frequently recompile the kernel. However, some modules must be built into the kernel and are not suitable for loading dynamically. An example of a built-in module is one that is required during kernel boot and must be available prior to the root file system being mounted.

You can set source-level breakpoints in a module after loading the module debug information into the debugger. For example, you can load the debug information using `add-symbol-file modex.ko`. To set a source-level breakpoint in a module before it is loaded into the kernel, use `break -p` to create a pending breakpoint. When the kernel loads the module, the debugger loads the symbols and applies the pending breakpoint.

When debugging a module, you must ensure that the module on your target is the same as that on your host. The code layout must be identical, but the module on your target does not require debug information.

Built-in module

To debug a module that has been built into the kernel, the procedure is the same as for debugging the kernel itself:

1. Compile the kernel together with the module.
2. Load the kernel image on to the target.
3. Load the related kernel image with debug information into the debugger
4. Debug the module as you would for any other kernel code.

Built-in (statically linked) modules are indistinguishable from the rest of the kernel code, so are not listed by the `info os-modules` command and do not appear in the **Modules** view.

Loadable module

The procedure for debugging a loadable kernel module is more complex. From a Linux terminal shell, you can use the `insmod` and `rmmod` commands to insert and remove a module. Debug information for both the kernel and the loadable module must be loaded into the debugger. When you insert and remove a module the debugger automatically resolves memory locations for debug information and existing breakpoints. To do this, the debugger intercepts calls within the kernel to insert and remove modules. This introduces a small delay for each action whilst the debugger stops the kernel to interrogate various data structures. For more information on debugging a loadable kernel module, see the tutorial in *Getting Started with DS-5*.

Note

A connection must be established and *Operating System* (OS) support enabled within the debugger before a loadable module can be detected. OS support is automatically enabled when a Linux kernel image is loaded into the debugger. However, you can manually control this by using the `set os` command.

Related concepts

6.10.2 About debugging a Linux kernel on page 6-156.
6.7 About debugging bare-metal symmetric multiprocessing systems on page 6-150.

Related tasks

2.6 Configuring a connection to a Linux kernel on page 2-48.

Related references

3.2 Running, stopping, and stepping through an application on page 3-72.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

5.1 Examining the target execution environment on page 5-136.
5.2 Examining the call stack on page 5-137.
3.14 Handling UNIX signals on page 3-90.
3.15 Handling processor exceptions on page 3-92.
11.4 Breakpoints view on page 11-268.
11.6 Commands view on page 11-275.
11.9 Disassembly view on page 11-285.
11.15 Memory view on page 11-302.
11.17 Modules view on page 11-312.
11.18 Registers view on page 11-314.
11.28 Variables view on page 11-337.

Related information

Debugging a loadable kernel module.

6.10.4 About debugging ThreadX

ThreadX is a real-time operating system from Express Logic, Inc.

DS-5 Debugger provides the following ThreadX RTOS visibility:

- Comprehensive thread list with thread status and objects on which the threads are blocked/suspended.
- All major ThreadX objects including semaphores, mutexes, memory pools, message queues, event flags, and timers.
- Stack usage for individual threads.
- Call frames and local variables for all threads.

To enable ThreadX support in DS-5 Debugger, in the **Debug Configuration** dialog, select **ThreadX** in the **OS Awareness** tab. ThreadX OS awareness is activated when ThreadX is initialized on the target device.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.11 About debugging TrustZone enabled targets

ARM TrustZone® is a security technology designed into some ARM processors. For example, the Cortex™-A class processors. It segments execution and resources such as memory and peripherals into secure and normal worlds.

When connected to a target that supports TrustZone and where access to the secure world is permitted, then the debugger provides access to both secure and normal worlds. In this case, all addresses and address-related operations are specific to a single world. This means that any commands you use that require an address or expression must also specify the world that they apply to, with a prefix. For example `N:0x1000` or `S:0x1000`.

Where:

N:
For an address in Normal World memory.

S:
For an address in Secure World memory.

If you want to specify an address in the current world, then you can omit the prefix.

When loading images and debug information it is important that you load them into the correct world. The debug launcher panel does not provide a way to directly specify an address world for images and debug information, so to achieve this you must use scripting commands instead. The **Debugger** tab in the debugger launcher panel provides an option to run a debug initialization script or a set of arbitrary debugger commands on connection. Here are some example commands:

- Load image only to normal world (applying zero offset to addresses in the image)

```
load myimage.axf N:0
```

- Load debug information only to secure world (applying zero offset to addresses in the debug information)

```
file myimage.axf S:0
```

- Load image and debug information to secure world (applying zero offset to addresses)

```
loadfile myimage.axf S:0
```

When an operation such as loading debug symbols or setting a breakpoint needs to apply to both normal and secure worlds then you must perform the operation twice, once for the normal world and once for the secure world.

Registers such as `$PC` have no world. To access the content of memory from an address in a register that is not in the current world, you can use an expression, `N:0+$PC`. This is generally not necessary for expressions involving debug information, because these are associated with a world when they are loaded.

Related references

11.4 Breakpoints view on page 11-268.
11.6 Commands view on page 11-275.
11.9 Disassembly view on page 11-285.
11.15 Memory view on page 11-302.
11.17 Modules view on page 11-312.
11.18 Registers view on page 11-314.
11.28 Variables view on page 11-337.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

ARM Security Technology Building a Secure System using TrustZone Technology.
Technical Reference Manual.
Architecture Reference Manual.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.12 About debugging a Unified Extensible Firmware Interface (UEFI)

UEFI defines a software interface to control the start-up of complex microprocessor systems. UEFI on ARM allows you to control the booting of ARM-based servers and client computing devices.

DS-5 provides a complete UEFI development environment which enables you to:

- Fetch the UEFI source code via the Eclipse Git plug-in.
- Build the source code using ARM Compiler.
- Download the executables to a software model (a Cortex-A9x4 FVP is provided with DS-5) or to a hardware target (available separately).
- Run/debug the code using DS-5 Debugger.
- Debug dynamically loaded modules at source-level using Jython scripts.

For more information, see this blog: *UEFI Debug Made Easy*

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.13 About debugging MMUs

DS-5 Debugger provides various features to debug Memory Management Unit (MMU) related issues.

A Memory Management Unit is a hardware feature that controls virtual to physical address translation, access permissions, and memory attributes. The MMU is configured by system control registers and translation tables stored in memory.

A device can contain any number of MMUs. If a device has cascaded MMUs, then the output address of one MMU is used as the input address to another MMU. A given translation depends on the context in which it occurs and the set of MMUs that it passes through.

For example, a processor that implements the ARMv7A hypervisor extensions, such as Cortex-A15, includes at least three MMUs. Typically one is used for hypervisor memory, one for virtualization and one for normal memory accesses within an OS. When in hypervisor state, memory accesses pass only through the hypervisor MMU. When in normal state, memory accesses pass first through the normal MMU and then through the virtualization MMU. For more information see the *ARM Architecture Reference Manual*.

DS-5 Debugger provides visibility of MMU translation tables for some versions of the ARM Architecture. To help you debug MMU related issues, DS-5 Debugger enables you to:

- Convert a virtual address to a physical address.
- Convert a physical address to a virtual address.
- View the MMU configuration registers and override their values.
- View the translation tables as a tree structure.
- View the virtual memory layout and attributes as a table.

You can access these features using the MMU view in the graphical debugger or using the MMU commands from the command line.

Cache and MMU data in DS-5 Debugger

In some specific circumstances, DS-5 Debugger cannot provide a fully accurate view of the translation tables due to its limited visibility of the target state.

The MMU hardware on the target performs a translation table walk by doing one or more translation table lookups. These lookups require accessing memory by physical address (or intermediate physical address for two stage translations). However, to read or modify translation table entries, the CPU accesses memory by virtual address. In each of these cases, the accessed translation table entries are permitted to reside in the CPU's data caches. This means that if a translation table entry resides in a region of memory marked as write-back cacheable and the CPU's data cache is enabled, then any modification to a translation table entry might not be written to the physical memory immediately. This is not a problem for the MMU hardware, which has awareness of the CPU's data caches.

To perform translation tables walks, DS-5 Debugger must also access memory by physical address. It does this by disabling the MMU. Because the MMU is disabled, these memory accesses might not take into account the contents of CPU's data caches. Hence these physical memory accesses might return stale data.

To avoid stale translation tables entries in DS-5 Debugger:

- When walking translation tables where the debugger has data cache awareness, you can enable cache-aware physical memory accesses. Use the command:

  ```
  set mmu use-cache-for-phys-reads true
  ```
- If you think that the translation table entries contain stale data, then you can use the debugger to manually clean and invalidate the contents of the CPU caches. Use the command:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
cache flush
```

Note

Flushing large caches might take a long time.

Related concepts

6.16 About debugging caches on page 6-167.

Related references

11.16 MMU view on page 11-308.

Related information

DS-5 Debugger MMU commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.14 About *Debug and Trace Services Layer* (DTSL)

Debug and Trace Services Layer (DTSL) is a software layer within the DS-5 Debugger stack. It sits between the debugger and the RDDI target access API.

DTSL takes responsibility for:

- Low level debugger component creation and configuration. For example, CoreSight component configuration, which can also involve live re-configuration.
- Target access and debug control.
- Capture and control of trace data with:
  - in-target trace capture components, such as ETB
  - off-target trace capture device, such as DSTREAM™.
- Delivery of trace streams to the debugger or other 3rd party trace consumers.

DTSL is implemented as a set of Java classes which are typically implemented (and possibly extended) by Jython scripts. A typical DTSL instance is a combination of Java and Jython.

A simple example of this is when DTSL connects to a simple platform containing a Cortex-A8, ETM, and ETB. When the DTSL connection is activated it runs a Jython script to create the DTSL configuration. This configuration is populated with a Java `Device` object called `Cortex-A8`, a `TraceSource` object called `ETM`, and a `TraceCaptureDevice` object called `ETB`. The Debugger, or another program using DTSL, can then access the DTSL configuration to retrieve these objects and perform debug and trace operations.

Note

DTSL Jython Scripting should not be confused with DS-5 Debugger Jython Scripting. They both use Jython but operate at different levels within the software stack. It is however possible for a debugger Jython Script to use DTSL functionality.

ARM has made DTSL available for your own use so that you can create Java or Jython programs to access and control the target platform.

For details, see the DTSL documents and files provided with DS-5 here:

```
<DS-5 Install folder>\sw\DTSL
```

Related references

Chapter 15 Debug and Trace Services Layer (DTSL) on page 15-439.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.15 About CoreSight™ Target Access Library

CoreSight on-target access library allows you to interact directly with CoreSight devices. This supports use-cases such as enabling flight-recorder trace in a production system without the need to connect an external debugger.

The library offers a flexible programming interface allowing a variety of use cases and experimentation.

It also offers some advantages compared to a register-level interface. For example, it can:

- Manage any unlocking and locking of CoreSight devices via the lock register, OS Lock register, programming bit, power-down bit.
- Attempt to ensure that the devices are programmed correctly and in a suitable sequence.
- Handle variations between devices, and where necessary, work around known issues. For example, between variants of ETM/PTMs.
- Become aware of the trace bus topology and can generally manage trace links automatically. For example enabling only funnel ports in use.
- Manage “claim bits” that coordinate internal and external use of CoreSight devices.

For details, see the CoreSight example provided with DS-5 here:

```
<DS-5 Install folder>/examples/CoreSight_Access_Library.zip
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.16 About debugging caches

DS-5 Debugger allows you to view contents of caches in your system. For example, L1 cache or TLB cache.

You can either view information about the caches in the **Cache Data** view or by using the `cache list` and `cache print` commands in the **Commands** view.

Cache Data: L1 Instruction TLB

Linked: smp_primes-A15MPCore-versatile

L1 Instruction TLB | CPU Caches: Cortex-A15_0

Virtual Address	Physical Address	Valid	OS	IS	nG	M	NS	H	VMID	ASID	MAIR	Domain
0x80000000	0x80000000	1	1	1	0	1	0	0	0	0	0x4F	0
0x80001000	0x80001000	1	1	1	0	1	0	0	0	0	0x4F	0
0x0	0x0	0	1	1	0	1	0	0	0	0	0x1	0
0x50670000	0x56F10F3000	0	0	1	1	0	1	1	1	192	0x2	0
0x70C81000	0xEC1BC0000	0	0	1	1	0	1	0	42	44	0x22	0
0x2BA10000	0x7A2D633000	0	0	1	0	0	0	0	90	74	0x14	0
0x50670000	0x56F10F3000	0	0	1	1	1	0	0	10	72	0x2	0
0x93393000	0x720B012000	0	0	0	0	0	0	0	186	44	0xA2	8
0x38679000	0x7AA422D000	0	0	0	1	0	0	1	2	175	0x6B	8
0x8A600000	0xCB779AA000	0	0	0	0	0	1	0	52	94	0x40	1
0xA8772000	0xFC40F83000	0	0	1	1	1	1	0	16	232	0x13	2
0xE0A00000	0xAAB1950000	0	0	1	1	0	0	0	65	156	0x3	2
0x39731000	0xD8013B6000	0	0	1	1	1	0	0	53	24	0x30	12
0x19048000	0x95E1162000	0	0	1	1	0	0	0	137	1	0x3	1
0x4B466000	0x12F80F8000	0	0	1	1	0	1	0	169	0	0xF	0
0x70074000	0x3491043000	0	0	1	1	0	0	1	134	110	0xB	9
0x52314000	0x9BAF49C000	0	0	1	0	0	1	0	35	105	0x82	2
0xA0A51000	0x7E992F4000	0	1	0	0	0	1	0	11	225	0x43	0
0x19E25000	0x42F4B40000	0	1	0	1	0	1	0	152	184	0x42	8
0x78635000	0xDE98353000	0	1	0	0	0	0	0	67	96	0x9A	1
0x50670000	0x56F10F3000	0	0	1	1	0	0	1	33	40	0x2	0
0x86D72000	0x14C13420000	0	0	1	1	0	1	1	8	230	0x46	0

Figure 6-4 Cache Data view (showing L1 TLB cache)

Note

Cache awareness is dependent on the exact device and connection method.

The **Cache debug mode** option in the **DTSL Configuration Editor** dialog enables or disables the reading of cache RAMs in the **Cache Data** view. Selecting this option enables the reading of cache RAMs every time the target stops, if the **Cache Data** view is suitably configured.

Enabling the **Preserve cache contents in debug state** option in the **DTSL Configuration Editor** preserves the cache contents while the core is stopped. If this option is disabled, there is no guarantee that the cache contents will be preserved when the core is stopped.

Note

For the most accurate results, enable the **Preserve cache contents in debug state** option in the **DTSL Configuration Editor** dialog. When this option is not enabled, the information presented might be less accurate due to debugger interactions with the target.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

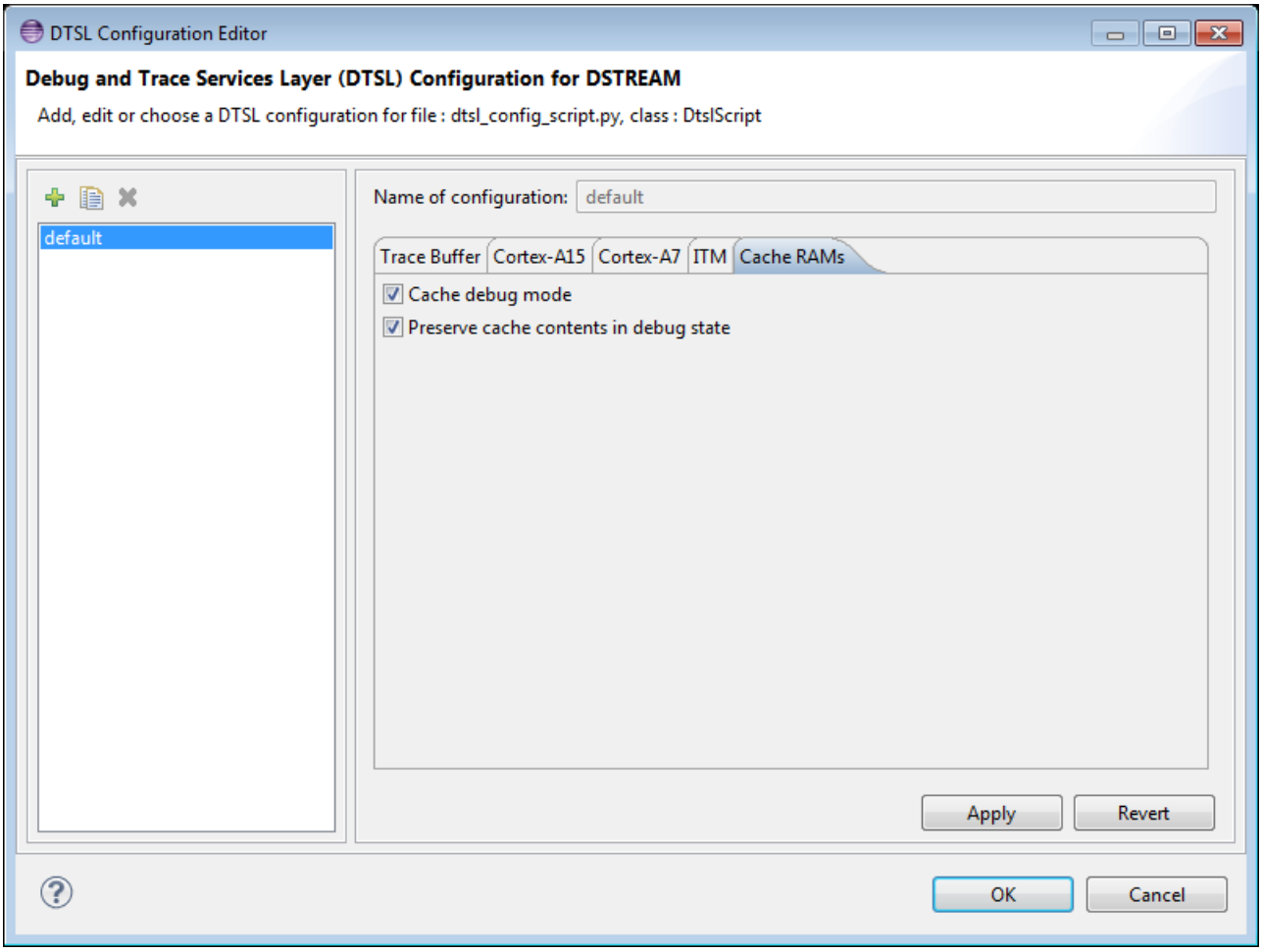


Figure 6-5 DTSL Configuration Editor (Cache RAMs configuration tab)

Note

For processors based on the ARMv8 architecture, there are restrictions on cache preservation:

- Cache preservation is not possible when the MMU is configured to use the short descriptor translation table format.
- When using the long descriptor translation table format, cache preservation is possible but the TLB contents cannot be preserved.

You can either enable the options prior to connecting to the target from the **Debug Configurations** dialog, or after connecting from the **Debug Control** view context menu.

Note

On some devices, reading cache data can be very slow. To avoid issues, do not enable DTSL options that are not required. Also, if not required, close any cache views in the user interface.

You can use the **Memory** view to display the target memory from the perspective of the different caches present on the target. On the command line, to display or read the memory from the perspective of a cache, prefix the memory address with `<cacheViewID=value>:`. For the Cortex-A15 processor, possible values of `cacheViewID` are:

- `L1I`
- `L1D`
- `L2`
- `L3`

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

For example:

```
# Display memory from address 0x9000 from the perspective of the L1D cache.
x/16w N<cacheViewID=L1D>:0x9000

# Dump memory to myFile.bin, from address 0x80009000 from the perspective of the L2 cache.
dump binary memory myFile.bin S<cacheViewID=L2>:0x80009000 0x10000

# Append to myFile.bin, memory from address 0x80009000 from the perspective of the L3 cache.
append memory myFile.bin <cacheViewID=L3>:0x80009000 0x10000
```

Related references

11.21 Cache Data view on page 11-321.

11.15 Memory view on page 11-302.

11.46 DTSL Configuration Editor dialog box on page 11-372.

Related information

DS-5 Debugger cache commands.

DS-5 Debugger memory commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

6.17 About DS-5 Debugger support for overlays

Overlaying is a programming method that allows applications to share execution regions of memory between different pieces of code at runtime. A piece of code can be transferred to the overlay region to be executed when needed. This piece of code is replaced with another when needed.

Code does not need to be stored in memory and could reside in other storage such as off-chip flash memory. Embedded systems, especially systems without support for virtual memory addressing and systems with limited memory, sometimes use overlays.

An overlaid application consists of:

- Several overlays – These are blocks of code that are not resident in memory all the time.
- The overlay manager (must be part of the non-overlaid code) – The overlay manager takes care of loading and unloading different overlays as they are needed.
- Several overlay regions – These are regions in memory that overlays are loaded into as needed. Each overlay region can contain different overlays at different times.
- Some non-overlaid code – This is code that is permanently resident in memory.
- Data (both RO and RW) – Data is never overlaid.

As a developer, you must decide which functions from your application are used in overlays. You must also decide which functions are used in the same overlay.

You can specify the functions to overlay by annotating the function declarations in your source code. The annotation indicates which overlay each function must be in.

During compilation, the linker assigns overlays to a particular region. When overlays are loaded, it can only be loaded into that region. The linker also detects direct calls between overlays, and between overlays and non-overlaid code. The linker then redirects the calls through veneers, which call the overlay manager to automatically load the target overlay.

DS-5 Debugger automatically enables overlay support on the presence of linker generated tables and functions as described by the following symbols:

- `Region$$Count$$AutoOverlay`
- `LoadAddr$$Table$$AutoOverlay`
- `CurrLoad$$Table$$AutoOverlay`
- `__ARM_notify_overlay_loaded`

After loading your overlay-enabled application in DS-5, you can work with overlays from both the command-line console and from the user interface:

- To see detailed information about the currently loaded overlays and the functions within each overlay, use the ***Overlays*** on page 11-320 view. You can also use the *`info overlays`* command to view information about the currently loaded overlays and functions within each overlay.
- To enable or disable overlay support, use the *`set overlays enable`* command with the `on`, `off`, or `auto` options. The default setting is `auto`.

See the `overlay_manager` example that is provided with DS-5 for a reference implementation of overlays.

Related references

11.20 Overlays view on page 11-320.

Related information

DS-5 Debugger command: info overlays.

DS-5 Debugger command: set overlays enabled.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 7
Debugging with Scripts

Describes how to use scripts containing debugger commands to enable you to automate debugging operations.

It contains the following sections:

- *7.1 Exporting DS-5 Debugger commands generated during a debug session* on page 7-172.
- *7.2 Creating a DS-5 Debugger script* on page 7-173.
- *7.3 Creating a CMM-style script* on page 7-174.
- *7.4 Support for importing and translating CMM scripts* on page 7-175.
- *7.5 About Jython scripts* on page 7-177.
- *7.6 Jython script concepts and interfaces* on page 7-179.
- *7.7 Creating Jython projects in Eclipse for DS-5* on page 7-180.
- *7.8 Creating a Jython script* on page 7-183.
- *7.9 Running a script* on page 7-185.
- *7.10 Use case scripts* on page 7-187.
- *7.11 Metadata for use case scripts* on page 7-188.
- *7.12 Definition block for use case scripts* on page 7-189.
- *7.13 Defining the Run method for use case scripts* on page 7-191.
- *7.14 Defining the options for use case scripts* on page 7-192.
- *7.15 Defining the validation method for use case scripts* on page 7-195.
- *7.16 Example use case script definition* on page 7-196.
- *7.17 Multiple use cases in a single script* on page 7-197.
- *7.18 usecase list command* on page 7-198.
- *7.19 usecase help command* on page 7-199.
- *7.20 usecase run command* on page 7-200.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.1 Exporting DS-5 Debugger commands generated during a debug session

You can work through a debug session using all the toolbar icons and menu options as required.

A full list of all the DS-5 Debugger commands generated during the current debug session is recorded in the **History** view. Before closing Eclipse, you can select the commands that you want in your script file and click on **Export the selected lines as a script file** to save them to a file.

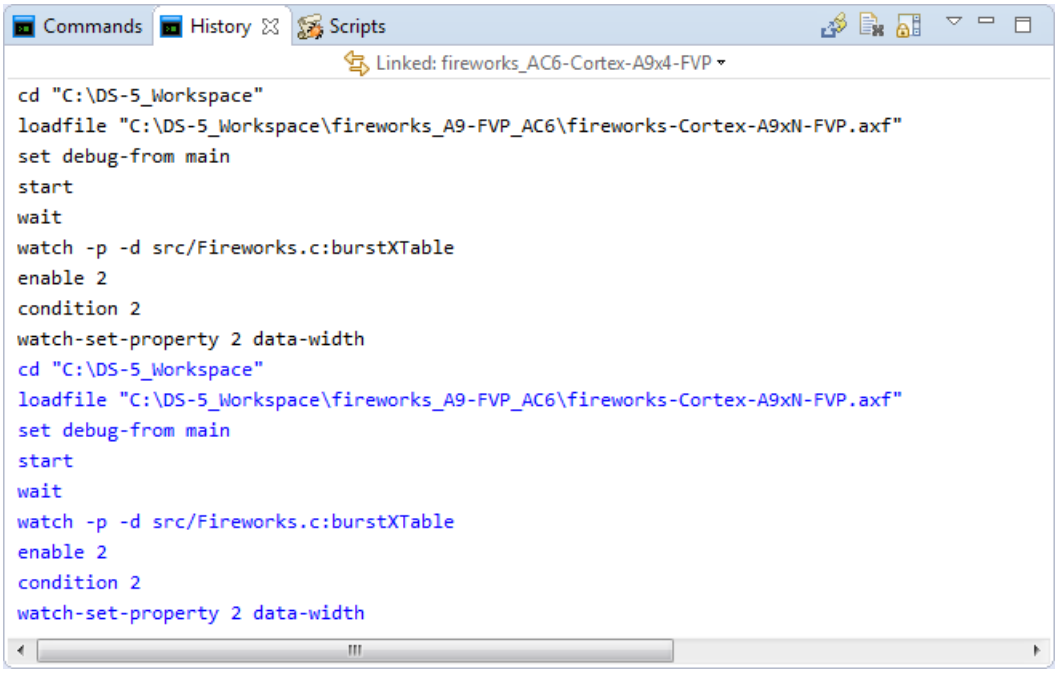


Figure 7-1 Commands generated during a debug session

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.2 Creating a DS-5 Debugger script

Shows a typical example of a DS-5 Debugger script.

The script file must contain only one command on each line. Each command can be identified with comments if required. The `.ds` file extension must be used to identify this type of script.

```
# Filename: myScript.ds
# Initialization commands
load "struct_array.axf"       # Load image
file "struct_array.axf"       # Load symbols
break main                    # Set breakpoint at main()
break *0x814C                 # Set breakpoint at address 0x814C
# Run to breakpoint and print required values
run                           # Start running device
wait 0.5s                     # Wait or time-out after half a second
info stack                    # Display call stack
info registers                # Display info for all registers
# Continue to next breakpoint and print required values
continue                      # Continue running device
wait 0.5s                     # Wait or time-out after half a second
info functions                # Displays info for all functions
info registers                # Display info for all registers
x/3wx 0x8000                  # Display 3 words of memory from 0x8000 (hex)
...
# Shutdown commands
delete 1                      # Delete breakpoint assigned number 1
delete 2                      # Delete breakpoint assigned number 2
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.3 Creating a CMM-style script

DS-5 provides a small subset of CMM-style commands which you can use to create a CMM-style script.

The debugger script file must conform to the following standards:

- The script file must contain only one command on each line. If necessary, you can add comments using the `//` tags.
- The `.cmm` or `.t32` file extension must be used to identify a CMM-style script.

After creating your script, you must use the DS-5 Debugger *`source`* command to load and run the script.

The example below shows a typical CMM-style script.

Example 7-1 Sample CMM-style script

```
// Filename: myScript.cmm
                system.up                       ; Connect to target and device
                data.load.elf "hello.axf"       ; Load image and symbols
                // Setup breakpoints and registers
                break.set main /disable         ; Set breakpoint and immediately disabled
                break.set 0x8048                ; Set breakpoint at specified address
                break.set 0x8060                ; Set breakpoint at specified address
                register.set R0 15              ; Set register R0
                register.set PC main            ; Set PC register to symbol address
                ...
                break.enable main               ; Enable breakpoint at specified symbol
                // Run to breakpoint and display required values
                go                              ; Start running device
                var.print "Value is: " myVar     ; Display string and variable value
                print %h r(R0)                  ; Display register R0 in hexadecimal
                // Run to breakpoint and print stack
                go                              ; Run to next breakpoint
                var.frame /locals /caller       ; Display all variables and function callers
                ...
                // Shutdown commands
                break.delete main               ; Delete breakpoint at address of main()
                break.delete 0x8048             ; Delete breakpoint at address
                break.delete 0x8060             ; Delete breakpoint at specified address
                system.down                     ; Disconnect from target
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.4 Support for importing and translating CMM scripts

You can use the import and translate CMM script feature in DS-5 to reuse existing CMM scripts for your platform. After the translation is complete, the CMM script is converted into a Jython script which you can then run in DS-5.

During the *CMM file import process* on page 7-175 in DS-5:

- Translates and maps the CMM commands to their equivalent Jython commands or calls to the DS-5 Debugger API.

  If a CMM command translation is not supported, it is marked up as a stub function in the resultant Jython script. Using the information contained in the stub function, you can implement your own functionality for unsupported CMM commands.

  See *7.4.2 Supported CMM commands for translations* on page 7-176 for the list of commands that are currently translated.
- Translates flow control statements in CMM such as IF, ELSE IF, ELSE, WHILE, and RePeaT to their Jython equivalents.
- Also imports and process complex nested commands and functions, CMM variables, and variable assignments. CMM subroutines that are specified with labels, ENTRY commands for subroutine parameters, and RETURN statements to return values from subroutines are converted directly to valid Jython subroutine syntax.

Logging and error handling

For every translated CMM script, the translation process also creates a log file and places it in the same folder as the translated script file. The log contains a summary, the detailed breakdown of the translated elements, and details of any errors, if any.

To view the log, right-click on the imported CMM script and select **Show log for the translation of** `<YourFilename.cmm>`.

7.4.1 Importing and translating a CMM script

If you have existing CMM scripts for your platform, you can use the script import feature in DS-5 to import and translate them.

Prerequisites

Scripts are associated with a debug configuration. When importing or editing scripts, first select the associated debug configuration for your target in the **Debug Control** view.

Procedure

1. To import a CMM script into DS-5, in the **Scripts** view, click **Import a script or directory** and select Import and translate a CMM script.

   Note

   You can also drag and drop the script to be imported into the script view, either from the **Project Explorer** view or your operating system file explorer.

2. Browse and select the CMM script that you want to import, and click **Open**.
3. Choose a location for the translated CMM script and click **OK**. To view the imported CMM script, in the **Scripts** view, expand the **CMM** node and locate your script.

The CMM scripts are converted to Jython scripts during the import process, and CMM commands are converted to their equivalent DS-5 Debugger commands. See *7.4.2 Supported CMM commands for translations* on page 7-176 to view the list of commands supported by the CMM command translation process in DS-5.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related references

7.4 Support for importing and translating CMM scripts on page 7-175.
7.4.2 Supported CMM commands for translations on page 7-176.
11.23 Scripts view on page 11-326.

7.4.2 Supported CMM commands for translations

The following CMM commands are supported by the translation process.

- `Break.Set` - Set a breakpoint or watchpoint.
- `Break.Delete` - Delete an address or symbol breakpoint or watchpoint.
- `pBreak.Delete` - Delete a source level breakpoint or watchpoint.
- `Core` or `Core.Select` - Switch to the numbered core in the connection.
- `Data.Load` - Load an image.
- `Data.Load.Elf` - Load an ELF format file.
- `Data.Load.Bin` - Load a binary format file.
- `Data.Load.auto` - Load a file after automatically detecting the file format.
- `Data.Long` - Read a 32-bit value from memory.
- `Data.Set` - Write byte-wise to memory.
- `Go.Direct` or `Go` - Continue to run the core (additionally set temporary breakpoints before running).
- `Print` - Print the output.
- `Register` - Read a register.
- `Register.Set` - Write a register.
- `System.ResetTarget` or `Sys.ResetTarget` - Reset the target on the current connection.
- `Wait` - Wait until a specified condition is true or for a set time period.

For detailed descriptions and formats for these individual commands, check the documentation provided with your debugger.

Related tasks

7.4.1 Importing and translating a CMM script on page 7-175.

Related references

7.4 Support for importing and translating CMM scripts on page 7-175.
11.23 Scripts view on page 11-326.

Related references

11.23 Scripts view on page 11-326.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.5 About Jython scripts

Jython is a Java implementation of the Python scripting language. It provides extensive support for data types, conditional execution, loops and organization of code into functions, classes and modules, as well as access to the standard Jython libraries.

Jython is an ideal choice for larger or more complex scripts. These are important concepts that are required in order to write a debugger Jython script.

The `.py` file extension must be used to identify this type of script.

```
# Filename: myScript.py
import sys
from arm_ds.debugger_v1 import Debugger
from arm_ds.debugger_v1 import DebugException
# Debugger object for accessing the debugger
debugger = Debugger()
# Initialization commands
ec = debugger.getCurrentExecutionContext()
ec.getExecutionService().stop()
ec.getExecutionService().waitForStop()
# in case the execution context reference is out of date
ec = debugger.getCurrentExecutionContext()
# load image if provided in script arguments
if len(sys.argv) == 2:
    image = sys.argv[1]
    ec.getImageService().loadImage(image)
    ec.getExecutionService().setExecutionAddressToEntryPoint()
    ec.getImageService().loadSymbols(image)
    # we can use all the DS commands available
    print "Entry point: ",
    print ec.executeDSCommand("print $ENTRYPOINT")
    # Sample output:
    #         Entry point: $8 = 32768
else:
    pass # assuming image and symbols are loaded
# sets a temporary breakpoint at main and resumes
ec.getExecutionService().resumeTo("main") # this method is non-blocking
try:
    ec.getExecutionService().waitForStop(500) # wait for 500ms
except DebugException, e:
    if e.getErrorCode() == "JYI31": # code of "Wait for stop timed out" message
        print "Waiting timed out!"
        sys.exit()
    else:
        raise # re-raise the exception if it is a different error
ec = debugger.getCurrentExecutionContext()
def getRegisterValue(executionContext, name):
    """Get register value and return string with unsigned hex and signed
    integer, possibly string "error" if there was a problem reading
    the register.
    """
    try:
        value = executionContext.getRegisterService().getValue(name)
        # the returned value behaves like a numeric type,
        # and even can be accessed like an array of bytes, e.g. 'print value[:]'
        return "%s (%d)" % (str(value), int(value))
    except DebugException, e:
        return "error"
# print Core registers on all execution contexts
for i in range(debugger.getExecutionContextCount()):
    ec = debugger.getExecutionContext(i)
    # filter register names starting with "Core::"
    coreRegisterNames = filter(lambda name: name.startswith("Core::"),
                               ec.getRegisterService().getRegisterNames())
    # using Jython list comprehension get values of all these registers
    registerInfo = ["%s = %s" % (name, getRegisterValue(ec, name))
                                        for name in coreRegisterNames]
    registers = ", ".join(registerInfo[:3]) # only first three
    print "Identifier: %s, Registers: %s" % (ec.getIdentifier(), registers)
# Output:
#         Identifier: 1, Registers: Core::R0 = 0x00000010 (16), Core::R1 = 0x00000000 (0),
Core::R2 = 0x0000A4A4 (42148)
#         ...
```

Related tasks

7.7.1 Creating a new Jython project in Eclipse for DS-5 on page 7-180.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.7.2 Configuring an existing project to use the DS-5 Jython interpreter on page 7-181.
7.8 Creating a Jython script on page 7-183.
7.9 Running a script on page 7-185.

Related references

7.6 Jython script concepts and interfaces on page 7-179.
11.39 Script Parameters dialog box on page 11-357.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.6 Jython script concepts and interfaces

Summary of important DS-5 Debugger Jython interfaces and concepts.

Imports

The debugger module provides a Debugger class for initial access to DS-5 Debugger, with further classes, known as services, to access registers and memory. Here is an example showing the full set of module imports that are typically placed at the top of the Jython script:

```
from arm_ds.debugger_v1 import Debugger
from arm_ds.debugger_v1 import DebugException
```

Execution Contexts

Most operations on DS-5 Debugger Jython interfaces require an execution context. The execution context represents the state of the target system. Separate execution contexts exist for each process, thread, or processor that is accessible in the debugger. You can obtain an execution context from the Debugger class instance, for example:

```
# Obtain the first execution context
debugger = Debugger()
ec = debugger.getCurrentExecutionContext()
```

Registers

You can access processor registers, coprocessor registers and peripheral registers using the debugger Jython interface. To access a register you must know its name. The name can be obtained from the **Registers** view in the graphical debugger. The RegisterService enables you to read and write register values, for a given execution context, for example:

```
# Print the Program Counter (PC) from execution context ec
value = ec.getRegisterService().getValue('PC')
print 'The PC is %s' %value
```

Memory

You can access memory using the debugger Jython interface. You must specify an address and the number of bytes to access. The address and size can be an absolute numeric value or a string containing an expression to be evaluated within the specified execution context. Here is an example:

```
# Print 16 bytes at address 0x0 from execution context ec
print ec.getMemoryService().read(0x0, 16)
```

DS Commands

The debugger jython interface enables you to execute arbitrary DS-5 commands. This is useful when the required functionality is not directly provided in the Jython interface. You must specify the execution context, the command and any arguments that you want to execute. The return value includes the textual output from the command and any errors. Here is an example:

```
# Execute the DS-5 command 'print $ENTRYPOINT' and print the result
print ec.executeDSCommand('print $ENTRYPOINT')
```

Error Handling

The methods on the debugger Jython interfaces throw DebugException whenever an error occurs. You can catch exceptions to handle errors in order to provide more information. Here is an example:

```
# Catch a DebugException and print the error message
try:
  ec.getRegisterService().getValue('ThisRegisterDoesNotExist')
except DebugException, de:
  print "Caught DebugException: %s" % (de.getMessage())
```

For more information on DS-5 Debugger Jython API documentation select **Help Contents** from the **Help** menu.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.7 Creating Jython projects in Eclipse for DS-5

To work with Jython scripts in DS-5, the project must use DS-5 Jython as the interpreter. You can either create a new Jython project in Eclipse for DS-5 with DS-5 Jython set as the interpreter or configure an existing project to use DS-5 Jython as the interpreter.

This section contains the following subsections:

- *7.7.1 Creating a new Jython project in Eclipse for DS-5* on page 7-180.
- *7.7.2 Configuring an existing project to use the DS-5 Jython interpreter* on page 7-181.

7.7.1 Creating a new Jython project in Eclipse for DS-5

Use these instructions to create a new Jython project and select DS-5 Jython as the interpreter.

Procedure

1. Select **File** > **New** > **Project...** from the main menu.
2. Expand the **PyDev** group.
3. Select **PyDev Project**.

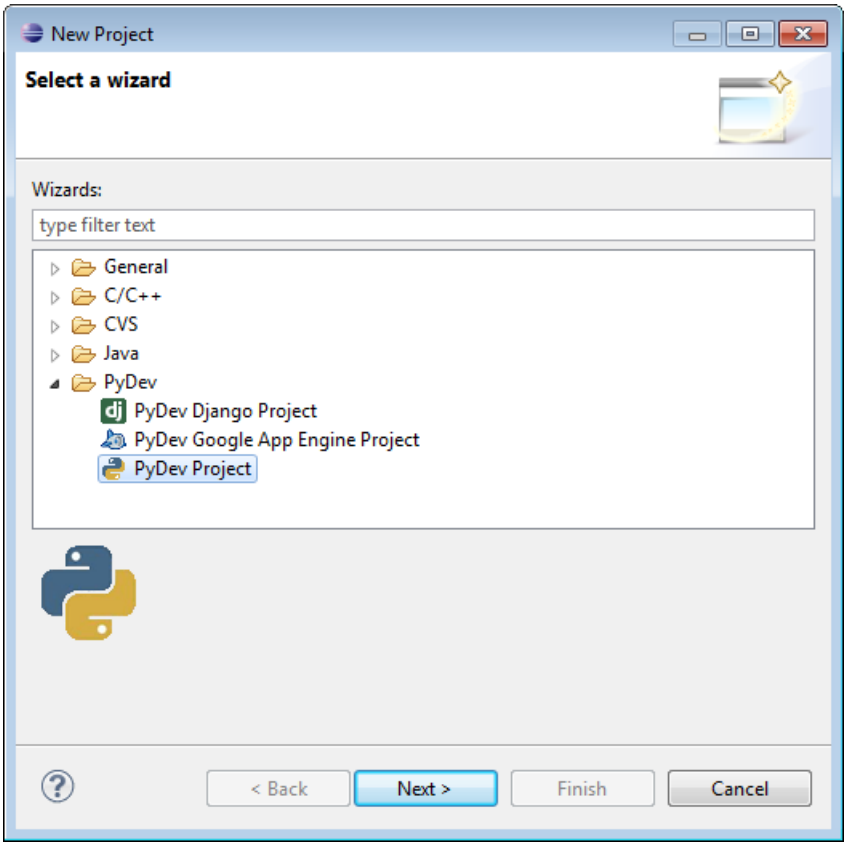


Figure 7-2 PyDev project wizard

4. Click **Next**.
5. Enter the project name and select relevant details:
   a. In Project name, enter a suitable name for the project.
   b. In Choose the project type, select **Jython**.
   c. In Interpreter, select **DS-5 Jython**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

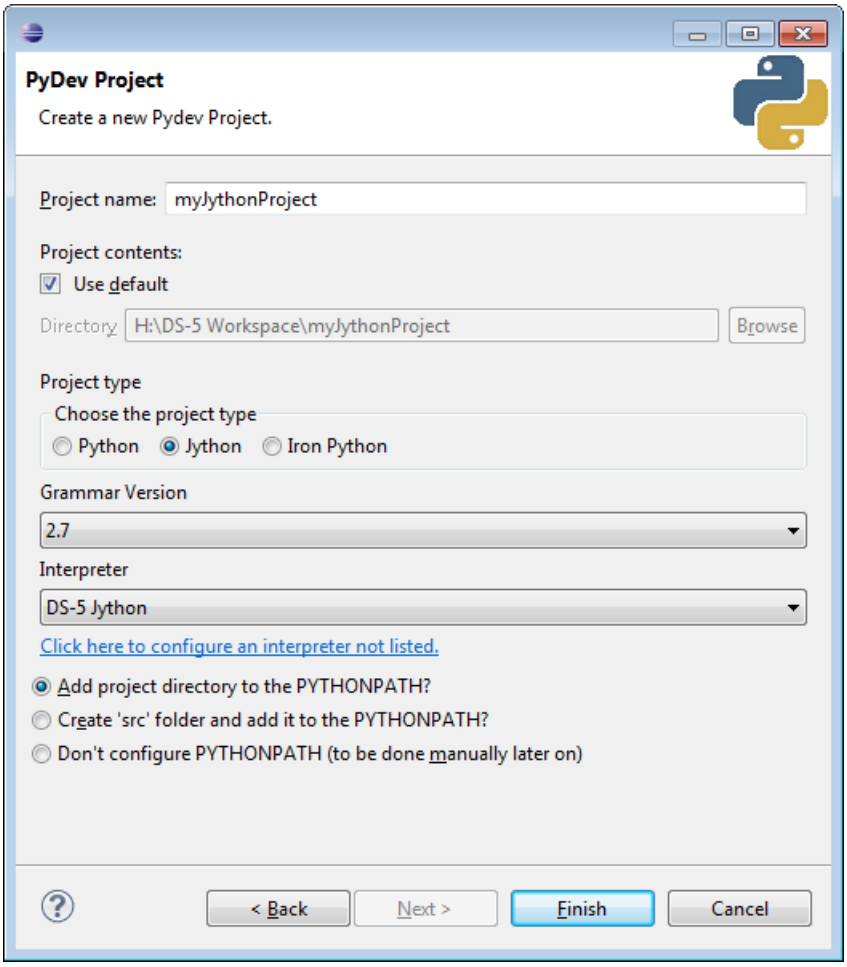


Figure 7-3 PyDev project settings

6. Click **Finish** to create the project.

Related concepts

7.5 About Jython scripts on page 7-177.

Related tasks

7.7.2 Configuring an existing project to use the DS-5 Jython interpreter on page 7-181.
7.8 Creating a Jython script on page 7-183.
7.9 Running a script on page 7-185.

Related references

7.6 Jython script concepts and interfaces on page 7-179.
11.39 Script Parameters dialog box on page 11-357.

7.7.2 Configuring an existing project to use the DS-5 Jython interpreter

Use these instructions to configure an existing project to use DS-5 Jython as the interpreter.

Procedure

1. In the **Project Explorer** view, right-click the project and select **PyDev** > **Set as PyDev Project** from the context menu.
2. From the **Project** menu, select **Properties** to display the properties for the selected project.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Note

You can also right-click a project and select **Properties** to display the properties for the selected project.

3. In the Properties dialog box, select **PyDev - Interpreter/Grammar**.
4. In Choose the project type, select **Jython**.
5. In Interpreter, select **DS-5 Jython**.
6. Click **OK** to apply these settings and close the dialog box.
7. Add a Python source file to the project.

Note

The `.py` file extension must be used to identify this type of script.

Related concepts

7.5 About Jython scripts on page 7-177.

Related tasks

7.7.1 Creating a new Jython project in Eclipse for DS-5 on page 7-180.
7.8 Creating a Jython script on page 7-183.
7.9 Running a script on page 7-185.

Related references

7.6 Jython script concepts and interfaces on page 7-179.
11.39 Script Parameters dialog box on page 11-357.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.8 Creating a Jython script

Shows a typical workflow for creating and running a Jython script in the debugger.

Procedure

1. Create an empty Jython script file.
2. Right-click the Jython script file and select **Open**.
3. Add the following code to your file in the editor:

```
from arm_ds.debugger_v1 import Debugger
from arm_ds.debugger_v1 import DebugException
```

Note

With this minimal code saved in the file you have access to auto-completion list and online help. ARM recommends the use of this code to explore the Jython interface.

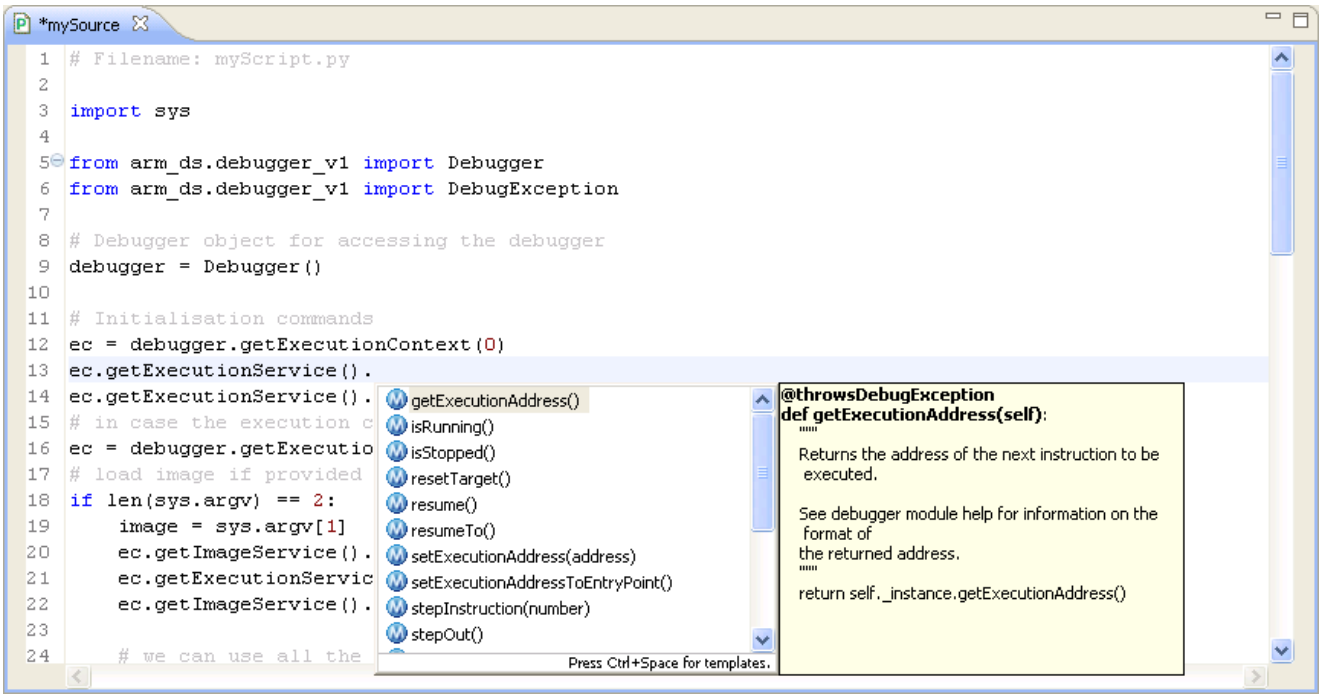


Figure 7-4 Jython auto-completion and help

4. Edit the file to contain the desired scripting commands.
5. Run the script in the debugger.

You can also view an entire Jython interface in the debugger by selecting a debugger object or interface followed by the keyboard and mouse combination **Ctrl+Click**. This opens the source code that implements it.

Related concepts

7.5 About Jython scripts on page 7-177.

Related tasks

7.7.1 Creating a new Jython project in Eclipse for DS-5 on page 7-180.
7.7.2 Configuring an existing project to use the DS-5 Jython interpreter on page 7-181.
7.9 Running a script on page 7-185.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related references

7.6 Jython script concepts and interfaces on page 7-179.
11.39 Script Parameters dialog box on page 11-357.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.9 Running a script

Use the **Scripts** view to run a script in DS-5. You can run a script file immediately after the debugger connects to the target.

Procedure

1. To run a script from Eclipse:
   a. Launch Eclipse.
   b. Configure a connection to the target.

      Note

      A DS-5 Debugger configuration can include the option to run a script file immediately after the debugger connects to the target. To do this, in the **Debugger** tab of the DS-5 **Debug Configuration** dialog box, select the appropriate script file option. See *Debug Configurations - Debugger tab* on page 11-364 for more information.

   c. Connect to the target.
2. After your target is up and running, select the scripts that you want to execute and click the **Execute Selected Scripts** button.

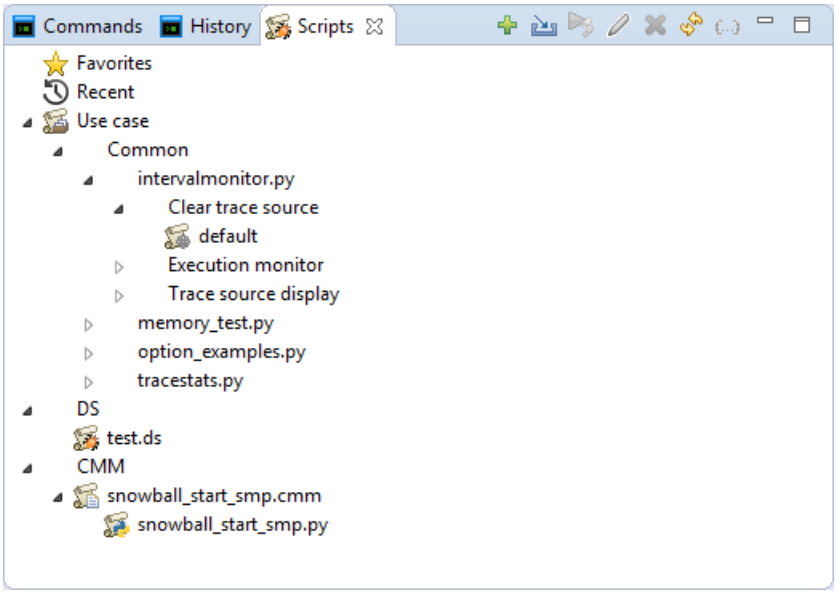


Figure 7-5 Scripts view

Note

Debugger views are not updated when commands issued in a script are executed.

Related concepts

7.5 About Jython scripts on page 7-177.

Related tasks

7.7.1 Creating a new Jython project in Eclipse for DS-5 on page 7-180.

7.7.2 Configuring an existing project to use the DS-5 Jython interpreter on page 7-181.

7.8 Creating a Jython script on page 7-183.

Related references

7.1 Exporting DS-5 Debugger commands generated during a debug session on page 7-172.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.2 Creating a DS-5 Debugger script on page 7-173.
7.3 Creating a CMM-style script on page 7-174.
11.6 Commands view on page 11-275.
11.14 History view on page 11-300.
7.6 Jython script concepts and interfaces on page 7-179.
11.39 Script Parameters dialog box on page 11-357.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.10 Use case scripts

Use case scripts provide an extension to existing scripts that can be used in DS-5.

DS-5 provides many pre-defined platform and model configurations in the configuration database for connecting to and debugging a range of targets. The configuration database can be extended using the Platform Configuration Editor or Model Configuration editor.

When a connection to a configuration is established, you can then run a use case script to invoke custom behavior. You can use Jython and access the ARM Debug and Trace Services Layer (DTSL) libraries and debugger APIs. You can use use case scripts to provide a complex trace configuration, trace pin multiplexing or configure multiple Coresight components within a single script.

Use case scripts provide a simple but highly configurable way to implement user-defined functionality without having to write any boilerplate code for setting up, configuring and maintaining a script. Use case scripts still have access to the full scripting APIs.

The benefits of use case scripts include:

Use case scripts work with DS-5
There are built-in functions within DS-5 to query, list, and run use case scripts including those in configuration databases and platform specific scripts. Use case scripts are analyzed and validated before they are run. A clear error message is reported if there are errors in the construction of the script.

Built-in functionality
Use case scripts take a set of options to configure the values given to the script on the command line and have a built-in mechanism to save and load sets of options. A trace configuration for a particular target or a complex set of options to recreate a bug can be saved and loaded when the script is run.

Flexibility
Use case scripts provide an easy way of changing the number of arguments, options, and names of methods as the script develops. You can define positional arguments to use case scripts. It is easy to add, remove or modify positional arguments. When running the script from the command line, you must specify values for the positional arguments. Multiple use cases are supported within a single use case script to allow sharing of common code, where each use case provides a single piece of functionality.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.11 Metadata for use case scripts

A use case definition block is a comment block that is usually at the start of the script.

The definition block can define various metadata:

- The title of the use case.
- A brief description of the use case.
- Where the options must be retrieved from for the use case.
- The method to validate the use case.
- A multiline help text which can provide usage text and a more verbose description of the use case.
- The entry point to the use case.

Only the entry point is required to define a use case. Other metadata definitions are optional.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.12 Definition block for use case scripts

Each use case definition block must begin with a `USECASE` header line to define the start of a use case. Without the header, DS-5 does not recognize the script as a use case script.

Tags describe the content of a use case. Each tag is surrounded by dollar (`$`) signs to distinguish them from any other text. All tags are defined `$<tag>$ <value>` with the exception of the `$Help$` tag. If a tag is defined in the use case definition block it can only be present once. Duplicate names of tags are not accepted in a single use case.

Only the `$Run$` tag which describes the entry point or main method to the use case needs to be defined for a valid use case. To report meaningful help when searching for use case scripts on the DS-5 command-line, it is recommended that you also define the `$Title$` and `$Description$` tags in each use case.

Run

The `$Run$` tag specifies the name of the entry point to a single use case. When you run a use case on the command line, it calls the method with the `$Run$` tag. For details of how to define the entry point, and how to supply additional arguments to the method, see *7.13 Defining the Run method for use case scripts* on page 7-191.

Example 7-2 Examples

```
...
$Run$ mainMethod
...
```

Title

The `$Title$` tag specifies the title in a use case definition block. This is a single line string which is the title of this use case script and is displayed when searching for use case scripts on the command-line.

Example 7-3 Examples

```
...
$Title$ Usecase Title
...
```

Description

The `$Description$` tag specifies the description in a use case definition block. This is a single line string which is the description of this use case and is displayed when searching for use case scripts on the command-line.

Example 7-4 Examples

```
...
$Description$ A brief description of this use case
...
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Options

The `$Options$` tag specifies a method within the use case script, which can be called to retrieve a list of options. For a description of how to define the options function, and how to construct a list of options, see *7.14 Defining the options for use case scripts* on page 7-192.

Example 7-5 Examples

```
...
$Options$ myOptions
...
```

Validation

The `$Validation$` tag specifies the validation method in the use case definition block. You must specify this to validate the options provided when the script is run. For a description of how to define the validation function, see *7.15 Defining the validation method for use case scripts* on page 7-195.

Example 7-6 Examples

```
...
$Validation$ myValidation
...
```

Help

The use of `$Help$` tags is slightly different from the use of other tags. The `$Help$` tag enables writing a multiline block of text, which appears in the output when a user requests help about the use case script. This can be used to provide usage description, parameters for the use case scripts, or a more verbose help text.

To define a block of help text, enclose the block in `$Help$` tags. Formatting, such as new lines and spaces are preserved in the `$Help$` block. Everything, including the definition of other tags, are consumed within a `$Help$` block. The `$Help$` block must be completed before other tags or code is defined.

Example 7-7 Examples

```
$Help$
This is part of the help text
...
$Help$
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.13 Defining the Run method for use case scripts

The method named in the `$Run$` tag must have at least one parameter, called `options`, which provides access to the script options.

Example 7-8 Examples

```
...
$Run$ mainMethod
...
```

```
def mainMethod(options):
    print "Running the main method"
```

It is possible to define an entry point to the use case that requires more than one parameter. The definition of the `$Run$` tag only defines the function name. The definition of the function within the script defines how many parameters are needed.

Example 7-9 Examples

```
...
$Run$ main
...
```

```
# main method with positional arguments
def main(options, filename, value):
    print "Running the main method"
    # Using the positional arguments supplied to the script.
    print "Using file: " + filename + " and value: " + value
```

In this example `main` requires two parameters, `filename` and `value` which must be supplied on the command-line when the use case script is run.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.14 Defining the options for use case scripts

Each use case has a list of options which specify a set of values which can be supplied on the command-line to a particular use case to configure what values are supplied when use case is run.

When you define options, you can group or nest them to organize and provide a more descriptive set of options.

The method which provides the options is defined with the `$Options$` tag in a use case definition block. The `$Options$` tag provides the name of a method in the script which returns a single list of options.

Example 7-10 Examples

```
...
$Options$ myOptions
...
```

```
def myOptions():
      return [list_of_options]
```

It is important that the function that supplies the options takes no arguments and returns a list of options in the same format as described below. If the `$Options$` tag is defined, and the function named in this tag is not present in the script or the function used to supply the options takes arguments, then an error occurs when running the script.

There are 5 types of option that can be used to define options to a use case script. These are:

- UseCaseScript.booleanOption.
- UseCaseScript.enumOption.
- UseCaseScript.radioEnumOption.
- UseCaseScript.integerOption.
- UseCaseScript.stringOption.

All of these options require:

- A variable name, that is used to refer to the option in a use case script.
- A display name.
- A default value that must be of the same type as the defined option.

UseCaseScript.booleanOption
: Describes a boolean. Possible values are `True` or `False`.

UseCaseScript.integerOption
: Describes a whole integer value such as: 4, 99 or 100001. In addition to the fields required by all options, a minimum and a maximum value can be supplied which restricts the range of integers this option allows. Additionally, an output format of the integer option can be defined, which can be either decimal (base 10) or hexadecimal (base 16).

UseCaseScript.stringOption
: Describes a string such as `traceCapture` or `etmv4` which can be used, for example, to refer to the Coresight components in the current system by name.

UseCaseScript.enumOption
UseCaseScript.radioEnumOption
: Both these describe enumerations. These can be used to describe a list of values that are allowed for this option. Enumeration values can be strings or integers.

Example 7-11 Examples

```
UseCaseScript.booleanOption(name="timestamps", displayName="Enable global timestamping",
defaultValue=True)
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Defines a boolean option “timestamps” which is true by default.

```
UseCaseScript.stringOption(name="traceBuffer", "Trace Capture Method", defaultValue="none")
```

Defines a string option “traceBuffer” with a default value “none”.

```
UseCaseScript.integerOption(name="cores", displayName="Number of cores", defaultValue=1,
min=1, max=16, format=UseCaseScript.DEC)
```

Defines an integer option “cores” with a default value of 1, minimum value of 1 and maximum value of 16. The output format is in decimal (base 10).

```
UseCaseScript.integerOption(name="retries", displayName="Attempts to retry", defaultValue=5,
min=1, format=UseCaseScript.HEX)
```

Defines an integer option “retries” with a default value of 5, minimum value of 1 and no maximum value. The output will be in hexadecimal (base 16).

```
UseCaseScript.enumOption(name="contextid", displayName="Context ID Size",  values = [("8",
"8 bits"), ("16", "16 bits"), ("32", "32 bits")] , defaultValue="32")
```

Defines an enumeration “contextid” with default value of “32”, the values are restricted to members of the enumeration: "8", "16" or "32".

Nesting Options

Options can be organized or grouped using the following:

- UseCaseScript.tabSet.
- UseCaseScript.tabPage.
- UseCaseScript.infoOption.
- UseCaseScript.optionGroup.

The groups are not associated with a value, and do not require a default. You can use the groups with the option names to construct a complete set of options.

To specify the nesting of options, each option can include an optional `childOptions` keyword which is a list of other options which are nested within this option. An example set of nested options can be seen below.

Example 7-12 Examples

The following example shows an options method, complete with a set of options.

```
def myOptions():
      return [
          UseCaseScript.optionGroup(
          name="options",
          displayName="Usecase Options",
          childOptions=[
              UseCaseScript.optionGroup(
                  name="connection",
                  displayName="Connection Options",
                  childOptions=[
                      UseCaseScript.integerOption(
                         name="cores",
                         displayName="Number of cores",
                         defaultValue=1,
                         min=1,
                         max=16),
                      UseCaseScript.stringOption(
                         name="traceBuffer",
                         displayName="Trace Capture Method",
                         defaultValue="none"),
                  ]
              ),
              UseCaseScript.enumOption(
              name="contextID",
              displayName="Context ID Size",
              values = [("8", "8 bits"), ("16", "16 bits"), ("32", "32
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
bits")] ,
              defaultValue="32"),
              ]
          ),
      ]
```

Options are accessed according to how they are nested within the list of options. In this example there is a group called `options` with two child options:

options.contextID
This is an enumeration within the options group, and stores the value of the contextID in this example.

options.connection
This is another group for nesting options. It does not store any value. It contains the options:

options.connection.cores
This is an integer that accesses `cores` variable.

options.connection.traceBuffer
This is a string that accesses `traceBuffer` variables in the list of options.

Using options in the script

The entry point and validation functions both take an `options` object, as the required first parameter, which can be used to get and set the option values. The functions that are provided to work with defined options are `getOptionValue(`*`name`*`)` and `setOptionValue(`*`name, value`*`)`.

For the `name` of the option, use the full name, for example `group.subgroup.variable`. The `value` must be of the correct type for the named variable, for example string, integer or a member of the enumeration.

To find out the full name of the option, either see the definition of options in the use case script or issue a `usecase help` *`script_name.py`* on the command-line.

DTSL Options

Options are defined in a similar way to the Debug and Trace Services Layer (DTSL) options, using the same parameters and way of nesting child options.

See *15.6 DTSL options* on page 15-462 and the example use case scripts in your DS-5 installation for more information on how to construct a list of options.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.15 Defining the validation method for use case scripts

The method defined using the `$Validation$` tag names a method in the use case script which provides validation for the use case.

The validation method takes a single parameter, called `options`, which can be used to access the options supplied to the script.

The example shows a validation method called `myValidation` in the use case definition block. The validation method is used to validate the set of options supplied to the use case script.

Example 7-13 Examples

```
...
$Validation$ myValidation
...
```

```
def myValidation(options):
    # Get the options which define the start and end of a trace range
    # These options have been defined in the function defined in the $Options$ tag
    start = options.getOptionValue("options.traceRange.start")
    end = options.getOptionValue("options.traceRange.end")
    # Conditional check for validation
    if(start >= end):
         # Report a specific error in the use case script if the validation check fails
         UseCaseScript.error("The trace range start must be before the end")
```

It is important that the function that supplies the validation takes a single parameter, which is the use case script object, used to access the options defined for use in the script.

If the `$Validation$` tag is defined, and the method referred to in this tag is not present in the script or the validation function takes the wrong number of arguments, an error occurs when running the script.

Error reporting

This validation example throws an error specific to use case scripts. If validation is not successful, for example start >= end, in our script, the DS-5 command-line displays:

```
UseCaseError: The trace range start must be before the end
```

It is possible not to use the built-in use case error reporting and throw a standard Jython or Java error such as:

```
raise RuntimeError("Validation was unsuccessful")
```

This displays an error in the DS-5 command-line:

```
RuntimeError: Validation was unsuccessful
```

However, it is recommended to use the built-in use case script error reporting so that a clear user-defined error is raised that originates from the use case script.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.16 Example use case script definition

This is an example of a complete use case script.

After a use case script is defined, you can use the command-line options in DS-5 to query and execute the script when connected to a target.

Example 7-14 Examples

```
"""
USECASE

$Title$ Display Title

$Description$ A brief description of this use case

# Refers to a function called myOptions which returns a list of options
$Options$ myOptions

# Refers to a function called myValidation which validates the options in the script
$Validation$ myValidation

$Help$
usage: usecase.py [options]
A longer description of this use case
And additional usage, descriptions of parameters and extra information.
...
...
$Help$

# Function called mainMethod which defines the entry point to this usecase
$Run$ mainMethod
"""
```

```
def myOptions():
      return [
          UseCaseScript.optionGroup(
              name="options",
              displayName="Usecase Options",
              childOptions=[
                  UseCaseScript.optionGroup(
                     name="connection",
                     displayName="Connection Options",
                     childOptions=[
                         UseCaseScript.integerOption(
                             name="cores",
                             displayName="Number of cores",
                             defaultValue=1,
                             min=1,
                             max=16),
                         UseCaseScript.stringOption(
                             name="traceBuffer",
                             displayName="Trace Capture Method",
                             defaultValue="none"),
                     ]
                  ),
                  UseCaseScript.enumOption(
                  name="contextID",
                  displayName="Context ID Size",
                  values = [("8", "8 bits"), ("16", "16 bits"), ("32", "32
bits")],
                  defaultValue="32"),
              ]
          ),
      ]

def myValidation(options):
    print "Performing validation..."
    if(options.getOptionValue("options.connection.cores") > 8):
        UseCaseScript.error("Having more than 8 cores is not allowed for this usecase")

def mainMethod(options, address):
    print "Running the main method"
    print "The address supplied %s" % address
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.17 Multiple use cases in a single script

You can define multiple use cases within a single script. This is useful to allow use cases to share common code, and each use case can provide a single piece of functionality.

Each use case requires its own use case definition block which begins with a `USECASE` header. When defining use cases in the same script, they can share options and validation functions but the entry point to each use case must be unique.

Multiple use case blocks can be defined as a single multiline comment at the top of the script:

Example 7-15 Examples

```
USECASE
...
...
$Run$ mainMethod

USECASE
...
...
$Run$ entry2
```

```
...
def mainMethod(options):
    print "Running the first main method"
...

def entry2(script, param1):
    print "Running the second main method"
...
```

Multiple use case blocks can be defined as separate blocks dispersed throughout the script:

Example 7-16 Examples

```
USECASE
...
...
$Run$ mainMethod
```

```
...
def mainMethod(options):
    print "Running the first main method"
...
```

```
USECASE
...
...
$Run$ entry2
```

```
...
def entry2(script, param1):
    print "Running the second main method"
...
```

There is no limit to how many use cases you can define in a single script.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.18 usecase list command

The `usecase list` command allows the user to search for use case scripts in various locations.

The output reports the location searched for use cases and, if any use case scripts are found, prints a table listing:

- The script name.
- Entry points to the script. Each entry point defines a single use case.
- The title of each use case.
- The description of each use case, if defined.

If a `usecase list` command is issued without any parameters on the command line, DS-5 reports all the use case scripts it finds in the current directory.

A `usecase list path/to/directory/` command lists any use case scripts it finds in the directory specified. The `usecase list` command accepts relative paths to locations as well as tilde (~) as the user home directory on Unix based systems.

Several use cases are shipped with DS-5 and are found in the default configuration database under `/Scripts/usecase/`. When creating a use case it can be added to `/Scripts/usecase/` in the default database, or a custom user database. These scripts are also listed by the `usecase list -s` command.

Use case scripts might be platform specific, and use cases can be defined as only visible for the current target. A use case script created in the configuration database in `/Boards/<Manufacturer>/<Platform>/` is only visible when a connection is made to the `<Manufacturer>/<Platform>` configuration.

`usecase list -p` lists all use case scripts associated with the current platform. For example if a connection was made to the configuration in `/ARM FVP (Installed with DS-5)/VE_AEMv8x1/` and the `usecase list -p` was run, only use case scripts in this directory for the current configuration are listed.

Issuing `usecase list -a` lists all scripts in the current working directory, in `/Scripts/usecase/` in the configuration database, and those for the current platform.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.19 usecase help command

The `usecase help` command is available to print help on how to use the use case scripts and information about the options available.

The syntax for running `usecase help` is:

`usecase help [`*`flag`*`] `*`script_name`*` [`*`entry_point`*`]`

Where:

flag

-p
To run a script for the current platform.

-s
To run a script in the `/Scripts/usecase/` directory in the configuration database.

entry_point
Is the name of the entry point or main method defined in the use case. If a use case script defines more than one entry point, then you must specify the *entry_point* parameter.

script_name
Is the name of the use case script.

Running use case help on a valid script prints:

- Text defined in a `$Help$` block in the use case script.
- A set of built-in options that are defined in every use case script.
- A list of information about the options defined in this use case.

For each option the help text lists:
- The display name of the option.
- The unique option name for getting or setting options.
- The type of option, which is integer, string, boolean, or enumeration.
- The default value of the option.

For enumeration options, a list of the enumerated values are listed. For integer options, the maximum and minimum values are displayed, if they have been specified.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

7.20 usecase run command

The `usecase run` command runs the script from the specified entry point.

The basic syntax for running a use case script from the command-line is:

`usecase run` *`script_name`* `[`*`options`*`]`

The options that you can use are defined in the method with the `$Options$` tag of the current use case within the script. You can get more information about them using the `usecase help` command.

The syntax for setting options on the command line is *`--options.name=value`* or *`--options.name value`*. If you do not specify a value for an option explicitly, the option takes the default value defined in the script.

Note

The examples use `options` as the name of the top level group of options. However, you can give a different name to the top level group of options in the use case script.

When issuing the `usecase run` command, rather than specifying an absolute path to a script, specify a `-p` or `-s` flag before the script name. For example, issue `usecase run -p` *`script_name`* `[`*`options`*`]` to run a use case script for the current platform.

If there is more than one use case defined in a single script, the entry point or main method to use when running the script must be defined. For scripts with multiple use cases the syntax is `usecase run` *`script_name entry_point`* `[`*`options`*`]`.

If the entry point to the use case accepts positional arguments, you must specify them on the command-line when the script is run. For example, if the main method in the use case script `positional.py` in the current working directory is defined as follows:

```
...
$Run$ main
...
```

```
def main(script, filename, value):
        print("Running the main method")
```

The syntax to run the script is:

```
usecase run positional.py [options] filename value
```

Example 7-17 Examples

```
usecase run myscript.py --options.enableETM=True --options.enableETM.timestamping=True
        --options.traceCapture "DSTREAM"
```

Runs a use case script called `myscript.py` in the current working directory, setting the options defined for this use case.

```
usecase run multipleEntry.py mainOne --options.traceCapture "ETR"
```

Runs a use case script called `multipleEntry.py` in the current working directory. The entry point to this use case script is `mainOne`. A single option is specified after the entry point.

```
usecase run -s multipleScript.py mainTwo filename.txt 100
```

Runs a use case script in the `/Scripts/usecase/` directory in the configuration database called `multipleScript.py` in the current working directory. The entry point to this use case script is `mainTwo` which defines two positional arguments. No options are supplied to the script.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Saving options

On the command-line, providing a long list of options might be tedious to type in every time the script is run over different connections. A solution to this is to use the built-in functionality `--save-options`.

For example, you can run the script `usecase run script_name --option1=..., --option2=... --save-options=/path/to/options.txt` where `options.txt` is the file in which to save the options. This saves the options to this use case script, at runtime, to `options.txt`.

If you do not specify an option on the command-line, its default value is saved to the specified file.

Loading options

After saving options to a file, there is a similar mechanism for loading them back in. Issuing `usecase run script_name --load-options=path/to/options.txt` loads the options in from `options.txt` and, if successful, runs the script.

You can combine options by providing options on the command-line and loading them from a file. Options from the command-line override those from a file.

Example:

The options file `options.txt` for `myscript.py` contains two option values:

- options.a=10.
- options.b=20.

Running `usecase run myscript.py --load-options=options.txt` results in `options.a` having the value 10 and `options.b` having the value 20, loaded from the specified file. If an option is set on the command-line, for example `usecase run --options.b=99 --load-options=options.txt`, it overrides those options retrieved from the file. `options.a` takes the value 10, but `options.b` takes the new value 99 provided on the command-line and not the one stored in the file. This is useful for storing a standard set of options for a single use case and modifying only those necessary at runtime.

Showing options

When running a script, the user might want to see what options are being used, especially if the options are loaded from an external file. The built-in option `--show-options` displays the name and value of all options being used in the script when the script is run.

Example 7-18 Examples

```
usecase run script_name --show-options
```

Prints out a list of the default options for this script.

```
usecase run script_name --option1=x, --option2=y --show-options
```

Prints out a list of options for the script, with updated values for option1 and option2.

```
usecase run script_name --load-options=file --show-options
```

Prints out a list of options taking their values from the supplied file. If an option is not defined in the loaded file, its default value is printed.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 8
Running DS-5 Debugger from the operating system command-line or from a script

This chapter describes how to use DS-5 Debugger from the operating system command-line or from a script.

It contains the following sections:

- *8.1 Overview: Running DS-5 Debugger from the command-line or from a script* on page 8-203.
- *8.2 Command-line debugger options* on page 8-204.
- *8.3 Running a debug session from a script* on page 8-209.
- *8.4 Specifying a custom configuration database using the command-line* on page 8-211.
- *8.5 Capturing trace data using the command-line debugger* on page 8-213.
- *8.6 DS-5 Debugger command-line console keyboard shortcuts* on page 8-215.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

8.1 Overview: Running DS-5 Debugger from the command-line or from a script

DS-5 Debugger can operate in a command-line only mode, with no graphical user interface.

This is very useful when automating debug and trace activities. By automating a debug session, you can save significant time and avoid repetitive tasks such as stepping through code at source level. This becomes particularly useful when you need to run multiple tests as part of regression testing.

This mode has the advantage of being extremely lightweight and therefore faster. However, by extension, it also lacks the enhancements that a GUI brings when connecting to a target device such as being able to see synchronization between your source code, disassembly, variables, registers, and memory as you step through execution.

If you want, you can drive the operation of DS-5 Debugger with individual commands in an interactive way. However, DS-5 Debugger when used from the command-line, is typically driven from scripts. With DS-5 Debugger, you might first carry out the required debug tasks in the graphical debugger. This generates a record of each debug task, which can then be exported from the **History** view as a (`.ds`) script.

You can edit scripts using the **Scripts** view. Alternatively, a debug script can be written manually using the *DS-5 Debugger commands* for reference.

DS-5 also supports Jython (.py) scripts which provide more capability than the native DS-5 scripting language. These can be loaded into DS-5 Debugger to automate the debugger to carry out more complex tasks.

See *Command-line debugger options* on page 8-204 for syntax and instructions on how to launch DS-5 Debugger from the command line.

Related tasks

8.4 Specifying a custom configuration database using the command-line on page 8-211.

Related references

8.2 Command-line debugger options on page 8-204.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

8.2 Command-line debugger options

The options listed below allow you to run DS-5 Debugger from the command-line without a graphical user interface.

If you are using Windows, use the DS-5 **Command Prompt**. On Linux, set the required environment variables, and use the UNIX shell.

Launch the command-line debugger using the following syntax:

```
debugger [--option arg] ...
```

Where:

`debugger`
: Invokes the DS-5 command-line debugger.

`--option arg`
: The debugger option and its arguments. This can either be to configure the command-line debugger, or to connect to a target.

`...`
: Additional options, if you need to specify any.

Note

Once connected to your target, use any of the *DS-5 Debugger commands* to access the target and start debugging.

For example, `info registers` displays all application level registers.

Options

`--browse`
: Browses for available connections and lists targets that match the connection type specified in the configuration database entry.

Note

You must specify `--cdb-entry arg` to use `--browse`.

`--cdb-entry arg`
: Specifies a target from the configuration database that the debugger can connect to.

Use `arg` to specify the target configuration. `arg` is a string, concatenated using entries in each level of the configuration database. The syntax of `arg` is:

`"Manufacturer::Platform::Project type::Execution environment::Activity::Connection type"`.

Use `--cdb-list` to determine the entries in the configuration database that the debugger can connect to. You can specify partial entries such as `"ARM Development Boards"` or `"ARM Development Boards::Versatile Express A9x4"` and press `Enter` to view the next possible entries.

For example, to connect to a ARM Versatile Express A9x4 target using DSTREAM and a USB connection, first use `--cdb-list` to identify the entries in the configuration database within `ARM Development Boards`, then use:

```
debugger --cdb-entry "ARM Development Boards::Versatile Express A9x4::Bare Metal
Debug::Bare Metal SMP Debug of all cores::Debug Cortex-A9x4 SMP::DSTREAM" --cdb-
entry-param "Connection=USB:000271"
```

`--cdb-entry-param arg`
: Specifies connection parameters for the debugger.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Use `arg` to specify the parameters and their values. The syntax for `arg` is comma separated pairs of parameters and values: `"param1=value1"`. Use `--cdb-list` to identify what parameters the debugger needs. Parameters that the debugger might need are:

`Connection`
: Specifies the TCP address or the USB port number of the debug adapter to connect to.

`Address`
: Specifies the address for a gdbserver connection.

`Port`
: Specifies the port for a gdbserver connection.

`dtsl_options_file`
: Specifies a file containing the DTSL options.

`Model parameters`
: Specifies parameters for a model connection. The model parameters depend on the specific model that the debugger connects to. See the documentation on the model for the parameters and how to configure them. The debugger uses the default model parameter values if you do not specify them.

Use `--cdb-entry-param` for each parameter.

For example `--cdb-entry-param "Connection=TestTarget" --cdb-entry-param "dtsl_options_file=my_dtsl_settings.dtslprops"`

`--cdb-list filter`
: Lists the entries in the configuration database. This option does not connect to any target.
The configuration database has a tree data structure, where each entry has entries within it. `--cdb-list` identifies the entries in each level of the database. The levels are:

1. Manufacturer
2. Platform
3. Project type
4. Execution environment
5. Activity
6. Connection type.

Use `filter` to specify the entries in each level, to identify the target and how to connect to it. `filter` is a string concatenated using entries in successive levels of the configuration database. The full syntax of `filter` is: `"Manufacturer::Platform::Project type::Execution environment::Activity::Connection type"`.
If you specify an incomplete `filter`, then `--cdb-list` shows the entries in the next level of the configuration database. So if you do not specify a `filter`, `--cdb-list` shows the `Manufacturer` entries from the first level of the configuration database. If you specify a `filter` using entries from the first and second levels of the database, then `--cdb-list` shows the `Project type` entries within the specified `Platform`. If you specify the complete `filter` then `--cdb-list` lists the parameters that need to be specified using `--cdb-list-param`.

Note

- The entries in the configuration database are case-sensitive.
- `Connection type` refers to DSTREAM or RVI, so there is no `Connection type` when connecting to a model.

To list all first level entries in the configuration database, use:

```
debugger --cdb-list
```

For example, to list all the configuration database entries for the manufacturer Altera, use:

```
debugger --cdb-list="Altera"
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

`--cdb-root arg`
Specifies additional configuration database locations in addition to the debugger's default configuration database.

Note

- To specify more than one configuration database, you must separate the directory paths using a colon (`:`) for Linux systems or a semicolon (`;`) for Windows systems.
- The order in which configuration database roots are specified is important when the same information is available in different databases. That is, the data in the location typed last (nearest to the end of full command-line) overrides data in locations before it.
- If you do not need any data from the default configuration database, use the additional command-line option `--cdb-root-ignore-default` to tell the debugger not to use the default configuration database.

`--cdb-root-ignore-default`
Ignores the default configuration database.

`--continue_on_error=true | false`
Specifies whether the debugger stops the target and exits the current script when an error occurs.

The default is `--continue_on_error=false`.

`--disable-semihosting`
Disables semihosting operations.

`--disable_semihosting_console`
Disables all semihosting operations to the debugger console.

`--enable-semihosting`
Enables semihosting operations.

`-h or --help`
Displays a summary of the main command-line options.

`-b=filename or --image=filename`
Specifies the image file for the debugger to load when it connects to the target.

`--interactive`
Specifies interactive mode that redirects standard input and output to the debugger from the current command-line console, for example, Windows Command Prompt or Unix shell.

Note

This is the default if no script file is specified.

`--log_config=arg`
Specifies the type of logging configuration to output runtime messages from the debugger. The `arg` can be:
`info` - Output messages using the predefined `INFO` level configuration. This level does not output debug messages. This is the default.
`debug` - Output messages using the predefined `DEBUG` level configuration. This option outputs both `INFO` level and `DEBUG` level messages.
`filename` - Specifies a user-defined logging configuration file to customize the output of messages. The debugger supports *`Log4j`* configuration files.

`--log_file=filename`
Specifies an output file to receive runtime messages from the debugger. If this option is not used then output messages are redirected to the console.

`--script=filename`
Specifies a script file containing debugger commands to control and debug your target. You can repeat this option if you have several script files. The scripts are run in the order specified and the debugger quits after the last script finishes. Add the `--interactive` option to the command-line if you want the debugger to remain in interactive mode after the last script finishes.

`-e arg or --semihosting-error arg`
Specifies a file to write semihosting `stderr`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

`-i arg or --semihosting-input arg`
: Specifies a file to read semihosting `stdin`.

`-o arg or --semihosting-output arg`
: Specifies a file to write semihosting `stdout`.

`--stop_on_connect=true | false`
: Specifies whether the debugger stops the target when it connects to the target device. To leave the target unmodified on connection, you must specify `false`. The default is `--stop_on_connect=true`.

`--top_mem=address`
: Specifies the stack base, also known as the top of memory. Top of memory is only used for semihosting operations.

`--target-os=name`
: Specifies the operating system on the target. Use this option if you want to debug the operating system on the target.

`--target-os-list`
: Lists the operating systems that you can debug with DS-5 Debugger.

Note

Specifying the `--cdb-entry` option is sufficient to establish a connection to a model. However to establish a connection in all other cases, for example, for Linux application debug or when using DSTREAM, you must specify both `--cdb-entry` and `--cdb-entry-param` options.

You must normally specify `--cdb-entry` when invoking the debugger for all other options to be valid. The exception to this are:

- `--cdb-list` and `--help` do not require `--cdb-entry`.
- `--cdb-root` can be specified with either `--cdb-list` or `--cdb-entry`.

Example 8-1 Examples

To connect to an ARM FVP Cortex-A9x4 model and specify an image to load, use:

```
debugger --cdb-entry "ARM FVP::VE_Cortex_A9x4::Bare Metal Debug::Bare Metal Debug::Debug
Cortex-A9x4 SMP" --image "C:\DS-5_Workspace\fireworks_A9x4-FVP\fireworks-Cortex-A9x4-FVP.axf"
```

To connect and debug a Linux application on a Beagleboard target, use:

```
debugger --cdb-entry "beagleboard.org::OMAP 3530::Linux Application Debug::gdbserver
(TCP)::Connect to already running gdbserver" --cdb-entry-param "Address=TCP:10.5.196.50" --
cdb-entry-param "Port=5350"
```

To connect and debug a Linux kernel on a Beagleboard target, use:

```
debugger --cdb-entry "beagleboard.org::OMAP 3530::Linux Kernel and/or Device Driver
Debug::Linux Kernel Debug::Debug Cortex-A8::DSTREAM" --cdb-entry-param "Connection=TCP:
10.5.196.50"
```

To connect to a single Cortex A15 core on the Versatile Express Cortex-A15x2+A7x3 target using DSTREAM and a TCP/IP connection:

```
debugger --cdb-entry "ARM Development Boards::Versatile_Express_V2P-CA15_A7::Bare Metal
Debug::Bare Metal Debug::Debug Cortex-A15_0::DSTREAM" --cdb-entry-param "Connection=TCP:
10.8.197.59"
```

To connect to a Juno ARM Development Platform (r0) big.LITTLE target using DSTREAM and a TCP/IP connection:

```
debugger --cdb-entry "ARM Development Boards::Juno ARM Development Platform (r0)::Bare Metal
Debug::Bare Metal Debug::Debug Cortex-A57/Cortex-A53 big.LITTLE::DSTREAM" --cdb-entry-param
"Connection=TCP:10.2.194.40"
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Tip

Once a debugger connection has been established, type `quit` when you want to exit the connection.

Related tasks

2.2 Launching DS-5 and connecting to DS-5 Debugger on page 2-36.

Related references

8.6 DS-5 Debugger command-line console keyboard shortcuts on page 8-215.
7.1 Exporting DS-5 Debugger commands generated during a debug session on page 7-172.
3.17 Using semihosting to access resources on the host computer on page 3-95.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

8.3 Running a debug session from a script

To automate a debug session from a script, create a text file with a `.ds` file extension and list, line-by-line, the debugger commands that you want to execute. Then, use the `debugger` command to run the script.

Debugger script format

The script is a text file with a `.ds` file extension. The debugger commands are listed one after the other in the file.

Things to remember when you create a `.ds` script file.

- The script file must contain only one command on each line.
- If required, you can add comments using `#`.
- Commands are not case-sensitive.
- The `.ds` file extension must be used for a DS-5 Debugger script.

Tip

If you are using the DS-5 graphical user interface (GUI) to perform your debugging, a full list of all the DS-5 Debugger commands generated during a debug session is recorded in the **History** view. You can select the commands that you want in your script file and right-click and select **Save selected lines as a script...** to save them to a file.

Example 8-2 Examples

A simple sample script file is shown below:

```
# Filename: myScript.ds
# Initialization commands
load file "struct_array.axf"  # Load image and symbols
break main                    # Set breakpoint at main()
break *0x814C                 # Set breakpoint at address 0x814C
# Run to breakpoint and print required values
run                           # Start running device
wait 0.5s                     # Wait or time-out after half a second
info stack                    # Display call stack
info registers                # Display info for all registers
# Continue to next breakpoint and print required values
continue                      # Continue running device
wait 0.5s                     # Wait or time-out after half a second
info functions                # Displays info for all functions
info registers                # Display info for all registers
x/3wx 0x8000                  # Display 3 words of memory from 0x8000 (hex)
delete 1                      # Delete breakpoint number 1
delete 2                      # Delete breakpoint number 2
```

Running a DS-5 script

After creating the script, use the `debugger` command to run the script using the command-line interface.

On Windows, use the **DS-5 Command Prompt**. On Linux, set the required environment variables, and use the UNIX shell.

There are two scenarios where you might run scripts:

- You have set up your target and it is connected to DS-5.

  In this case, use the *`source`* command to load your script.
- You are yet to configure the target and connect to it.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

In this case, you have to use the appropriate debugger options and arguments to configure and connect to your target. Along with the configuration options, use the `--script= filename` option to run your script.

For example:

```
debugger --cdb-entry "ARM Development Boards::Versatile Express A9x4::Bare Metal
Debug::Bare Metal SMP Debug of all cores::Debug Cortex-A9x4 SMP::DSTREAM"--cdb-
entry-param "Connection=TCP:10.5.20.64" --cdb-entry-param "dtsl_options_file=C:
\DS-5_Workspace\my_dtsl_settings.dtslprops" --script= C:\DS-5_Workspace
\my_script.txt
```

See *Specifying a custom configuration database using the command-line* on page 8-211 and *Capturing trace data using the command-line debugger* on page 8-213 for examples of how debugger options and arguments are used.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

8.4 Specifying a custom configuration database using the command-line

Some targets might not be available in the default DS-5 configuration database. For example, a custom target which is available only to you. In this case, you can specify a custom configuration database which contains the details for your target.

Use the DS-5 Debugger command-line options to view the entries in your custom configuration database and determine the connection names. Then, use additional commands and options to specify the details of your configuration database and connect to your target.

Procedure

1. Launch a DS-5 command-line console.
   - On Windows, select **Start** > **All Programs** > **ARM DS-5** > **DS-5 Command Prompt**.
   - On Linux:
     — Add the `DS-5_install_directory/bin` directory to your `PATH` environment variable. If it is already configured, then you can skip this step.
     — Open a terminal.
2. List the entries in the user-specified configuration databases. Use the following syntax:
   - On Windows, enter: `debugger --cdb-list --cdb-root path_to_cdb1[;path_to_cdb2]`. For example, `debugger --cdb-list --cdb-root C:\DS-5_Workspace\MyConfigDB1;DS-5_Workspace\MyConfigDB2`
   - On Linux, enter: `debugger --cdb-list --cdb-root path_to_cdb1[:path_to_cdb2]`. For example, `debugger --cdb-list --cdb-root /DS-5_Workspace/MyConfigDB1:DS-5_Workspace/MyConfigDB2`

   Where:
   `debugger`
   Is the command to invoke the DS-5 Debugger.
   `--cdb-list`
   Is the option to list the entries in the configuration database.
   `--cdb-root`
   Is the option to specify the path to one or more configuration databases.
   `path_to_cdb1 and path_to_cdb2`
   Are the directory paths to the configuration databases.

   Note

   DS-5 Debugger processes configuration databases from left to right. The information from processed databases are replaced with information from databases that are processed later.

   For example, if you want to produce a modified Cortex-A15 processor definition with different registers, then those changes can be added to a new database that resides at the end of the list on the command-line.

3. When you have determined the details of your target, use the following command-line syntax to connect to the target in your custom configuration database:

   ```
   debugger --cdb-entry "Manufacturer::Platform::Project type::Execution environment::Activity::Connection type" --cdb-root path_to_cdb1
   ```

   For example, on Windows:

   ```
   debugger --cdb-entry "ARM Development Boards::Versatile Express A9x4::Bare Metal Debug::Bare Metal SMP Debug of all cores::Debug Cortex-A9x4 SMP::DSTREAM" --cdb-entry-param "Connection=USB:000271" --cdb-root C:\DS-5_Workspace\MyConfigDB1
   ```

   Where:
   `debugger`
   Is the command to invoke DS-5 Debugger.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

`--cdb-entry`
: Specifies the target to connect to.

`Manufacturer::Platform::Project type::Execution environment::Activity::Connection type`
: Correspond to the entries in your custom configuration database. The entries have a tree data structure, where each entry has entries within it.

`--cdb-root`
: Is the command to specify your custom configuration database.

`path_to_cdb1`
: Is the directory path to your configuration database.

Note

- If you do not need any data from the default configuration database, use the additional command line option `--cdb-root-ignore-default` to tell the debugger not to use the default configuration database.
- To specify more than one configuration database, you must separate the directory paths using a colon or semicolon for a Linux or Windows system respectively.
- If connection parameters are required, specify them using the `--cdb-entry-param` option.

Related concepts

8.1 Overview: Running DS-5 Debugger from the command-line or from a script on page 8-203.

Related references

8.2 Command-line debugger options on page 8-204.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

8.5 Capturing trace data using the command-line debugger

To capture trace data using the command-line debugger, you must enable the relevant trace options in the *Debug and Trace Services Layer* (DTSL) configuration settings in DS-5.

For this task, it is useful to setup the DTSL options using the graphical interface of DS-5 Debugger.

Once you have setup the DTSL options, the debugger creates a file that contains the DTSL settings. You can then use this file when invoking the command-line debugger to perform trace data capture tasks, for example, run a script which contain commands to *start* and *stop* trace capture.

An example script file might contain the following commands:

```
loadfile C:\DS-5_Workspace\fireworks_panda\fireworks_panda.axf # Load an image to debug
start                          # Start running the image after setting a temporary breakpoint
wait                           # Wait for a breakpoint
trace start                    # Start the trace capture when the breakpoint is hit
advance plot3                  # Set a temporary breakpoint at symbol plot3
wait                           # Wait for a breakpoint
trace stop                     # Stop the trace when the breakpoint at plot3 is hit
trace report FILE=report.txt   # Write the trace output to report.txt
quit                           # Exit the headless debugging session
```

Procedure

1. Using the graphical interface of DS-5 Debugger, open the **Debug Configurations** dialog for your trace-capable target.
2. In the **Connections** tab, under **DTSL options**, click **Edit** to open the **DTSL Configuration Editor** dialog.
   a. Select a **Trace capture method** in the **Trace Buffer** tab.
   b. If required, select the relevant tab for your processor, and **Enable core trace**.
   c. **Apply** the settings.

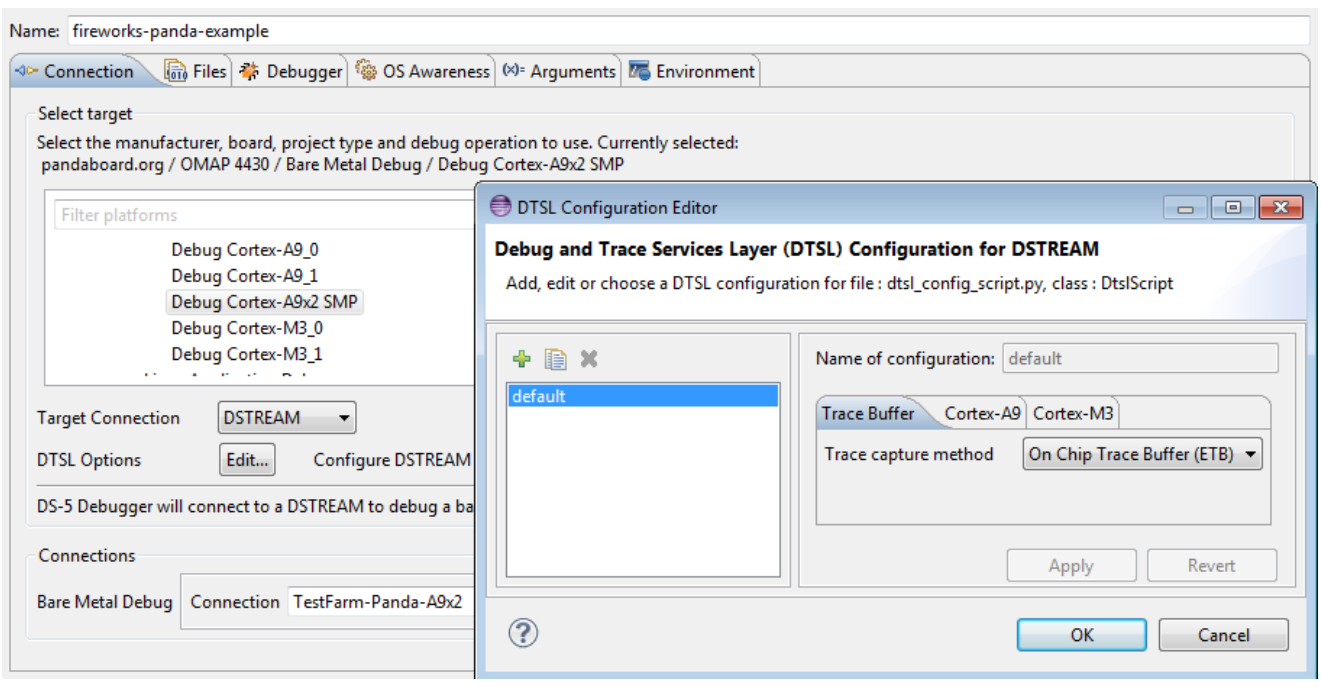


Figure 8-1 Enable trace in the DTSL options

These settings are stored in a `*.dtslprops` file in your workspace. The filename is shown in the **Name of configuration** field in the **DTSL Configuration Editor** dialog.In this example, the settings are stored in the `default.dtslprops` file.

3. Copy the *DTSL* settings file, for example `default.dtslprops`, from your workspace to a different directory and change its name, for example to `my_dtsl_settings.dtslprops`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4. Open the **DS-5 command prompt** and:
   a. Use the `--cdb-list` command-line argument to identify your target name and configuration.
   b. Invoke the command-line debugger with your target name and configuration and specify the *DTSL* options file using `--cdb-entry-params`.

      For example, `debugger --cdb-entry "pandaboard.org::OMAP 4430::Bare Metal Debug::Bare Metal Debug::Debug Cortex-A9x2 SMP::RealView ICE" --cdb-entry-param "Connection=TestFarm-Panda-A9x2" --cdb-entry-param "dtsl_options_file=C:\DS-5_Workspace\my_dtsl_settings.dtslprops"`

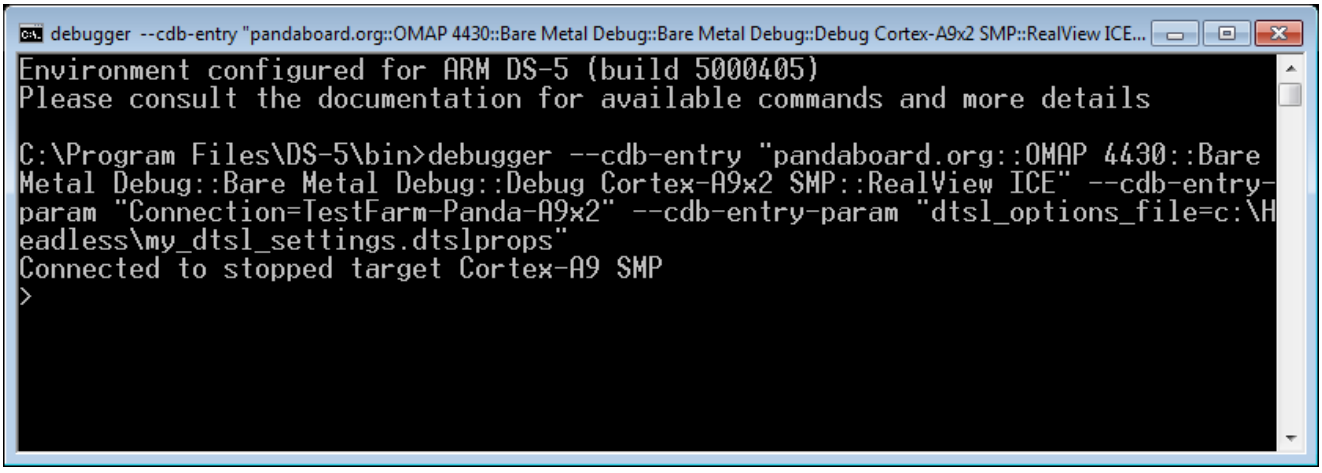


Figure 8-2 Command-line debugger connection with DTSL option enabled

The debugger connects to your target.

You can now *issue commands* to *load* and *run* an image, and also to *start* and *stop* trace capture.

If you create a script file containing trace capture commands, you can specify this script file when invoking the command-line debugger.

For example:

```
debugger --cdb-entry "pandaboard.org::OMAP 4430::Bare Metal Debug::Bare Metal
Debug::Debug Cortex-A9x2 SMP::RealView ICE" --cdb-entry-param "Connection=TestFarm-
Panda-A9x2" --cdb-entry-param "dtsl_options_file=C:\DS-5_Workspace
\my_dtsl_settings.dtslprops" --script=C:\DS-5_Workspace\my_script.txt.
```

Related concepts

8.1 Overview: Running DS-5 Debugger from the command-line or from a script on page 8-203.

Related references

8.2 Command-line debugger options on page 8-204.
11.40 Debug Configurations - Connection tab on page 11-358.
11.46 DTSL Configuration Editor dialog box on page 11-372.

Related information

DS-5 Debugger Tracing Commands.
Tracing using DS-5 Debugger from the Command Line.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

8.6 DS-5 Debugger command-line console keyboard shortcuts

DS-5 Debugger provides editing features, a command history, and common keyboard shortcuts to use when debugging from the command-line.

Each command you enter is stored in the command history. Use the UP and DOWN arrow keys to navigate through the command history, to find and reissue a previous command.

To make editing commands and navigating the command history easier, you can use the following keyboard shortcuts:

Ctrl+A
Move the cursor to the start of the line.

Ctrl+D
Quit the debugger console.

Ctrl+E
Move the cursor to the end of the line.

Ctrl+N
Search forward through the command history for the currently entered text.

Ctrl+P
Search back through the command history for the currently entered text.

Ctrl+W
Delete the last word.

DOWN arrow
Navigate down through the command history.

UP arrow
Navigate up through the command history.

Related tasks

8.2 Command-line debugger options on page 8-204.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 9
Working with the Snapshot Viewer

This chapter describes how to work with the Snapshot Viewer.

It contains the following sections:

- *9.1 About the Snapshot Viewer* on page 9-217.
- *9.2 Components of a Snapshot Viewer initialization file* on page 9-219.
- *9.3 Connecting to the Snapshot Viewer* on page 9-222.
- *9.4 Considerations when creating debugger scripts for the Snapshot Viewer* on page 9-223.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

9.1 About the Snapshot Viewer

Use the **Snapshot Viewer** to analyze a snapshot representation of the application state of one or more processors in scenarios where interactive debugging is not possible.

To enable debugging of an application using the **Snapshot Viewer**, you must have the following data:

- Register Values
- Memory Values
- Debug Symbols.

If you are unable to provide all of this data, then the level of debug that is available is compromised. Capturing this data is specific to your application, and no tools are provided to help with this. You might have to install exception or signal handlers to catch erroneous situations in your application and dump the required data out.

You must also consider how to get the dumped data from your device onto a workstation that is accessible by the debugger. Some suggestions on how to do this are to:

- Write the data to a file on the host workstation using semihosting.
- Send the data over a UART to a terminal.
- Send the data over a socket using TCP/IP.

Register values

Register values are used to emulate the state of the original system at a particular point in time. The most important registers are those in the current processor mode. For example, on an ARMv4 architecture processor these registers are R0-R15 and also the Program Status Registers (PSRs):

- Current Program Status Register (CPSR)
- Application Program Status Register (APSR)
- Saved Program Status Register (SPSR).

Be aware that on many ARM processors, an exception, a data abort, causes a switch to a different processor mode. In this case, you must ensure that the register values you use reflect the correct mode in which the exception occurred, rather than the register values within your exception handler.

If your application uses floating-point data and your device contains vector floating-point hardware, then you must also provide the **Snapshot Viewer** with the contents of the vector floating-point registers. The important registers to capture are:

- Floating-point Status and Control Register (FPSCR)
- Floating-Point EXCeption register (FPEXC)
- Single precision registers (S*n*)
- Double precision registers (D*n*)
- Quad precision registers (Q*n*).

Memory values

The majority of the application state is usually stored in memory in the form of global variables, the heap and the stack. Due to size constraints, it is often difficult to provide the **Snapshot Viewer** with a copy of the entire contents of memory. In this case, you must carefully consider the areas of memory that are of particular importance.

If you are debugging a crash, the most useful information to find out is often the call stack, because this shows the calling sequence of each function prior to the exception and the values of all the respective function parameters. To show the call stack, the debugger must know the current stack pointer and have access to the contents of the memory that contains the stack. By default, on ARM processors, the stack grows downwards, you must provide the memory starting from the current stack pointer and going up in memory until the beginning of the stack is reached. If you are unable to provide the entire contents of the stack, then a smaller portion starting at the current stack pointer is still useful because it provides the most recent function calls.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

If your application uses global (`extern` or file `static`) data, then providing the corresponding memory values enables you to view the variables within the debugger.

If you have local or global variables that point to heap data, then you might want to follow the relevant pointers in the debugger to examine the data. To do this you must have provided the contents of the heap to the **Snapshot Viewer**. Be aware that heap can often occupy a large memory range, so it might not be possible to capture the entire heap. The layout of the heap in memory and the data structures that control heap allocation are often specific to the application or the C library, see the relevant documentation for more information.

To debug at the disassembly level, the debugger must have access to the memory values where the application code is located. It is often not necessary to capture the contents of the memory containing the code, because identical data can often be extracted directly from the image using processing tools such as `fromelf`. However, some complications to be aware of are:

- Self-modifying code where the values in the image and memory can vary.
- Dynamic relocation of the memory address within the image at runtime.

Debug symbols

The debugger requires debug information to display high-level information about your application, for example:

- Source code
- Variable values and types
- Structures
- Call stack.

This information is stored by the compiler and linker within the application image, so you must ensure that you have a local debug copy of the same image that you are running on your device. The amount of debug information that is stored in the image, and therefore the resulting quality of your debug session, can be affected by the debug and optimization settings passed to the compiler and linker.

It is common to strip out as much of the debug information as possible when running an image on an embedded device. In such cases, try to use the original unstripped image for debugging purposes.

Related tasks

9.3 Connecting to the Snapshot Viewer on page 9-222.

Related references

9.2 Components of a Snapshot Viewer initialization file on page 9-219.
9.4 Considerations when creating debugger scripts for the Snapshot Viewer on page 9-223.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

9.2 Components of a Snapshot Viewer initialization file

Describes the groups and sections used to create a Snapshot Viewer initialization file.

The Snapshot Viewer initialization file is a simple text file consisting of one or more sections that emulate the state of the original system. Each section uses an *`option=value`* structure.

Before creating a Snapshot Viewer initialization file you must ensure that you have:

- One or more binary files containing a snapshot of the application that you want to analyze.

  Note

  The binary files must be formatted correctly in accordance with the following restrictions.

- Details of the type of processor.
- Details of the memory region addresses and offset values.
- Details of the last known register values.

To create a Snapshot Viewer initialization file, you must add grouped sections as required from the following list and save the file with `.ini` for the file extension.

`[device]`

A section for information about the processor or device. The following options can be used:

`name`
: This is the name that is reported from RDDI and is used to identify the device. This value is necessary and must be unique to each device.

`class`
: The general type of device, for example `core`, or `trace_source`.

`type`
: The specific device type, for example `Cortex-A9`, or `ETM`.

`location`
: This describes how the agent that produced the snapshot locates the device.

`[dump]`

One or more sections for contiguous memory regions stored in a binary file. The following options can be used:

`file`
: Location of the binary file.

`address`
: Memory start address for the specified region.

`length`
: Length of the region. If none specified then the default is the rest of file from the offset value.

`offset`
: Offset of the specified region from the start of the file. If none specified then the default is zero.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

`[regs]`

A section for standard ARM register names and values, for example, `0x0`.

Banked registers can be explicitly specified using their names from the *ARM Architecture Reference Manual*, for example, `R13_fiq`. In addition, the current mode is determined from the Program Status Registers (PSRs), enabling register names without mode suffixes to be identified with the appropriate banked registers.

The values of the PSRs and PC registers must always be provided. The values of other registers are only required if it is intended to read them from the debugger.

Consider:

```
[regs]
CPSR=0x600000D2 ; IRQ
SP=0x8000
R14_irq=0x1234
```

Reading the registers named SP, R13, or R13_irq all yield the value `0x8000`.

Reading the registers named LR, R14, or R14_irq all yield the value `0x1234`.

Note

All registers are 32-bits.

For more information about Snapshot Viewer file formats, see the documentation in *`DS-5_install_directory`*`\sw\debugger\snapshot`.

Restrictions

The following restrictions apply:

- Consecutive bytes of memory must appear as consecutive bytes in one or more dump files.
- Address ranges representing memory regions must not overlap.

Example 9-1 Examples

```
[device]
name=cpu_0
class=core
type=Cortex-A7                ; Selected processor
location=address:0x1200013000

; Location of a contiguous memory region stored in a dump file
[dump]
file="path/dumpfile1.bin"     ; File location (full path must be specified)
address=0x8000                ; Memory start address for specific region
length=0x0090                 ; Length of region
                              ; (optional, default is rest of file from offset)
; Location of another contiguous memory region stored in a dump file
[dump]
file="path/dumpfile2.bin"     ; File location
address=0x8090                ; Memory start address for specific region
offset=0x0024                 ; Offset of region from start of file
                              ; (optional, default is 0)
; ARM registers
[regs]
R0=0x000080C8
R1=0x0007C000
R2=0x0007C000
R3=0x0007C000
R4=0x00000363
R5=0x00008EEC
R6=0x00000000
R7=0x00000000
R8=0x00000000
R9=0xB3532737
R10=0x00008DE8
R11=0x00000000
R12=0x00000000
SP=0x0007FFF8
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
LR=0x0000808D
PC=0x000080B8
```

Related concepts

9.1 About the Snapshot Viewer on page 9-217.

Related tasks

9.3 Connecting to the Snapshot Viewer on page 9-222.

Related references

9.4 Considerations when creating debugger scripts for the Snapshot Viewer on page 9-223.

Related information

ARM Architecture Reference Manual.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

9.3 Connecting to the Snapshot Viewer

Describes how to launch the debugger from a command-line console and connect to the Snapshot Viewer.

A Snapshot Viewer provides a virtual target that you can use to analyze a snapshot of a known system state using the debugger.

Prerequisites

Before connecting you must ensure that you have a Snapshot Viewer initialization file containing static information about a target at a specific point in time. For example, the contents of registers, memory and processor state.

Procedure

- Launch the debugger in the command-line console using `--target` command-line option to pass the Snapshot Viewer initialization file to the debugger.

```
debugger --target=int.ini --script=int.cmm
```

Related concepts

9.1 About the Snapshot Viewer on page 9-217.

Related tasks

8.2 Command-line debugger options on page 8-204.

Related references

9.2 Components of a Snapshot Viewer initialization file on page 9-219.
9.4 Considerations when creating debugger scripts for the Snapshot Viewer on page 9-223.
8.6 DS-5 Debugger command-line console keyboard shortcuts on page 8-215.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

9.4 Considerations when creating debugger scripts for the Snapshot Viewer

Shows a typical example of an initialization file for use with the Snapshot Viewer.

The Snapshot Viewer uses an initialization file that emulates the state of the original system. The symbols are loaded from the image using the `data.load.elf` command with the `/nocode /noreg` arguments.

The snapshot data and registers are read-only and so the commands you can use are limited.

The following example shows a script using CMM-style commands to analyze the contents of the `types_m3.axf` image.

```
var.print "Connect and load symbols:"
system.up
data.load.elf "types_m3.axf"  /nocode /noreg
;Arrays and pointers to arrays
var.print ""
var.print "Arrays and pointers to arrays:"
var.print "Value of i_array[9999] is " i_array[9999]
var.print "Value of *(i_array+9999) is " *(i_array+9999)
var.print "Value of d_array[1][5] is " d_array[1][5]
var.print "Values of *((*d_array)+9) is " *((*d_array)+9)
var.print "Values of *((*d_array)) is " *((*d_array))
var.print "Value of &d_array[5][5] is " &d_array[5][5]
;Display 0x100 bytes from address in register PC
var.print ""
var.print "Display 0x100 bytes from address in register PC:"
data.dump r(PC)++0x100
;Structures and bit-fields
var.print ""
var.print "Structures and bit-fields:"
var.print "Value of values2.no is " values2.no
var.print "Value of ptr_values->no is " ptr_values->no
var.print "Value of values2.name is " values2.name
var.print "Value of ptr_values->name is " ptr_values->name
var.print "Value of values2.name[0] is " values2.name[0]
var.print "Value of (*ptr_values).name is " (*ptr_values).name
var.print "Value of values2.f1 is " values2.f1
var.print "Value of values2.f2 is " values2.f2
var.print "Value of ptr_values->f1 is " ptr_values->f1
var.print ""
var.print "Disconnect:"
system.down
```

Related concepts

9.1 About the Snapshot Viewer on page 9-217.

Related tasks

9.3 Connecting to the Snapshot Viewer on page 9-222.

Related references

9.2 Components of a Snapshot Viewer initialization file on page 9-219.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 10
Platform Configuration

You can configure models and hardware platforms using DS-5.

It contains the following sections:

- *10.1 DS-5 Configuration perspective* on page 10-225.
- *10.2 About importing platform and model configurations* on page 10-226.
- *10.3 About platform bring-up in DS-5* on page 10-228.
- *10.4 ARM debug and trace architecture* on page 10-229.
- *10.5 About the Platform Configuration Editor view* on page 10-230.
- *10.6 Creating a platform configuration* on page 10-231.
- *10.7 Editing a platform configuration in the PCE* on page 10-236.
- *10.8 About the device hierarchy in the PCE view* on page 10-242.
- *10.9 Manual platform configuration* on page 10-244.
- *10.10 Configuring your debug hardware unit for platform autodetection* on page 10-246.
- *10.11 Creating a new model configuration* on page 10-248.
- *10.12 Importing a custom model* on page 10-250.
- *10.13 Model Devices and Cluster Configuration* on page 10-252.
- *10.14 Adding a configuration database to DS-5* on page 10-253.
- *10.15 Configuration Database panel* on page 10-255.
- *10.16 Extending your configuration database* on page 10-257.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.1 DS-5 Configuration perspective

The DS-5 Configuration perspective enables you to import and manage configurations for models and hardware platforms.

To access the DS-5 Configuration perspective, click **Window** > **Open Perspective** > **DS-5 Configuration** from the main menu.

Use the DS-5 Configuration perspective to:

- Create a new DS-5 Debug Configuration Database
- View and configure models in the Model Configurations Editor.
- View and configure platforms in the Platform Configurations Editor.
- Import the configurations of your custom models and platforms into your DS-5 Debug Configuration Database.
- Create a launch configuration for the new model or platform configuration.

From the DS-5 Configuration perspective, you can use the **Tools** menu to access the following tools:

- Debug Hardware Firmware Installer
- Debug Hardware Configure IP.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.2 About importing platform and model configurations

The Platform Configuration Editor and Model Configuration Editor views enable you to import platform and model information into DS-5. This enables you to easily provide debug and trace support for platforms and models through RVI, DSTREAM, VSTREAM, or model connections.

The DS-5 Configuration Database holds the platform configuration and connection settings in DS-5. You can create new platform configurations in a new configuration database, which can extend the default configuration database.

Note

If there is already a configuration for your platform in the DS-5 Configuration Database, then you can use the existing configuration to connect to the platform, as described in *2.3 Configuring a connection to a bare-metal hardware target* on page 2-38. You do not have to use the Platform Configuration Editor unless you want to modify the platform configuration.

To create a new configuration, DS-5 uses information from:

- A configuration file, for a platform, created and saved using the Platform Configuration Editor.
- A configuration file, for a model that provides a CADI server, created and saved using the Model Configuration Editor. The model can be already running or you can specify the path and filename to the executable file.

You can create the following debug operations:

- Single processor and *Symmetric MultiProcessing* (SMP) bare-metal debug for hardware and models.
- Single processor and SMP Linux kernel debug for hardware.
- Linux application debug configurations for hardware.
- big.LITTLE configurations for cores that support big.LITTLE operation, such as Cortex-A15/Cortex-A7.

For hardware targets where a trace subsystem is present, appropriate *Debug and Trace Services Layer* (DTSL) options are produced. These can include:

- Selection of on-chip (*Embedded Trace Buffer* (ETB), *Micro Trace Buffer* (MTB), *Trace Memory Controller* (TMC) or other on-chip buffer) or off-chip (DSTREAMtrace buffer) trace capture.
- Cycle-accurate trace capture.
- Trace capture range.
- Configuration and capture of *Instruction Trace Macrocell* (ITM) trace to be handled by the DS-5 Event Viewer.

The Platform Configuration Editor does not create debug operations that configure non-instruction trace macrocells other than ITM.

For SMP configurations, the *Cross Trigger Interface* (CTI) synchronization is used on targets where a suitable CTI is present.

Using a CTI produces a much tighter synchronization with a very low latency in the order of cycles but the CTI must be fully implemented and connected in line with the ARM reference designs, and must not be used for any other purpose. Synchronization without using a CTI has a much higher latency, but makes no assumptions about implementation or usage.

You might have to manually configure off-chip TPIU trace for multiplexed pins and also perform calibrations to cope with signal timing issues.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

If you experience any problems or need to produce other configurations, contact your support representative.

Note

It is only possible to import platforms or models that can be auto-configured using DS-5. DS-5 produces a basic configuration with appropriate processor and CP15 register sets.

Related tasks

10.6 Creating a platform configuration on page 10-231.
10.14 Adding a configuration database to DS-5 on page 10-253.

Related references

10.15 Configuration Database panel on page 10-255.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.3 About platform bring-up in DS-5

Effective debug and trace support requires that the debugger has the necessary information about the platform it needs to debug.

The complexity of modern System-on-Chip (SoC) based platforms is increasing. The debugger needs to know:

- What devices are present on the SoC.
- The type and configuration details of each device.
- The base addresses of the CoreSight components.
- The type and index of the Access Ports (AP) to access the various CoreSight components.
- How the different devices relate or connect to each other (their topology).

DS-5 Debugger can automatically detect most of this information. However, it is common that the debugger is unable to detect certain features on a complex SoC. The reasons might be:

- The SoC does not make the information available to the debugger.
- The information from the SoC might be missing when parts of the SoC are powered down.
- Devices inside the SoC might interfere with topology detection.

DS-5 Debugger provides a simple and efficient platform bring-up process for all ARM CoreSight-based SoCs.

DS-5 Debugger does not make any assumptions about the platform configuration. Hence if it only has limited information about the platform, it can only provided limited debug and trace functionality. Hence it is common for the debugger to provide limited trace functionality for certain processors on the platform. You can augment the automatically detected platform configuration by manually providing data based on your knowledge of the SoC. This enables you to provide any missing parts of the topology definition. This is preferable because the DTSL scripts can be generated based on the augmented information rather than requiring manual editing.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.4 ARM debug and trace architecture

Modern ARM processors consist of several debug and trace components. Knowledge of what these components do and how they connect to each other is important for creating a platform configuration.

Debug units, such as DSTREAM, use JTAG to connect directly to physical devices. To detect the devices, the debug unit sends clock signals around the JTAG scan chain, which passes through all the physical devices in sequence. The physical devices on the JTAG scan chain can include:

- Legacy ARM processors, such as ARM7, ARM9, and ARM11 processors.
- ARM CoreSight Debug Access Port (DAP).
- Unknown or custom devices that are not based on ARM.

ARM Cortex processors and CoreSight devices are not present directly on the JTAG scan chain. Instead, ARM CoreSight Debug Access Ports provide access to CoreSight Memory Access Ports, which in turn provide access to additional JTAG devices or memory-mapped virtual devices, such as ARM Cortex processors and CoreSight devices. Each virtual device provides memory-mapped registers that a debugger can use to control and configure the device, or to read information from it.

There are different types of CoreSight devices.

- Embedded Trace Macrocell (ETM) and Program Flow Trace Macrocell (PTM) are trace sources that attach directly to a Cortex processor and non-invasively generate information about the operations performed by the processor. Each Cortex processor has its own revision of ETM or PTM that has specific functionality for that processor.
- Instrumentation Trace Macrocell (ITM) and System Trace Macrocell (STM) are trace sources that generate trace information about software and hardware events occurring across the System-on-Chip.
- Embedded Trace Buffer (ETB), Trace Memory Controller (TMC) and Trace Port Interface Unit (TPIU) are trace sinks that receive trace information generated by the trace sources. Trace sinks either store the trace information or route it to a physical trace port.
- Funnels and Replicators are trace links that route trace information from trace sources to trace sinks.
- Cross Trigger Interface (CTI) devices route events between other devices. The CTI network has a variety of uses, including:
  - Halting processors when trace buffers become full.
  - Routing trace triggers.
  - Ensuring tight synchronization between processors, for example when one processor in a cluster halts, the other processors in the cluster halt with minimal latency.

A debugger needs to know details of the physical JTAG scan chain, and it needs details of individual Cortex processors and CoreSight devices, including CoreSight AP index, ROM table base address, device type, revision, and implementation detail. However, a debugger also needs to know how devices are connected to each other. For example which processors are part of the same cluster, how the CTI network can pass event information between devices, and the topology of the trace sub-system. Without this information, a debugger might not be able to provide all of the control and configuration services that are available.

Related concepts

1.2 Overview: ARM® CoreSight™ debug and trace components on page 1-22.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.5 About the Platform Configuration Editor view

The Platform Configuration Editor (PCE) view enables you to create or modify debug configurations for connecting to your platform.

In the PCE view, you can:

- Review the devices on your development platform.
- Modify device information or add new devices that the debugger was unable to autodetect.
- Configure your debug hardware unit, and target-related features that are appropriate to correctly debug on your development platform.
- Review or modify the debug activities for the various processors on the platform.
- Build and save the platform configuration to an RDDI configuration file. The RDDI configuration file is used by the debugger to connect to the target processors on your development platform.

PCE enables you to easily specify the debug topology by defining the connections between the various processors, CoreSight components, and debug IP on the platform. This enables DS-5 Debugger to create the appropriate DTSL scripts that are necessary for the debug connection to the platform.

Note

DS-5 Debugger connects to the platform to autodetect the devices on the platform. DS-5 Debugger does not maintain the connection to the target after reading the device information from the platform.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.6 Creating a platform configuration

You can use the **Platform Configuration** wizard within DS-5 to create debug configurations for new platforms.

Creating a platform configuration in DS-5 requires a new **Platform Configuration** project in Eclipse.

Procedure

1. From the main menu in DS-5, select **File** > **New** > **Other** to open the new project dialog.
2. Select **DS-5 Configuration Database** > **Platform Configuration** and then click **Next**.

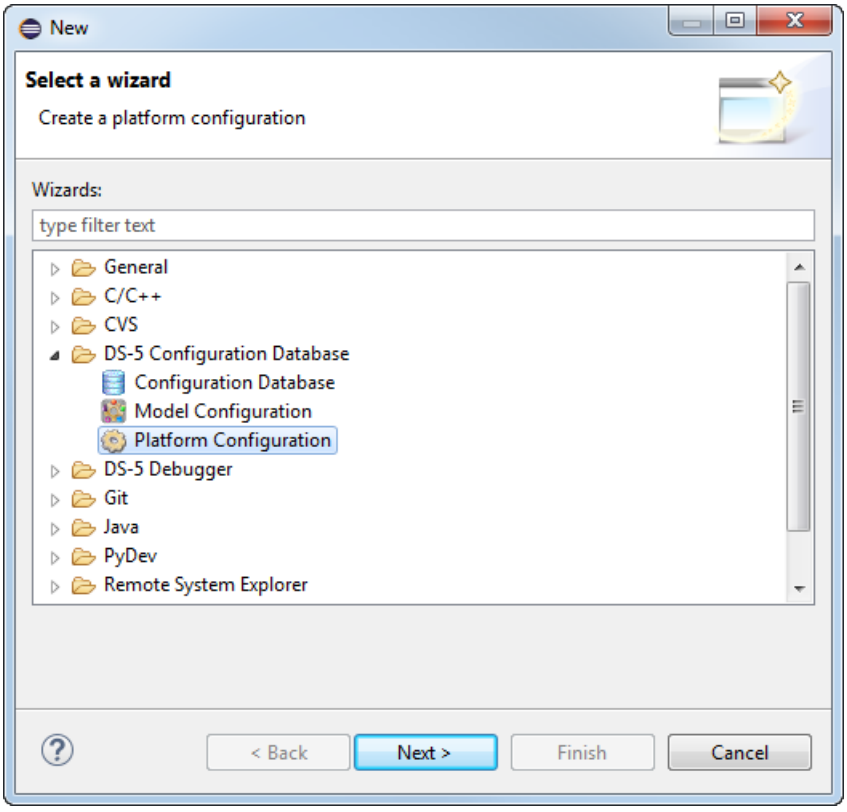


Figure 10-1 New PCE project

3. This shows the **Create Platform Configuration** dialog box. Select the required method to create the configuration for your platform and click **Next**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

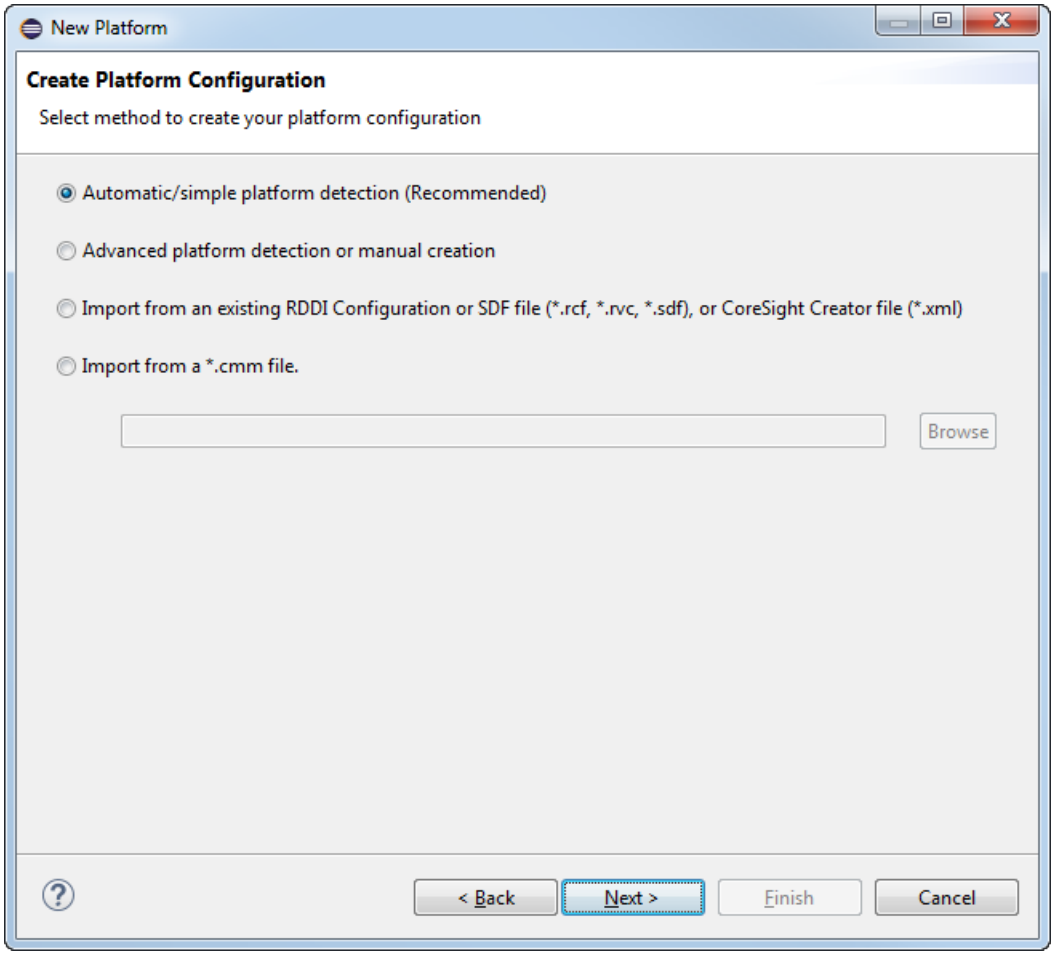


Figure 10-2 Platform creation options

The options are:

- **Automatic/simple platform detection**

  This is the recommended option. DS-5 automatically detects the devices that are present on your platform. It then provides you the opportunity to add more devices if needed and to specify how the devices are interconnected. Select this option, and click **Next** to select the debug hardware adapter that is attached to your platform or specify the **Connection Address** of your debug hardware adapter.
- **Advanced platform detection or manual creation**

  This option gives you control over the individual stages that are involved in reading the device information from your platform. It is useful if reading certain device information is likely to make the platform unresponsive.
- **Import from an existing RDDI configuration file (*.rcf, *.rvc, *.sdf), or a CoreSight Creator system description file (*.xml)**

  Use this option if you already have a configuration file for your platform. It imports minimal information about the components available on your platform, such as the base address. After importing, you can manually provide additional information and links between the components to enable full debug and trace support.
- **Import from a *.cmm file**Use this option to import a platform configuration from a CMM script (`*.cmm`) file.

  CMM scripts can contain target description information such as JTAG pre- and post- IR/DR bit information, core types, device base addresses, and CoreSight topology information. The PCE can

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

use this information to create a DS-5 platform configuration, complete with custom DTSL control tabs for trace configuration.

Some CMM scripts describe different targets (or different cores and trace devices in the same target) depending on the value of parameters that are passed to the script. If a CMM script requires parameters, you can enter them in the **CMM script parameters** field.

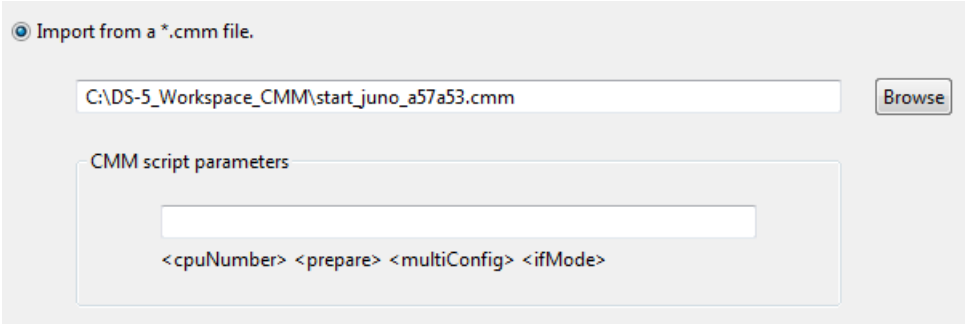


Figure 10-3 Enter CMM script parameters

Note

Your debug hardware must have the minimum firmware version installed when detecting a new platform. If you are using outdated firmware, DS-5 warns you during the platform detection process.

For example:

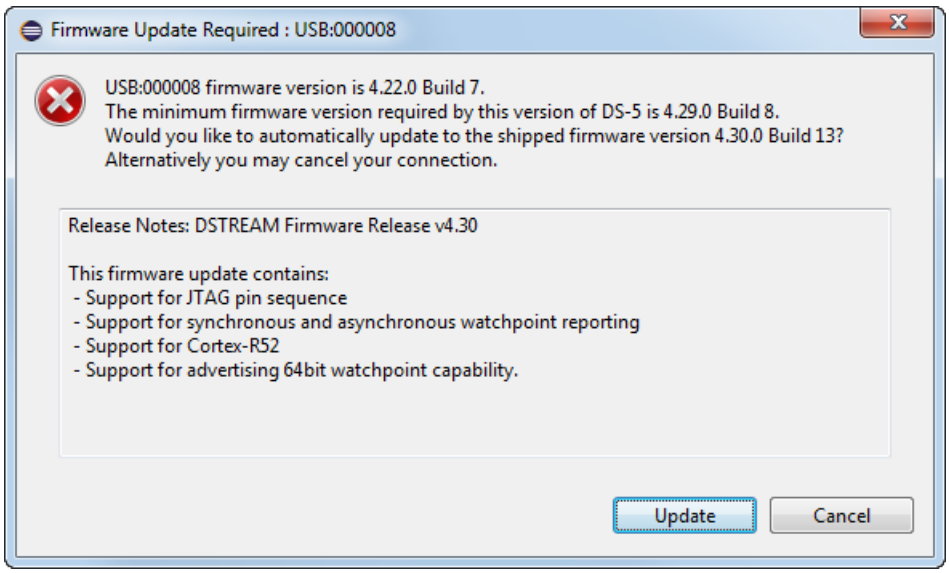


Figure 10-4 Debug hardware firmware update notification during platform configuration

Click **Update** to update your debug hardware firmware.

DS-5 connects to the platform and reads all the device information that it can from the platform. The **Summary** dialog box shows the list of devices that DS-5 autodetected on the platform.

Depending on your target, you might receive warnings and errors. If it is unable to obtain this information from the platform, DS-5 does not make assumptions about how the devices are connected. In particular, DS-5 might not have obtained all the necessary information about the trace devices on the platform. You can provide this information in the PCE view.

4. In the **Summary** dialog, choose what you would like to do next with the detected platform. You can:
   - **Save a Debug-Only DS-5 Platform Configuration**

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Select this option to save a debug-only configuration to your configuration database. You can open this in DS-5 later to modify it or you can use it to connect to and debug the platform later.

- **Save a Debug and Trace DS-5 Platform Configuration**

  Select this option to save a debug and trace configuration to your configuration database. You can open this in DS-5 later to modify it or you can use it to connect to and debug the platform later.

- **Edit platform in DS-5 Platform Configuration Editor**

  Select this option to save the configuration to your configuration database and open the PCE view.

  In the PCE view, you can provide information about the platform that DS-5 was unable to autodetect.

Note

All DS-5 platform configurations must be stored in a configuration database.

5. Click **Next**.
6. In the **New Platform** dialog box, select a configuration database, or click **Create New Database** to create a new configuration database and enter a name for your configuration database.

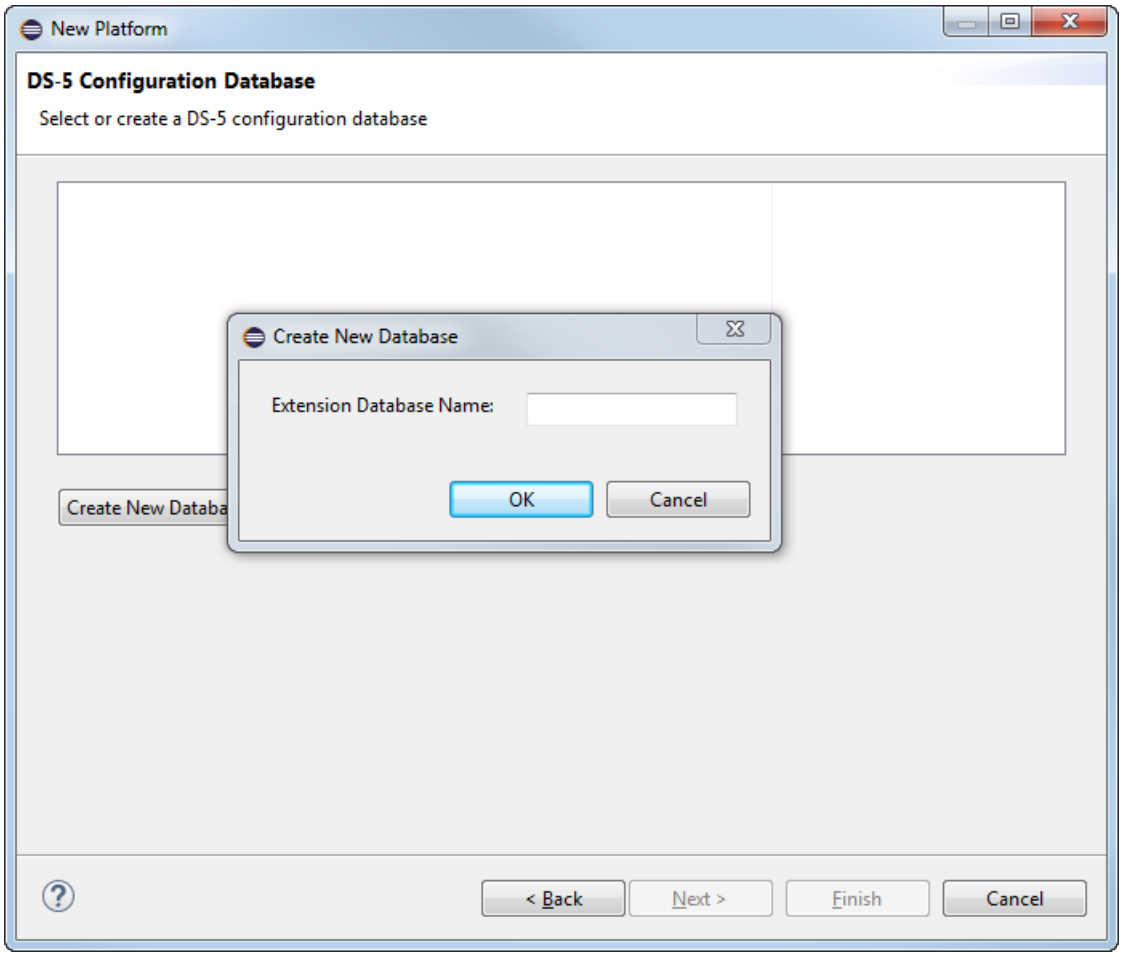


Figure 10-5 Create new configuration database

7. Click **OK** to save your configuration database and click **Next**.
8. In the **Platform Information** dialog box, enter the **Platform Manufacturer**, for example `ARM`. Enter the **Platform Name**, for example `Juno`. Optionally, if you want to provide a URL link to information about the platform, you can enter it in **Platform Info URL**. The URL appears in the **Debug Configurations** panel when you select a debug activity for the platform.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

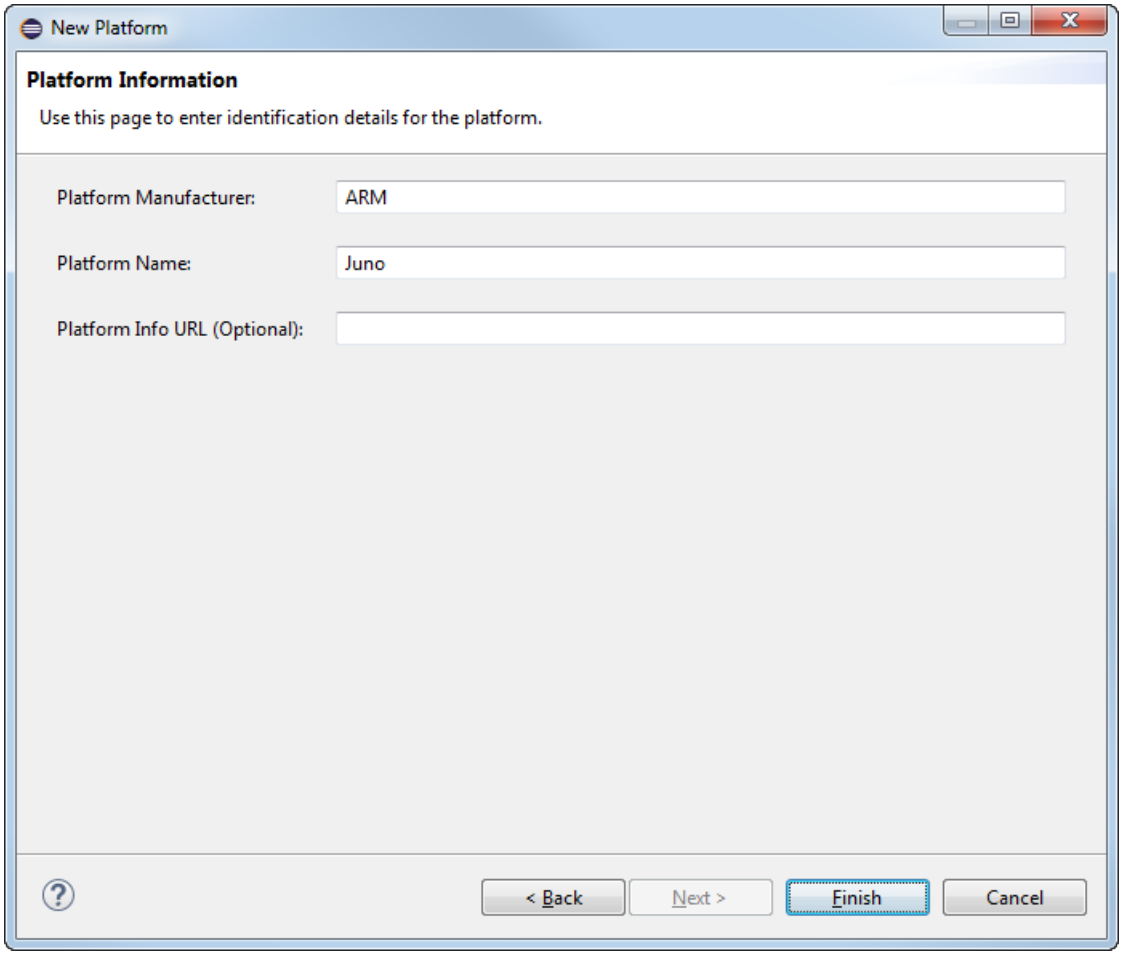


Figure 10-6 New platform information

9. Click **Finish** to complete adding the platform to your configuration database.
   You can view the configuration database and platform in the **Project Explorer**. If you selected the **Edit platform in DS-5 Platform Configuration Editor** option, the PCE view is opened with the details of your platform. See *Editing a platform configuration in the PCE* on page 10-236 for information on how to edit your platform configuration using PCE.

Related concepts

10.2 About importing platform and model configurations on page 10-226.

Related tasks

10.14 Adding a configuration database to DS-5 on page 10-253.

Related references

10.15 Configuration Database panel on page 10-255.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.7 Editing a platform configuration in the PCE

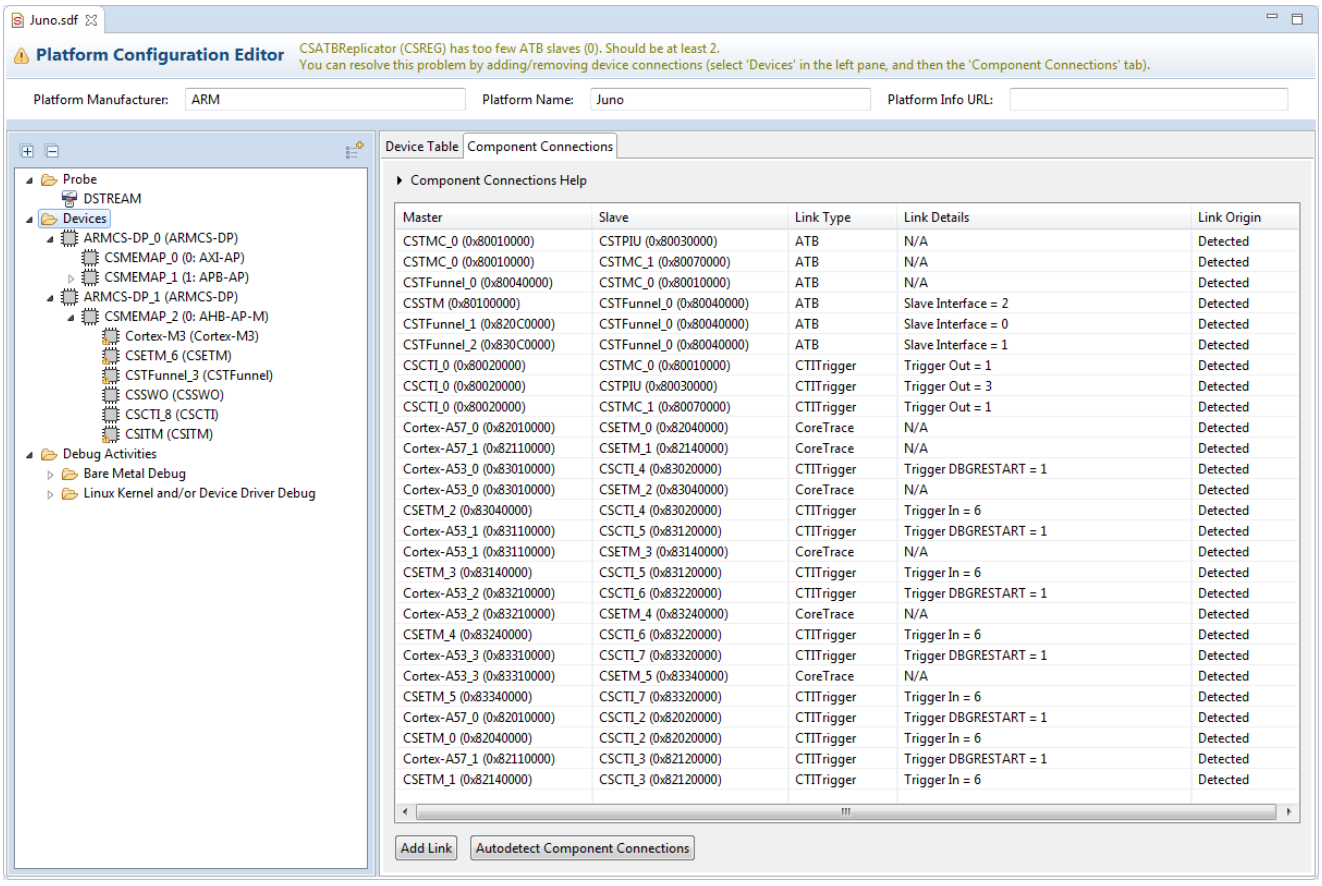
This shows you how to add component connections in the PCE view to support trace.

After you create a new platform configuration in DS-5, you can review the platform configuration. This shows the device summary in the PCE view. DS-5 might not detect all the devices on the platform or might not know how the devices are connected to each other. You can use the **Component Connections** table in PCE to:

- Describe the relationship between the cross-triggers.
- Describe the trace topology, for example which trace source is connected to which trace sink.

If the fields within the component connections table are not correctly populated, then cross-triggering or trace might not work.

You can use the PCE view to identify missing component connections and to add them to your platform configuration. The figure shows the configuration of an example platform in the PCE view after autodetection in DS-5.



Master	Slave	Link Type	Link Details	Link Origin
CSTMC_0 (0x80010000)	CSTPIU (0x80030000)	ATB	N/A	Detected
CSTMC_0 (0x80010000)	CSTMC_1 (0x80070000)	ATB	N/A	Detected
CSTFunnel_0 (0x80040000)	CSTMC_0 (0x80010000)	ATB	N/A	Detected
CSSTM (0x80100000)	CSTFunnel_0 (0x80040000)	ATB	Slave Interface = 2	Detected
CSTFunnel_1 (0x820C0000)	CSTFunnel_0 (0x80040000)	ATB	Slave Interface = 0	Detected
CSTFunnel_2 (0x830C0000)	CSTFunnel_0 (0x80040000)	ATB	Slave Interface = 1	Detected
CSCTI_0 (0x80020000)	CSTMC_0 (0x80010000)	CTITrigger	Trigger Out = 1	Detected
CSCTI_0 (0x80020000)	CSTPIU (0x80030000)	CTITrigger	Trigger Out = 3	Detected
CSCTI_0 (0x80020000)	CSTMC_1 (0x80070000)	CTITrigger	Trigger Out = 1	Detected
Cortex-A57_0 (0x82010000)	CSETM_0 (0x82040000)	CoreTrace	N/A	Detected
Cortex-A57_1 (0x82110000)	CSETM_1 (0x82140000)	CoreTrace	N/A	Detected
Cortex-A53_0 (0x83010000)	CSCTI_4 (0x83020000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A53_0 (0x83010000)	CSETM_2 (0x83040000)	CoreTrace	N/A	Detected
CSETM_2 (0x83040000)	CSCTI_4 (0x83020000)	CTITrigger	Trigger In = 6	Detected
Cortex-A53_1 (0x83110000)	CSCTI_5 (0x83120000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A53_1 (0x83110000)	CSETM_3 (0x83140000)	CoreTrace	N/A	Detected
CSETM_3 (0x83140000)	CSCTI_5 (0x83120000)	CTITrigger	Trigger In = 6	Detected
Cortex-A53_2 (0x83210000)	CSCTI_6 (0x83220000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A53_2 (0x83210000)	CSETM_4 (0x83240000)	CoreTrace	N/A	Detected
CSETM_4 (0x83240000)	CSCTI_6 (0x83220000)	CTITrigger	Trigger In = 6	Detected
Cortex-A53_3 (0x83310000)	CSCTI_7 (0x83320000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A53_3 (0x83310000)	CSETM_5 (0x83340000)	CoreTrace	N/A	Detected
CSETM_5 (0x83340000)	CSCTI_7 (0x83320000)	CTITrigger	Trigger In = 6	Detected
Cortex-A57_0 (0x82010000)	CSCTI_2 (0x82020000)	CTITrigger	Trigger DBGRESTART = 1	Detected
CSETM_0 (0x82040000)	CSCTI_2 (0x82020000)	CTITrigger	Trigger In = 6	Detected
Cortex-A57_1 (0x82110000)	CSCTI_3 (0x82120000)	CTITrigger	Trigger DBGRESTART = 1	Detected
CSETM_1 (0x82140000)	CSCTI_3 (0x82120000)	CTITrigger	Trigger In = 6	Detected

Figure 10-7 Component Connections

The title bar of the PCE view warns about the information that autodetection was unable to determine. You can click on the device in the device hierarchy to get more information. For example if you click on the Cortex-M3 processor, you might see a message about the missing information.

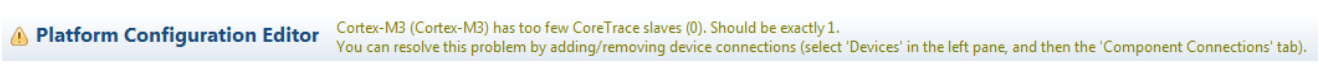


Figure 10-8 Missing slaves

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

The Cortex-M3 processor does not have any slave connections. Autodetection was unable to determine the topology information for the Cortex-M3 processor. The device hierarchy on the left-hand pane shows that the `Cortex-M3` processor and the trace source, `CSETM_6`, are under the same access port, `CSMEMAP_2`.

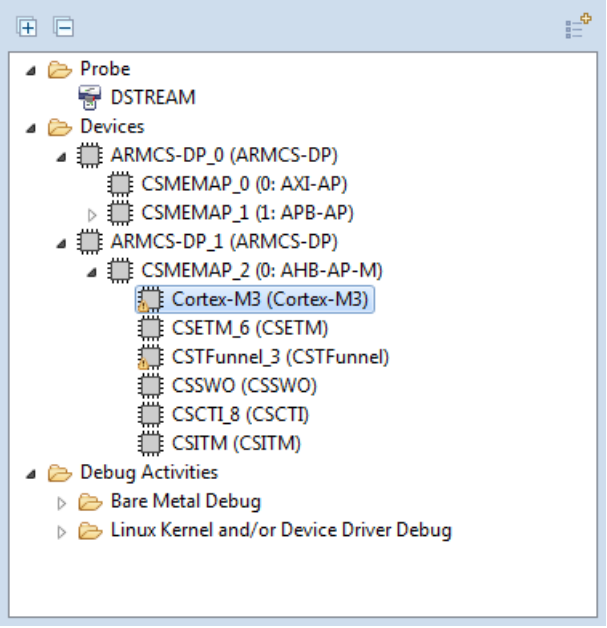


Figure 10-9 Device hierarchy

You can now add a component connection between the Cortex-M3 processor and the ETM to enable trace for the Cortex-M3 processor on the platform.

Note

To add the right components to your platform configuration you must know the device topology. This demonstrates adding components to an example platform.

Procedure

1. Select **Devices** in the left-hand pane.
2. Select the **Component Connections** tab in the right-hand pane.
3. To add a new component connection, click **Add Link**. This shows the **Add Link** dialog box.
4. Select `Cortex-M3` for the **Master** and select `CSETM_6` for the **Slave**. Click **Ok** to add the component connection.

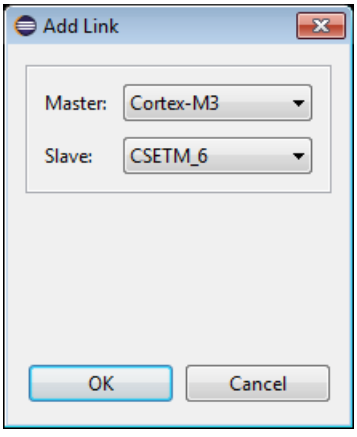


Figure 10-10 Add Core Trace

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

5. The PCE view shows that `CSETM_6` does not have any slave connections. The device hierarchy shows that there is a `CSCTI_8` component under the same access port. To add this component connection to `CSETM_6`, click **Add Link** and select `CSETM_6` for the **Master**, and `CSCTI_8` for the **Slave**.

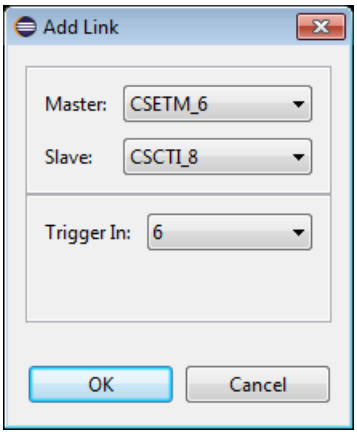


Figure 10-11 Add CTI Trigger

Note

Depending on the device you add a component connection for, you might have to specify additional parameters. For example:

- If you add a CTI as a master, then you must specify the trigger output port.
- If you add a CTI as a slave, then you must specify the trigger input port.
- If you add a Trace Replicator as a master, then you must specify the master interface.
- If you add a Trace Funnel as a slave, then you must specify the slave interface.

6. The **Component Connections** tab shows the user added component connections in the PCE view. Save the platform configuration.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Device Table | Component Connections

Component Connections Help

Master	Slave	Link Type	Link Details	Link Origin
CSETM_0 (0x82040000)	CSTFunnel_2 (0x830C0000)	ATB	Master Interface = 0, Slave Interface = 0	Detected
CSETM_1 (0x82140000)	CSTFunnel_2 (0x830C0000)	ATB	Master Interface = 0, Slave Interface = 0	Detected
CSTFunnel_1 (0x820C0000)	CSTFunnel_0 (0x80040000)	ATB	Master Interface = 0, Slave Interface = 0	Detected
CSTFunnel_1 (0x820C0000)	CSTFunnel_2 (0x830C0000)	ATB	Master Interface = 0, Slave Interface = 0	Detected
CSETM_2 (0x83040000)	CSTFunnel_2 (0x830C0000)	ATB	Master Interface = 0, Slave Interface = 1	Detected
CSETM_3 (0x83140000)	CSTFunnel_2 (0x830C0000)	ATB	Master Interface = 0, Slave Interface = 0	Detected
CSETM_4 (0x83240000)	CSTFunnel_2 (0x830C0000)	ATB	Master Interface = 0, Slave Interface = 1	Detected
CSETM_5 (0x83340000)	CSTFunnel_2 (0x830C0000)	ATB	Master Interface = 0, Slave Interface = 1	Detected
CSETM_6 (0xE0041000)	CSTFunnel_2 (0x830C0000)	ATB	Master Interface = 0, Slave Interface = 0	Detected
CSTFunnel_3 (0xE0042000)	CSTFunnel_2 (0x830C0000)	ATB	Master Interface = 0, Slave Interface = 3	Detected
CSCTI_0 (0x80020000)	CSTMC_0 (0x80010000)	CTITrigger	Trigger Out = 1	Detected
CSCTI_0 (0x80020000)	CSTPIU (0x80030000)	CTITrigger	Trigger Out = 3	Detected
CSCTI_0 (0x80020000)	CSTMC_1 (0x80070000)	CTITrigger	Trigger Out = 1	Detected
Cortex-A57_0 (0x82010000)	CSCTI_2 (0x82020000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A57_1 (0x82110000)	CSCTI_3 (0x82120000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A57_0 (0x82010000)	CSETM_0 (0x82040000)	CoreTrace	N/A	Detected
Cortex-A57_1 (0x82110000)	CSETM_1 (0x82140000)	CoreTrace	N/A	Detected
Cortex-A53_0 (0x83010000)	CSCTI_4 (0x83020000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A53_0 (0x83010000)	CSETM_2 (0x83040000)	CoreTrace	N/A	Detected
CSETM_2 (0x83040000)	CSCTI_4 (0x83020000)	CTITrigger	Trigger In = 6	Detected
Cortex-A53_1 (0x83110000)	CSCTI_5 (0x83120000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A53_1 (0x83110000)	CSETM_3 (0x83140000)	CoreTrace	N/A	Detected
CSETM_3 (0x83140000)	CSCTI_5 (0x83120000)	CTITrigger	Trigger In = 6	Detected
Cortex-A53_2 (0x83210000)	CSCTI_6 (0x83220000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A53_2 (0x83210000)	CSETM_4 (0x83240000)	CoreTrace	N/A	Detected
CSETM_4 (0x83240000)	CSCTI_6 (0x83220000)	CTITrigger	Trigger In = 6	Detected
Cortex-A53_3 (0x83310000)	CSCTI_7 (0x83320000)	CTITrigger	Trigger DBGRESTART = 1	Detected
Cortex-A53_3 (0x83310000)	CSETM_5 (0x83340000)	CoreTrace	N/A	Detected
CSETM_5 (0x83340000)	CSCTI_7 (0x83320000)	CTITrigger	Trigger In = 6	Detected
CSETM_0 (0x82040000)	CSCTI_2 (0x82020000)	CTITrigger	Trigger In = 6	Detected
CSETM_1 (0x82140000)	CSCTI_3 (0x82120000)	CTITrigger	Trigger In = 6	Detected
Cortex-M3 (0xE000ED00)	CSETM_6 (0xE0041000)	CoreTrace	N/A	User Added
CSETM_6 (0xE0041000)	CSCTI_8 (0xE0044000)	CTITrigger	Trigger In = 6	User Added

Add Link | Autodetect Component Connections

Figure 10-12 User added component connections

7. Build the platform configuration. To build the platform configuration, right-click the project in the Project Explorer view and select **Build Platform**.

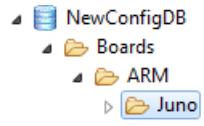


Figure 10-13 Project Explorer

8. In the build platform dialog box, select **Full Debug and Trace**. This regenerates the Debug Configuration files with the user added CoreSight trace components. If you select **Debug Only**, the Debug Configuration files only contain configuration for a debug session without trace capability.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

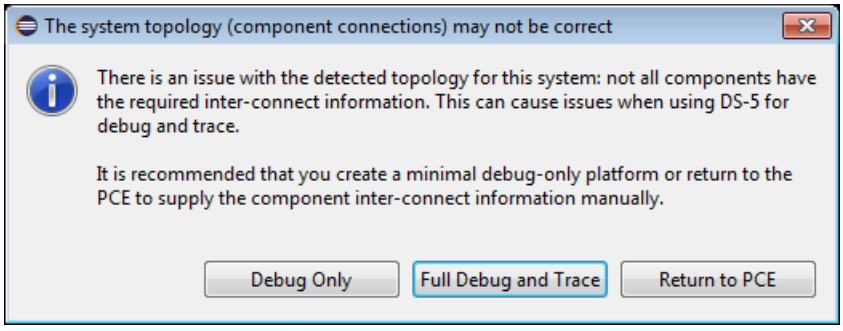


Figure 10-14 Full debug and trace

9. Open the **Debug Configurations** view by right-clicking in the Project Explorer view and selecting **Debug As** > **Debug Configurations...**.

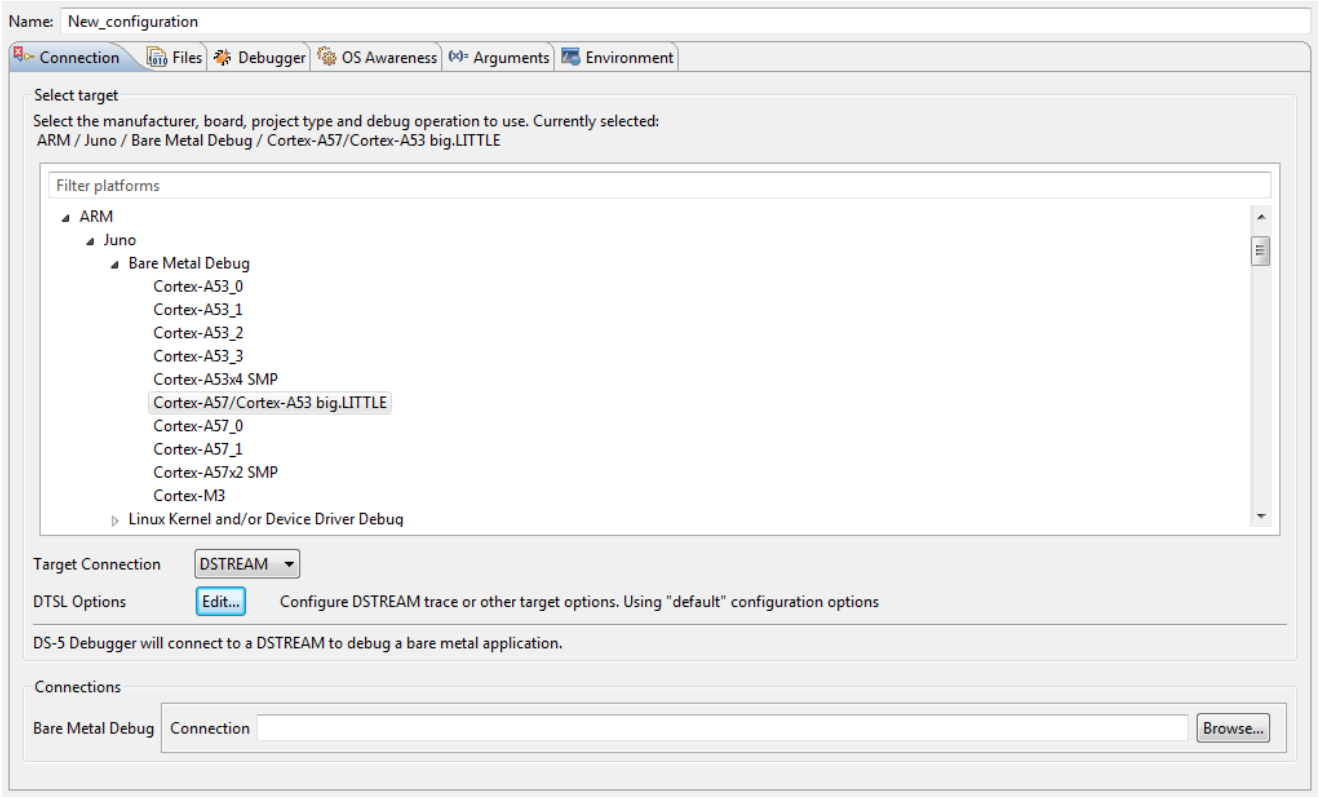


Figure 10-15 Debug Activities

10. Select your platform and debug activity from the **Connection** tab in the **Debug Configurations** dialog box.

    Note

    To see your new platform in the **Debug Configurations** list, your configuration database must be specified in **Window** > **Preferences** > **DS-5** > **Configuration Database**.

11. Click **Edit** on **DTSL Options**. This shows that the new platform configuration provides trace capability for the Cortex-M3 processor.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

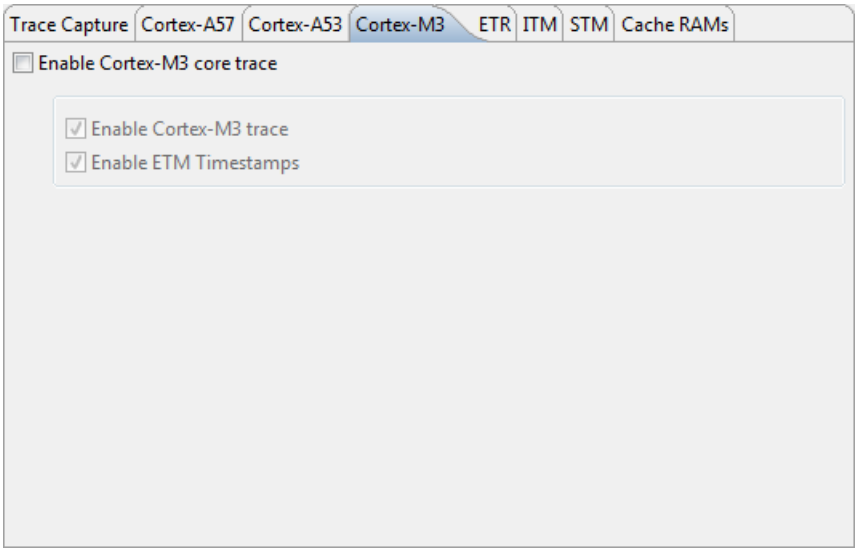


Figure 10-16 DTSL Options

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.8 About the device hierarchy in the PCE view

The device hierarchy in the PCE view shows the devices on the platform.

In the PCE view, you can add or remove devices to configure the platform for how you want to debug the platform. This shows the device hierarchy of an example platform. DS-5 Debugger might not autodetect all the devices on the platform. If you want to use these undetected devices in the debug session, you must first add them to the device hierarchy and configure them appropriately.

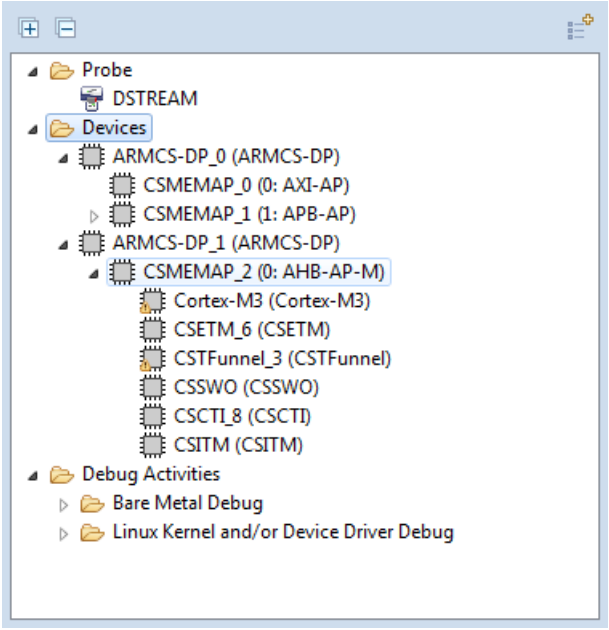


Figure 10-17 Device hierarchy

Alternatively, if you only want a simple debug session and do not need some of the devices that have been autodetected, then you can remove them from the device hierarchy.

The context menu for the device hierarchy contains:

Toggle Devices Panel
This shows or hides the supported devices that you can add to the JTAG scan chain or device hierarchy.

Add Custom Device
This adds a custom device to the JTAG scan chain.

Autodetect Component Connections
This starts the autodetection to detect the connections between the various components on the platform.

Enumerate APs
This is available for Debug Access Ports (DAP) on the device hierarchy. This enumerates the Access Ports under the DAP.

Read CoreSight ROM Tables
This reads the CoreSight ROM tables to obtain more information about the devices from the various access ports. This might cause certain devices on the platform to become unresponsive. In such cases, you can unselect this option during autodetection, in the right-hand pane after selecting your debug hardware **Probe**.

Remove Device
This removes the device from the hierarchy.

You can add a device as a sibling or as a child, by drag-and-dropping from the Devices Panel to the appropriate place in the device hierarchy.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

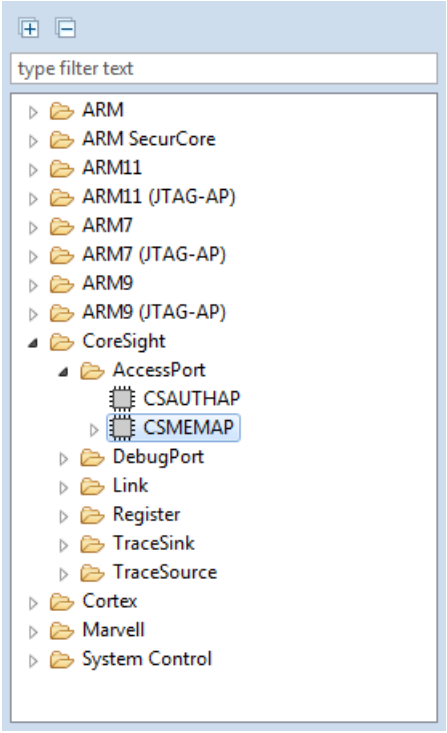


Figure 10-18 Devices Panel

Any device that you add or remove from the hierarchy changes the topology of the SoC. You must ensure that the topology is appropriate for your platform. After adding new devices, you can configure the devices in the right-hand pane in the PCE view.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.9 Manual platform configuration

You can manually create the platform configuration if DS-5 does not automatically detect the platform configuration.

DS-5 uses all the information that it reads from the platform to create a custom platform configuration. However, sometimes it is not possible for DS-5 to read all of the information that it needs from a platform. There could be many reasons for this:

- JTAG routing or security devices might prevent DS-5 from discovering details of physical JTAG devices.
- Debug or trace might be partially or fully disabled.
- Devices might be powered down, or their clocks might be disabled. This can make devices unresponsive to requests for information, and can affect individual devices, entire clusters, or all the devices in a ROM table.
- ROM tables might be missing, incomplete, or at the wrong address.
- Integration Test registers might not be fully implemented, or their operation might be limited by other devices.
- The platform might contain unsupported devices.

Autoconfiguring the platform might cause the target to stop and reset. If you do not want to reset the target, you can manually create the platform configuration using DS-5.

To manually create the platform configuration:

1. Select **Advanced platform detection or manual creation** from the **New Platform** dialog box, as shown in *10.6 Creating a platform configuration* on page 10-231.
2. Provide the necessary topology information using PCE in DS-5.
3. This creates a new System Description File (.sdf). Save and build the sdf file.

To provide the necessary topology information using PCE, refer to the topology diagram for your platform to know how to describe the configuration. When you know the topology, you can add the components using these steps:

1. Create the JTAG scan chain, by adding all the devices that are on the scan chain. You can drag-and-drop devices to the scan chain from the *device panel* on page 10-242 into the **Devices** folder in the PCE view. The devices must be in the right order on the JTAG scan chain.

   Note

   You can also add custom or unsupported devices to the JTAG scan chain. To add a custom device, right-click on the **Devices** folder and select **Add Custom Device**. You must specify the correct JTAG Instruction Register (IR) length for these devices. You can provide any name for the custom device. You cannot debug a custom device. However, adding the custom device in the correct order and with the correct length enables you to debug the supported devices in the same scan chain. It is not possible to consolidate unknown devices on the scan chain. For example two custom devices with instructions lengths of 4 and 5 bits cannot be replaced by a single custom device of instruction length 9 bits.

2. Before you can add CoreSight devices or Cortex processors to the device hierarchy, you must add a CoreSight Debug Access Port (DAP), for example ARMCS-DP. For each DAP, you must add the CoreSight Memory Access Ports (AP) that you need, for example CSMEMAP. You must specify the correct index and type of each AP.
3. Add the Cortex processors and CoreSight devices to the correct AP on the correct DAP. To do this, drag-and-drop them from the devices panel into the correct AP. Since the CoreSight devices are memory-mapped, you can add them in any order. However, you must ensure that the device type and ROM table base address are correct.
4. Add the component connection information to specify how the devices are connected to each other. *10.7 Editing a platform configuration in the PCE* on page 10-236 describes this.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

If you do not need trace support, then you do not need to provide details and topology for trace devices. DS-5 will read as much information as it can. You must always review the information that has been collected before deciding what further information is necessary. If DS-5 fails to read information, it might be an indication of a deeper problem than missing information.

For example, if DS-5 fails to discover the base addresses because the devices are completely powered down, it might not be possible to provide debug support even if the information is provided manually. This is because the powered down devices are not responsive to the debugger. You might need to perform other operations, such as enabling clocks or powering processor clusters, before debug and trace are possible.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.10 Configuring your debug hardware unit for platform autodetection

Automatically detecting the correct configuration for your platform requires correct configuration of your debug hardware unit.

In the **Autodetect** tab of the Platform Configuration Editor (PCE) view, you can configure key settings used in autodetection, such as whether to use JTAG or Serial Wire Debug (SWD), and the clock speed.

The left-hand pane in the Platform Configuration Editor contains:

Probe
This shows the configuration for your debug hardware unit, for example your DSTREAM unit. You can enter the **Connection Address** in the **Autodetect** tab if you want to autodetect the platform again after modifying the debug hardware settings.

Devices
This shows the scan chain and device hierarchy of your platform. The device hierarchy usually consists of one or more Debug Access Ports (DAP). Each DAP consists of one or more Access Ports (AP). Each AP shows the devices that have been detected through that access port.

Debug Activities
This shows the type of debug activities you can perform on the target. The debug activities are accessible from the **Debug Configurations** dialog box when you want to start a debug session.

Procedure

1. Select your debug hardware unit from the **Probe** in the left-hand pane of the PCE view.
2. Select the **Autodetect** tab from the right-hand pane.

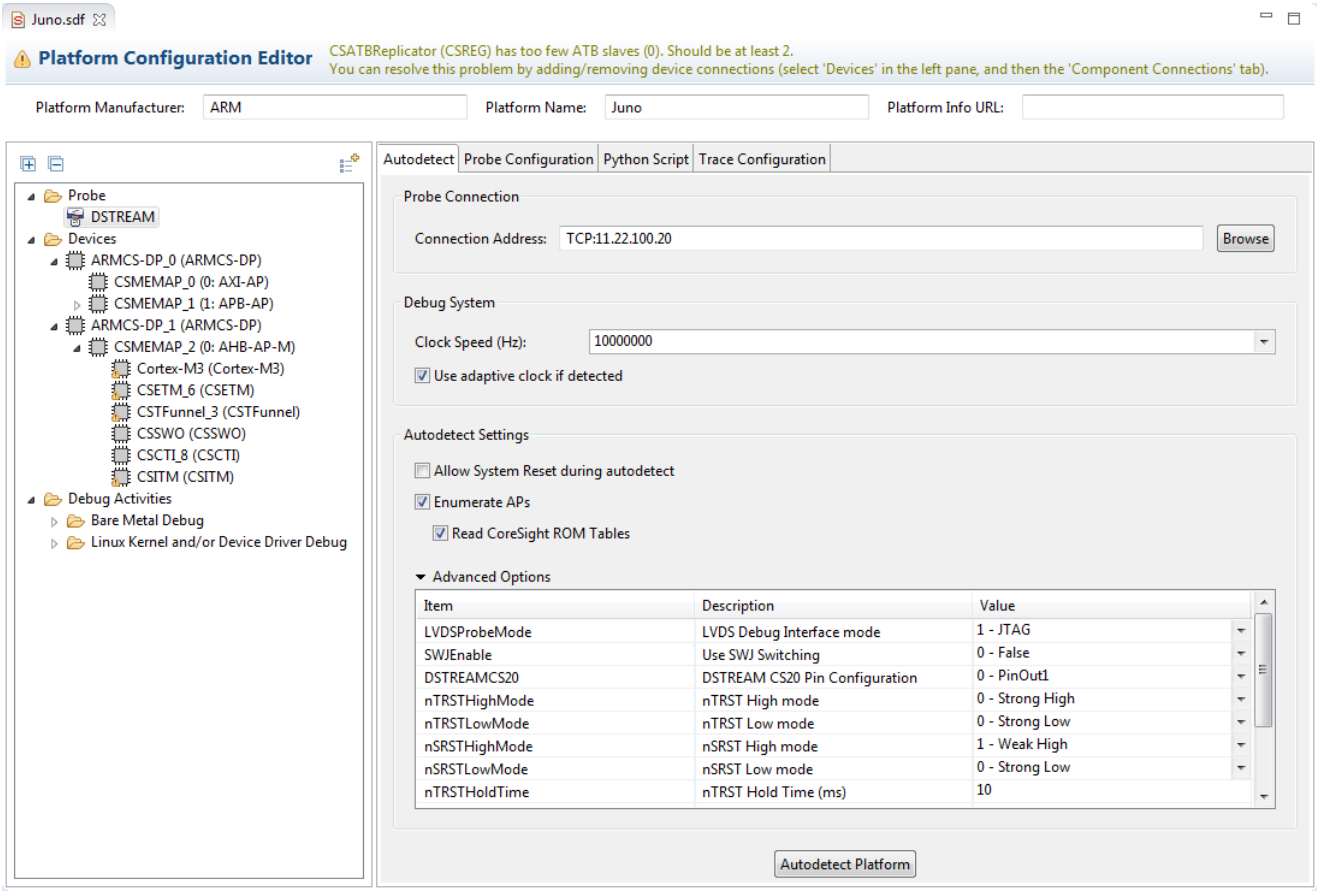


Figure 10-19 Autodetect settings

3. Enter the **Connection Address** of your debug hardware unit or click **Browse** to select one.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

4. Expand **Advanced Options** to configure your debug hardware unit appropriately. Here you can set the LVDS Debug Interface Mode to either JTAG or SWD for connecting to the target. If you use a JTAG connection, then you must set the JTAG type and clock speed appropriately. Other options that are important for autodetection include the reset hold and delay times, drive strengths, reset behavior during autodetection, and cable pin configurations.

   Note

   If your target supports both JTAG and SWD, you must first enable Use SWJ Switching. The **Probe Configurations** tab provides these settings and other configuration options for your debug hardware unit.

5. Click **Autodetect Platform** to automatically detect the platform.

   The debug hardware unit interrogates the scan chain at the current clock speed. If the clock speed is too high, some devices on the scan chain might not be detected. If you suspect that this is happening, decrease the clock speed.
6. Click on **Devices** in the left-had pane to review the automatically detected platform configuration.
7. Add any missing topology links for the platform in the **Component Connections** tab.
8. Build the platform configuration by right-clicking the platform configuration project in the **Project Explorer** view and selecting **Build Platform**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.11 Creating a new model configuration

DS-5 Debugger provides built-in support for connecting to a large range of ARM FastModel products. To use any other simulation model with DS-5 Debugger you must first create and import the model configuration into a DS-5 Configuration database.

Procedure

1. Open the Configuration Perspective.
2. Select **File** > **New** > **Configuration Database** to open the **New Configuration Database** dialog.
3. Enter a name for the new database and click **Finish**.
4. In the **Project Explorer** view, right click and select **New** > **Model Configuration** from the context menu to open the **New Model** dialog.
5. Select the database in which to create the new model entry, then click **Next**. This opens the **Select Method for Connecting to Model** dialog.
6. Select the method for connecting to the model. The options are:
   a. **Launch and connect to a specific model.** Click **Next** to select a specific model from the file system. Click **File** to browse for a model, for example from the DS-5 installation.
   b. **Browse for model running on local host.** Click **Next** to browse for models running on the local host. Then click **Browse** to display the list of running models. Select the model from the **Model Browser** dialog.
7. Click **Finish** to connect to the model. This opens the Models Configuration Editor, where you can view and edit the devices in the model.
8. Click **Save** to save the changes to the model to the `.mdf` file.
9. Click **Import** to create DS-5 Configuration database files. This adds the configuration to the DS-5 preferences.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

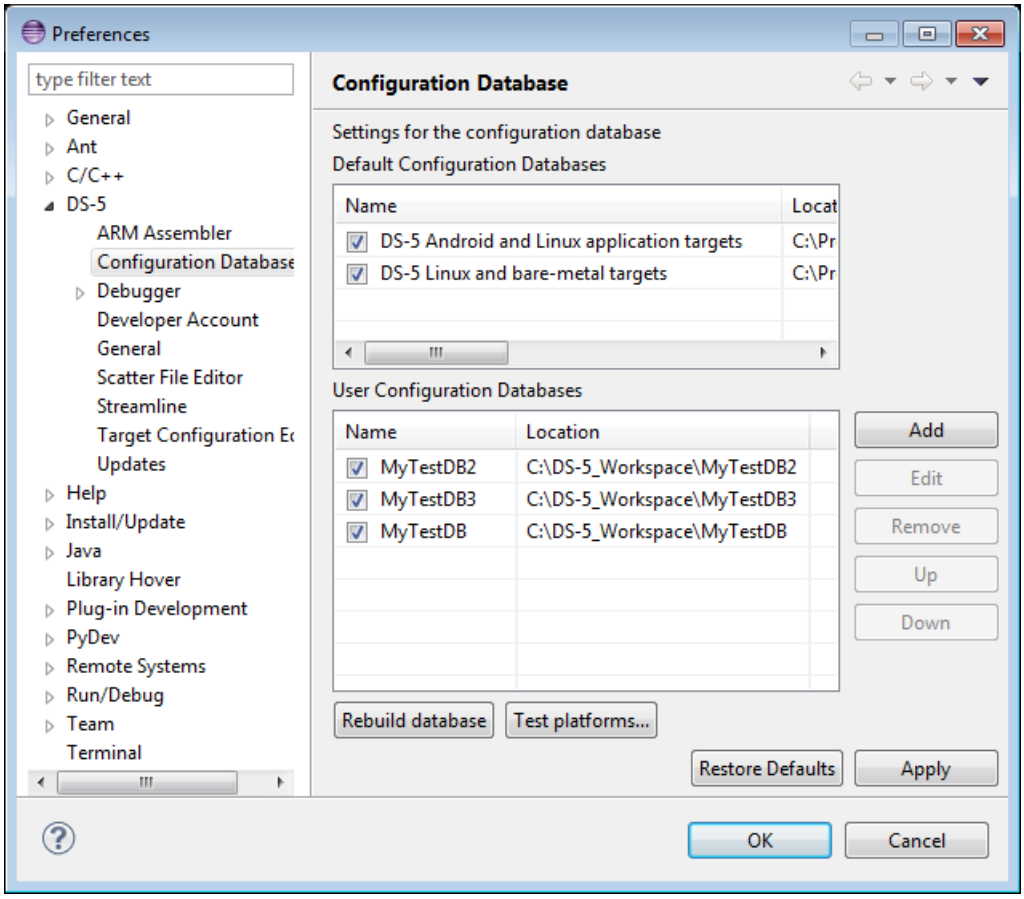


Figure 10-20 Configuration Database

10. Click **Debug** to create a new Debug Configuration entry and open the **Debug Configurations** dialog. You must configure the connection before starting the debug session.

Related references

10.13 Model Devices and Cluster Configuration on page 10-252.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.12 Importing a custom model

If you have built your own custom CADI-compliant model, to connect to it using DS-5, you have to create a new entry in the DS-5 configuration database. Depending on how the model is defined in the configuration database, DS-5 can either launch the model or can connect to an already running model.

Note

ARM FVPs not provided with DS-5 installation must be defined in the `PATH` environment variable of your OS to be available for DS-5.

You must add the *`DS-5_install_directory`*`/bin` directory to your `PATH` environment variable and restart Eclipse.

- For Windows, enter `set PATH=<your model path>\bin;%PATH%`
- For Linux, enter `export PATH=<your model path>/bin:$PATH`

To ensure that the modified path is available in future sessions:

- For Windows, right-click **My Computer** > **Properties** > **Advanced system settings** > **Environment Variables** and under **User Variables**, create a `PATH` variable with the value `<your model path>\bin`, or else append `;<your model path>\bin` to any existing `PATH` variable.
- For Linux, set up the `PATH` in the appropriate shell configuration file. For example, in `.bashrc`, add the line `export PATH=<your model path>/bin:$PATH`

For the models you build yourself, follow the instructions as described in this topic.

Procedure

1. Launch your model and start the CADI server.
   - If your model is a library file:
     - On Windows, select **Start** > **All Programs** > **ARM DS-5** > **DS-5 Command Prompt** and enter `model_shell -m <your model path and name> -S`.
     - On Linux, open a new terminal and run: *`DS-5_install_directory`*`/bin/model_shell -m <your model path and name> -S`
   - If your model is an executable file, at the command prompt, enter `<your model path and name> -S`.

   Note

   For more information about options available with the `model_shell` utility in DS-5, enter `model_shell --help` at the DS-5 command prompt.

2. Launch DS-5 and open the DS-5 Configuration perspective. Create a new model configuration as shown in *10.11 Creating a new model configuration* on page 10-248.
   a. Browse the list of models running on the local host.
   b. If there is more than one active CADI-compliant model simulation, DS-5 lists the available connections. Select the one you want to connect to.
   c. If needed, select a core to modify.
   d. If needed, enter the name of the **Platform Manufacturer**.

      Note

      If you do not enter a name for the platform manufacturer, you can find the platform you added listed under **Imported** in the list of platforms in the **Debug Configurations** dialog.

   e. Enter the name of the **Platform**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3. Rebuild the DS-5 Configuration database:
   - From the DS-5 menu, select **Window** > **Preferences** > **DS-5** > **Configuration Database** and click **Rebuild database**.

   Your model is now available as one of the targets in the configuration database. Use the **Debug Configurations** dialog to create, manage, and run configurations for this target.

Related concepts

2.1 Overview: Debug connections in DS-5 Debugger on page 2-34.

10.2 About importing platform and model configurations on page 10-226.

Related tasks

2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.

2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.

2.6 Configuring a connection to a Linux kernel on page 2-48.

2.3 Configuring a connection to a bare-metal hardware target on page 2-38.

8.4 Specifying a custom configuration database using the command-line on page 8-211.

Related information

Component Architecture Debug Interface Developer Guide.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.13 Model Devices and Cluster Configuration

Use the Model Devices and Cluster Configuration tab to view and configure the devices in the model.

Executable Devices
Lists the cores available within the model. You can add, remove, or edit the available cores.

Associations
Lists the non-executable devices within the model. You can expand the associations to see how the non-executable devices are mapped. You can delete items from the associations view or add items from the list of available non-executable devices.

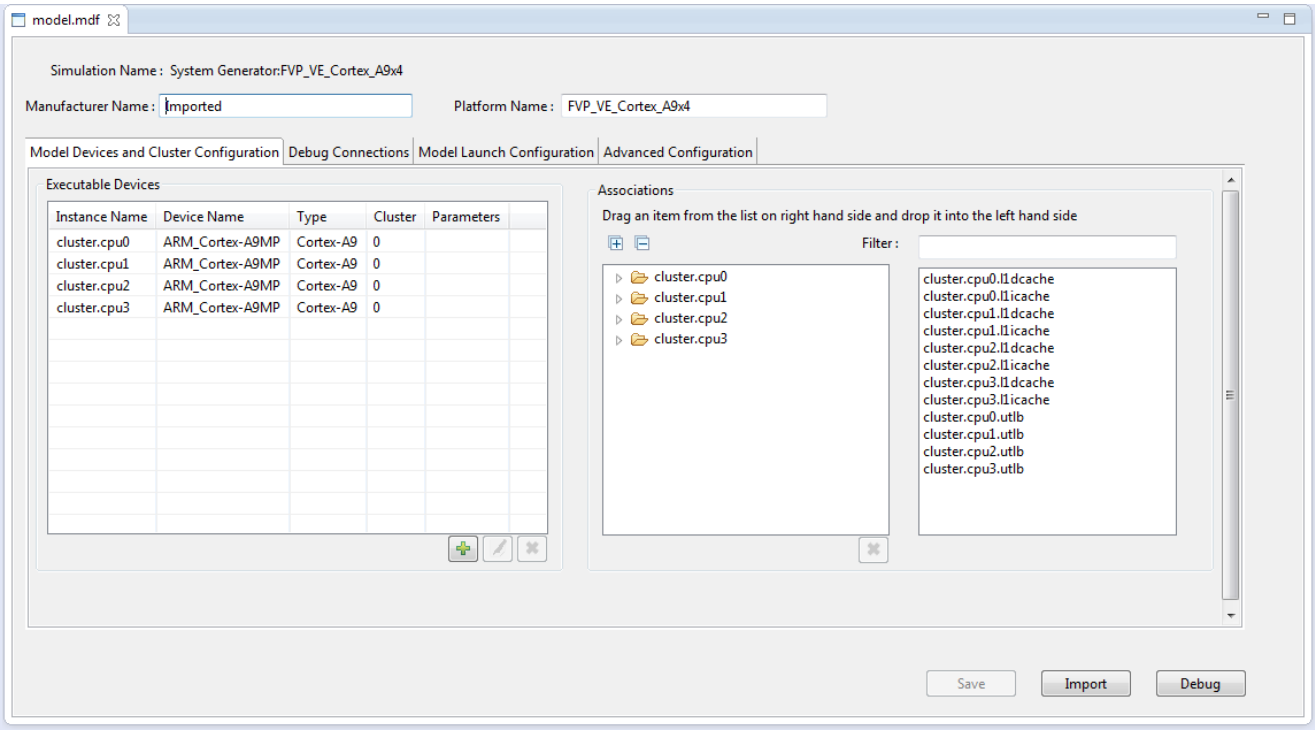


Figure 10-21 Model Devices and Cluster Configuration tab

Related tasks

10.11 Creating a new model configuration on page 10-248.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.14 Adding a configuration database to DS-5

You can add configuration databases from other DS-5 sources into your installation of DS-5.

Prerequisites

An existing configuration database.

Procedure

1. Launch DS-5, and from the main menu, select **Window** > **Preferences**.
2. Expand the **DS-5** configuration group.
3. Select **Configuration Database**.
4. Click **Add...** and in the **Add configuration database location** dialog:
   a. Give a **Name** for the configuration database, for example, `MyConfigDB`.
   b. Click **Browse** and select the database.
   c. Click **OK** to close the dialog box.
5. If necessary, change the order of the database. DS-5 processes the databases from top to bottom with the information in the lower databases replacing information in the higher databases. For example, if you want to produce a modified Cortex-A15 processor definition with different registers, then those changes can be added to a new database that resides lower down in the list.
   a. Select the new database.
   b. Click **Up** or **Down** as required.

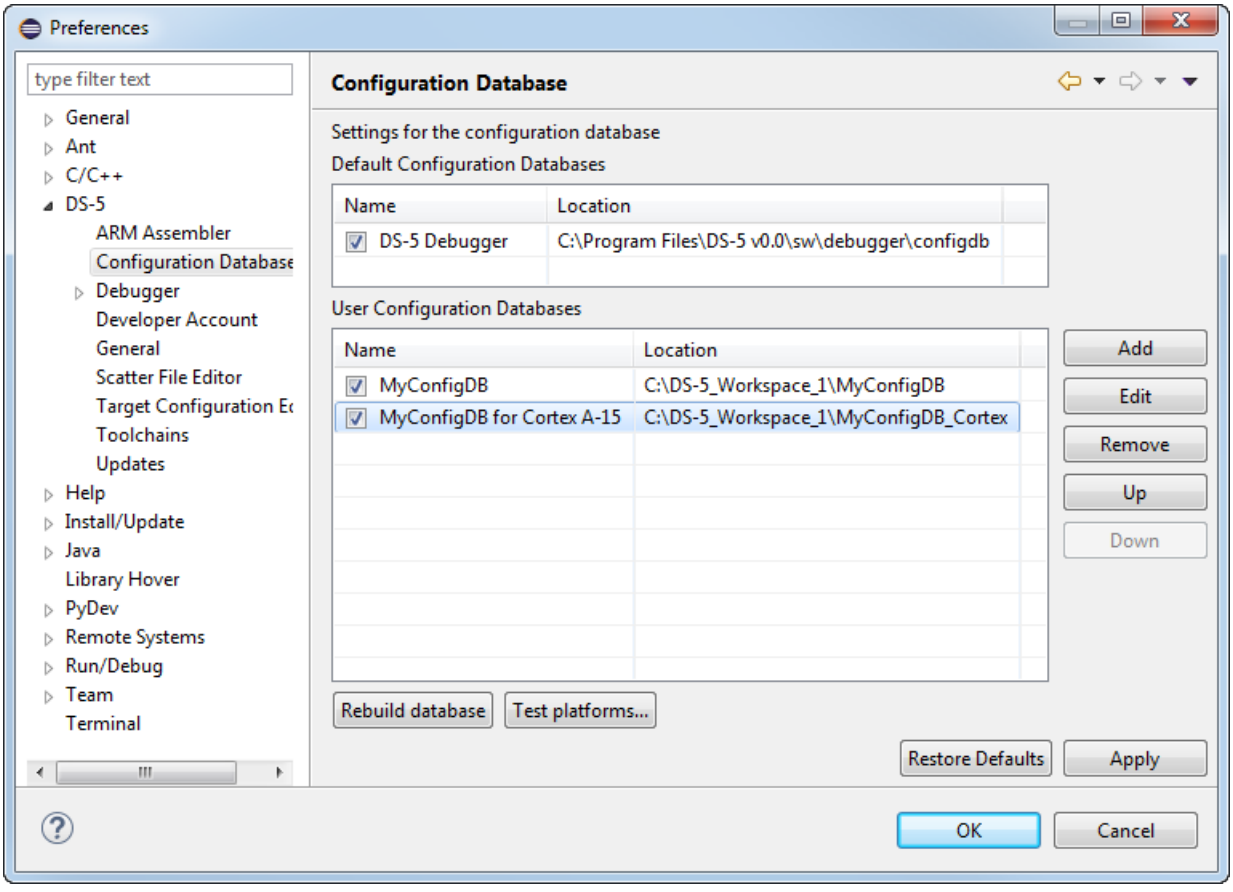


Figure 10-22 Adding a configuration database

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Note

DS-5 provides built-in databases containing a default set of target configurations. You can enable or disable built-in databases, but you cannot delete them.

6. Click **Rebuild database...**.
7. Click **OK** to close the dialog box and save the settings.
   After you have successfully added your configuration database, you can view your platforms in the **Debug Configuration** dialog, under the **Manufacturer** area you specified.

Related concepts

10.2 About importing platform and model configurations on page 10-226.

Related tasks

10.6 Creating a platform configuration on page 10-231.

Related references

10.15 Configuration Database panel on page 10-255.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.15 Configuration Database panel

Use the **Configuration Database** panel to manage the configuration database settings.

Default Configuration Databases

Displays the default DS-5 configuration databases.

Note

ARM recommends that you do not disable these.

User Configuration Databases

Enables you to add your own configuration database.

Add

Opens a dialog box in which you can select a configuration database to add.

Edit

Opens a dialog box in which you can modify the name and location of the selected configuration database.

Remove

Removes the selected configuration database.

Up

Moves the selected configuration database up the list.

Down

Moves the selected configuration database down the list.

Note

Databases process from top to bottom with information in the lower databases replacing information in higher databases. For example, if you produced a modified core definition with different registers, you would add it to the database at the bottom of the list so that the database uses it instead of the core definitions in the shipped database.

Rebuild database

Rebuilds the configuration database.

Test platforms...

Enables you to select which platforms to test, then tests them, and reports any errors found.

Restore Defaults

Removes all the configuration databases from the field text that do not belong to the DS-5 default system.

Apply

Saves the current configuration database settings.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

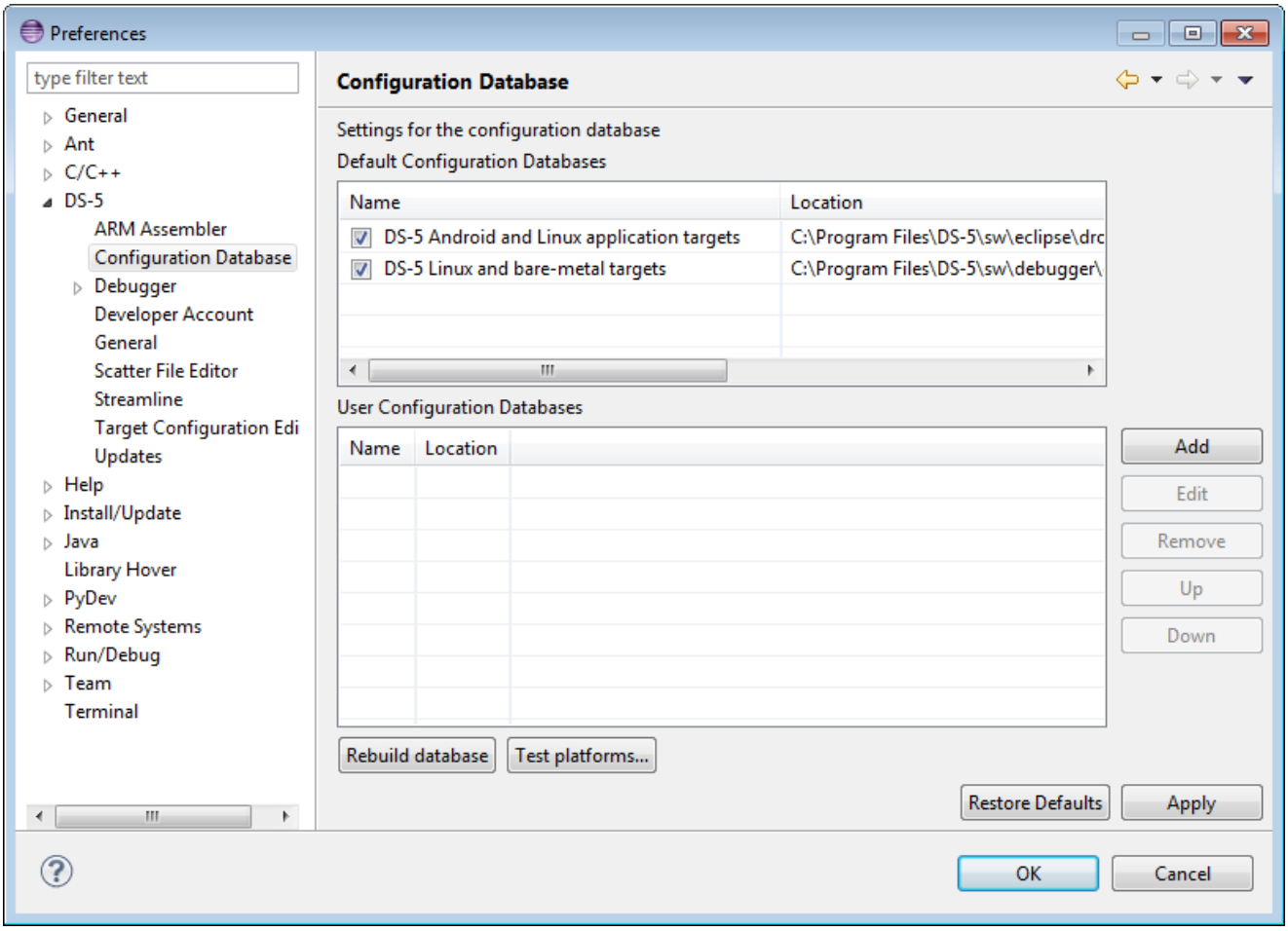


Figure 10-23 Configuration Database panel

Related concepts

10.2 About importing platform and model configurations on page 10-226.

Related tasks

10.6 Creating a platform configuration on page 10-231.
10.14 Adding a configuration database to DS-5 on page 10-253.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

10.16 Extending your configuration database

By default, the **Platform Configuration Editor** auto-detects components that are already available in the main **Configuration Database**. You can increase the number of auto-detected components by creating a `components.xml` file and adding it to the `Components` folder in your **Configuration Database** folder.

To summarize, these are the main steps involved in extending component auto-detection capabilities:

1. Create a `components.xml` and add the details of your parts into it.
2. In your custom configuration database folder, create a folder called `Components`.
3. Place your custom `components.xml` file in the `Components` folder.

Structure of the components.xml file

The `components.xml` is structurally made up of several elements with associated attributes. For example:

```
<componentDatabase version="1.0">

  <manufacturer>      <!-- Manufacturer elements contain the manufacturer name, the JEP code
for the manufacturer, and one or more parts.-->

    <name>ARM</name>      <!-- The part manufacturer name. -->

      <jepcode>0x43B</jepcode>     <!--The manufacturer JEDEC JEP-106 Manufacturer ID Code.
          <part>    <!--Declaration of a part.-->

               <number>0x9D7</number>      <!-- The part ID. This is required for the part
to be successfully detected. -->

               <name>CSPMU</name>         <!-- The part name. If a firmware template does
not exist for a part, then the CoreSight REG template will be used for the part. -->

               <description>New CoreSight PMU part</description>      <!--A brief
description of the part.-->

               <DEVTYPE>0x16</DEVTYPE>     <!-- The part type. This is optional. If the part
number is shared by multiple components, use <DEVTYPE> to
                                                  differentiate between various parts.-->

               <DEVARCH>0x16</DEVARCH>    <!-- The development architecture. This is
optional. If the part number is shared by multiple components, use DEVARCH to
                                                  differentiate between various development
architectures. -->

               <uses_template>CSPMU</uses_template>     <!--Alternate template for the part.
Use this element to override any firmware template.-->

         </part>

  </manufacturer>

</componentDatabase>
```

Table 10-1 Elements used in the components.xml file

Element name	Description
`<componentDatabase>`	The `components.xml` file definition. Use the `version` attribute to define file versions, for example: `<componentDatabase version="1.0">`
`<manufacturer>`	Manufacturer elements contain the manufacturer name, the JEP code for the manufacturer, and one or more parts.
`<name>`	The part manufacturer name.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Table 10-1 Elements used in the components.xml file (continued)

Element name	Description
`<jepcode>`	The manufacturer JEDEC JEP-106 Manufacturer ID Code. JEP106 provides for a 7-bit "Identity Code" plus a mechanism for extending the range of codes by use of a "Continuation Code". See *What is the JEDEC JEP-106 Manufacturer ID Code and how is it used?* for more information about JEDEC JEP-106 Manufacturer ID Code.
`<part>`	Declaration of a component part.
`<number>`	The part ID. This is required for the part to be successfully detected. If your part has multiple IDs, you can list them separated by a semicolon (;). So for example, <number>0x9D7;0xD14</number>.
`<DEVTYPE>`	The part type. This is optional. If the part number is shared by multiple components, use <DEVTYPE> to differentiate between various parts.
`<DEVARCH>`	The development architecture. This is optional. If the part number is shared by multiple components, use DEVARCH to differentiate between various development architectures.
`<name>`	The part name. If a firmware template does not exist for a part, then the CSREG template will be used for the part.
`<uses_template>`	Alternate template for the part. Use this element to override any firmware template.
`<description>`	A brief description of the part.
`<core_definition>`	The core definition. Used to indicate which DS-5 configuration database core definition must be used. If this is not available, `<name>` value is used for the core definition.
`<family>`	The processor core family name.
`<class>`	The device class of the component. This can be `TraceSink`, `TraceSource`, `TraceLink`, or `CoreExecutable`.
`<architecture>`	The core's architecture. For example, `ARMv7-A`, `ARMv7-R`, `ARMv7-M`, `ARMv8-A`, `ARMv8-R`, `ARMv8-M`.
`<MPCore>`	Indicates that this component is a Symmetric Multi-Processing (SMP) capable core.
`<device_info_list>`	A set of `device_info` items, which contain the information (key/value pairs) required for PCE to be able to create and configure the correct DTSL objects.
`<Option>`	An option for the value of a `device_info` item. These are fixed for any given component type, that is, new ones cannot be added, and removing existing ones causes failures.
`<topology_info>`	A set of topology link constraint information items. This describes maximum/minimum and master/slave interface connections for any given interface type, for example, `ATB`, `CTI_Trigger`, or `CoreTrace`.
`<atb_link>`	Information for minimum/maximum connections for `ATB` interfaces.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Table 10-1 Elements used in the components.xml file (continued)

Element name	Description
`<core_trace_link>`	Information for minimum/maximum connections for `CoreTrace` interfaces.
`<cti_link>`	Information for minimum/maximum connections for `CTI` interfaces.

Examples part definitions

The examples below provide some sample configurations.

Example 10-1 Adding a CoreSight Performance Monitoring Unit (PMU) - 1

```
<part>
  <number>0x9D7</number>
  <name>CSPMU</name>
  <description>New CoreSight PMU part</description>
  <DEVTYPE>0x16</DEVTYPE>
  <DEVARCH>0x16</DEVARCH>
</part>
```

Example 10-2 Adding a CoreSight Performance Monitoring Unit (PMU) - 2

```
<part>
  <number>0x999</number>
  <name>MyNewPart</name>
  <description>New PMU Type</description>
  <DEVTYPE>0x16</DEVTYPE>
  <DEVARCH>0x16</DEVARCH>
  <uses_template>CSPMU </uses_template>
</part>
```

Example 10-3 Adding a core

```
<part>
  <number>0xD13;0xD14</number>
  <name>MyNewCore</name>
  <description>My new core type</description>
  <DEVTYPE>0x15</DEVTYPE>
  <DEVARCH>0x15</DEVARCH>
  <uses_template>V8A-Generic</uses_template>
  <core_definition>MyNewCoreDefinition<core_definition>
  <family>Cortex</family>
  <class>CoreExecutable</class>
  <architecture>ARMv8-A</architecture>
  <MPCore>True</MPCore>
</part>
```

Example 10-4 Adding a CoreSight Embedded Trace Macrocell

```
<part>
  <number>0x9B6</number>
  <name>CSETM</name>
  <description>CoreSight Embedded Trace Macrocell</description>
  <device_info_list>
    <device_info name="VERSION" description="ETM Version" type="string" value="4.0">
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
          <Option>3.0</Option>
          <Option>3.1</Option>
          <Option>3.2</Option>
          <Option>3.3</Option>
          <Option>3.4</Option>
          <Option>3.5</Option>
          <Option>4.0</Option>
          <Option>4.2</Option>
        </device_info>
        <device_info name="SUPPORTS_CONTEXT_IDS" description="Context IDs supported"
type="bool" value="True"/>
        <device_info name="SUPPORTS_CYCLE_ACCURATE" description="Cycle-Accurate tracing
supported" type="bool" value="True"/>
        <device_info name="SUPPORTS_DATA_VALUE_TRACE" description="Data Value trace
supported" type="bool" value="True"/>
        <device_info name="SUPPORTS_DATA_ADDRESS_TRACE" description="Data Address trace
supported" type="bool" value="True"/>
        <device_info name="SUPPORTS_DATA_ONLY_MODE" description="Data-Only tracing
supported" type="bool" value="True"/>
        <device_info name="SUPPORTS_TIMESTAMPS" description="Timestamps are supported"
type="bool" value="True"/>
        <device_info name="SUPPORTS_TRACE_RANGES" description="Trace Ranges are supported"
type="bool" value="True"/>
      </device_info_list>
      <topology_info>
        <atb_link position="master" minSlaves="1" numMasterInterfaces="1"/>
        <core_trace_link position="slave" minMasters="1" maxMasters="1"/>
        <cti_link position="master" minSlaves="0" maxSlaves="1" devices="CSCTI"/>
      </topology_info>
    </part>
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 11
DS-5 Debug Perspectives and Views

Describes the DS-5 Debug perspective and related views in the Eclipse *Integrated Development Environment* (IDE).

It contains the following sections:

- *11.1 App Console view* on page 11-263.
- *11.2 ARM Asm Info view* on page 11-265.
- *11.3 ARM assembler editor* on page 11-266.
- *11.4 Breakpoints view* on page 11-268.
- *11.5 C/C++ editor* on page 11-272.
- *11.6 Commands view* on page 11-275.
- *11.7 Debug Control view* on page 11-278.
- *11.8 Stack view* on page 11-282.
- *11.9 Disassembly view* on page 11-285.
- *11.10 Events view* on page 11-289.
- *11.11 Event Viewer Settings dialog box* on page 11-291.
- *11.12 Expressions view* on page 11-294.
- *11.13 Functions view* on page 11-298.
- *11.14 History view* on page 11-300.
- *11.15 Memory view* on page 11-302.
- *11.16 MMU view* on page 11-308.
- *11.17 Modules view* on page 11-312.
- *11.18 Registers view* on page 11-314.
- *11.19 OS Data view* on page 11-319.
- *11.20 Overlays view* on page 11-320.
- *11.21 Cache Data view* on page 11-321.
- *11.22 Screen view* on page 11-323.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

- *11.23 Scripts view* on page 11-326.
- *11.24 Target Console view* on page 11-328.
- *11.25 Target view* on page 11-329.
- *11.26 Trace view* on page 11-331.
- *11.27 Trace Control view* on page 11-334.
- *11.28 Variables view* on page 11-337.
- *11.29 Timed Auto-Refresh Properties dialog box* on page 11-343.
- *11.30 Memory Exporter dialog box* on page 11-344.
- *11.31 Memory Importer dialog box* on page 11-345.
- *11.32 Fill Memory dialog box* on page 11-346.
- *11.33 Export Trace Report dialog box* on page 11-347.
- *11.34 Breakpoint Properties dialog box* on page 11-349.
- *11.35 Watchpoint Properties dialog box* on page 11-352.
- *11.36 Tracepoint Properties dialog box* on page 11-353.
- *11.37 Manage Signals dialog box* on page 11-354.
- *11.38 Functions Filter dialog box* on page 11-356.
- *11.39 Script Parameters dialog box* on page 11-357.
- *11.40 Debug Configurations - Connection tab* on page 11-358.
- *11.41 Debug Configurations - Files tab* on page 11-361.
- *11.42 Debug Configurations - Debugger tab* on page 11-364.
- *11.43 Debug Configurations - OS Awareness tab* on page 11-367.
- *11.44 Debug Configurations - Arguments tab* on page 11-368.
- *11.45 Debug Configurations - Environment tab* on page 11-370.
- *11.46 DTSL Configuration Editor dialog box* on page 11-372.
- *11.47 About the Remote System Explorer* on page 11-374.
- *11.48 Remote Systems view* on page 11-375.
- *11.49 Remote System Details view* on page 11-376.
- *11.50 Target management terminal for serial and SSH connections* on page 11-377.
- *11.51 Remote Scratchpad view* on page 11-378.
- *11.52 Remote Systems terminal for SSH connections* on page 11-379.
- *11.53 Terminal Settings dialog box* on page 11-380.
- *11.54 Debug Hardware Configure IP view* on page 11-382.
- *11.55 Debug Hardware Firmware Installer view* on page 11-384.
- *11.56 Connection Browser dialog box* on page 11-387.
- *11.57 DS-5 Debugger menu and toolbar icons* on page 11-388.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.1 App Console view

Use the **App Console** view to interact with the console I/O capabilities provided by the semihosting implementation in the ARM C libraries. To use this feature, semihosting support must be enabled in the debugger.

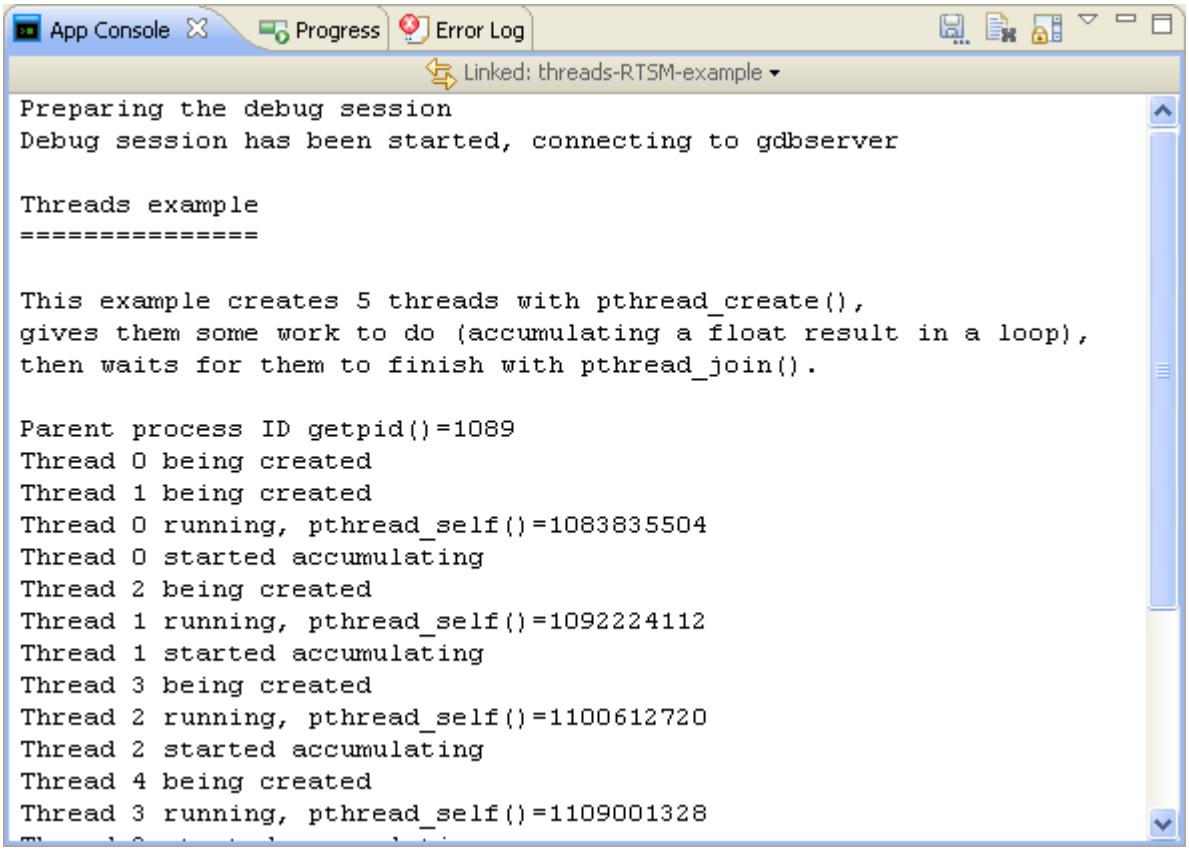


Figure 11-1 App Console view

Note

Default settings for this view, for example the maximum number of lines to display, are controlled by the DS-5 Debugger option in the Preferences dialog box. You can access these settings by selecting **Preferences** from the **Window** menu.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *`context`*
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively, you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Save Console Buffer
: Saves the contents of the **App Console** view to a text file.

Clear Console
: Clears the contents of the **App Console** view.

Toggles Scroll Lock
: Enables or disables the automatic scrolling of messages in the **App Console** view.

View Menu
: This menu contains the following options:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

New App Console View
Displays a new instance of the **App Console** view.

Bring to Front for Write
If enabled, the debugger automatically changes the focus to this view when a semihosting application prompts for input.

Copy
Copies the selected text.

Paste
Pastes text that you have previously copied. You can paste text only when the application displays a semihosting prompt.

Select All
Selects all text.

Related references

3.17 Using semihosting to access resources on the host computer on page 3-95.

3.18 Working with semihosting on page 3-97.

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.2 ARM Asm Info view

Use the **ARM Asm Info** view to display the documentation for an ARM or Thumb® instruction or directive.

When you are editing assembly language source files, which have a `.s` extension, using the ARM assembler editor, you can access more information by:

1. Selecting an instruction or directive.
2. Pressing **F3**.

The related documentation is displayed in the **ARM Asm Info** view. The **ARM Asm Info** view is automatically shown when you press **F3**.

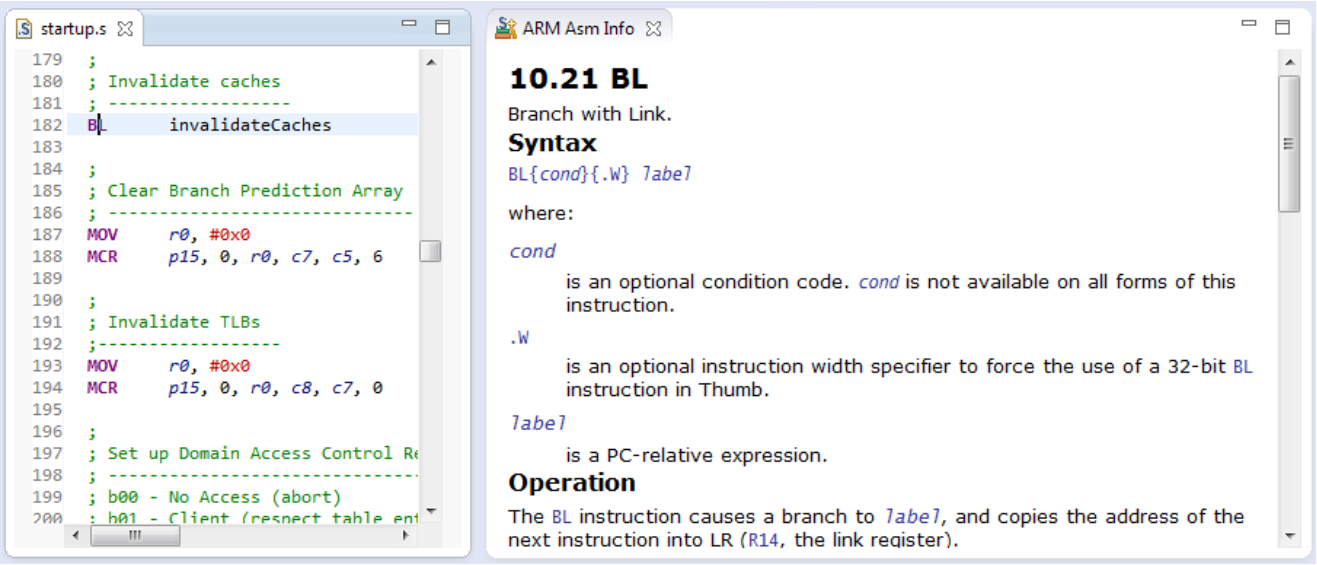


Figure 11-2 ARM Asm Info view

To manually show this view:

1. Ensure that you are in the DS-5 Debug perspective.
2. Select **Window** > **Show View** > **Other...** to open the Show View dialog box.
3. Select the **ARM Asm Info** view from the **DS-5 Debugger** group.

Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.
11.3 ARM assembler editor on page 11-266.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.3 ARM assembler editor

Use the ARM assembler editor to view and edit ARM assembly language source code. It provides syntax highlighting, code formatting, and content assist for auto-completion.

This editor also enables you to:

- Select an instruction or directive and press **F3** to view the related ARM assembler reference information.
- Set, remove, enable, or disable a breakpoint.
- Set or remove a trace start or stop point.

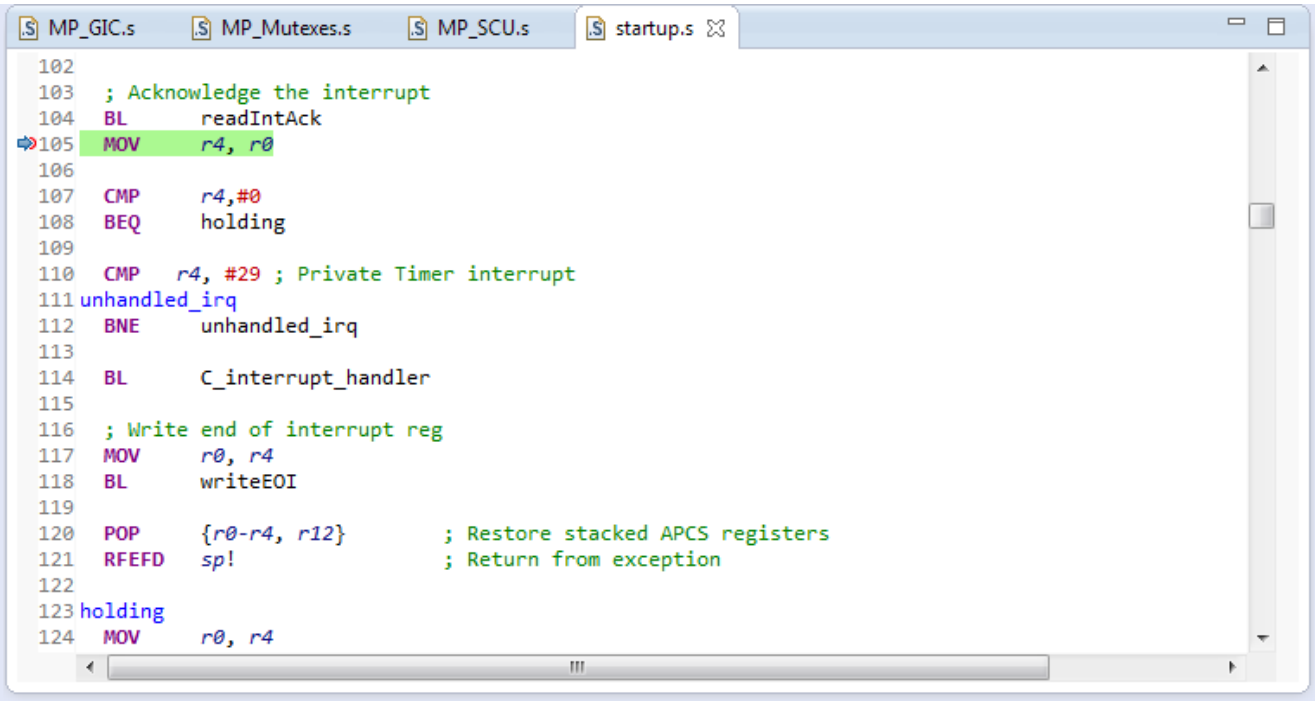


Figure 11-3 ARM assembler editor

In the left-hand margin of each editor tab you can find a marker bar that displays view markers associated with specific lines in the source code.

To set a breakpoint, double-click in the marker bar at the position where you want to set the breakpoint. To delete a breakpoint, double-click on the breakpoint marker.

Action context menu options

Right-click in the marker bar, or the line number column if visible, to display the action context menu for the ARM assembler editor. The options available include:

DS-5 Breakpoints menu

The following breakpoint options are available:

Toggle Breakpoint

Adds or removes a breakpoint.

Toggle Hardware Breakpoint

Sets or removes a hardware breakpoint.

Resolve Breakpoint

Resolves a pending breakpoint.

Disable Breakpoint, Enable Breakpoint

Disables or enables the selected breakpoint.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Toggle Trace Start Point
Sets or removes a trace start point.

Toggle Trace Stop Point
Sets or removes a trace stop point.

Toggle Trace Trigger Point
Starts a trace trigger point at the selected address.

Breakpoint Properties...
Displays the Breakpoint Properties dialog box for the selected breakpoint. This enables you to control breakpoint activation.

Default Breakpoint Type
The following breakpoint options are available:

DS-5 C/C++ Breakpoint
Select to use the DS-5 Debug perspective breakpoint scheme. This is the default for the DS-5 Debug perspective.

Note

The **Default Breakpoint Type** selected causes the top-level **Toggle Breakpoint** menu in this context menu and the double-click action in the left-hand ruler to toggle either CDT Breakpoints or DS-5 Breakpoints. This menu is also available from the **Run** menu in the main menu bar at the top of the C/C++, Debug, and DS-5 Debug perspectives.

The menu options under **DS-5 Breakpoints** do not honor this setting and always refer to DS-5 Breakpoints.

Show Line Numbers
Show or hide line numbers.

For more information on the other options not listed here, see the dynamic help.

Related references

3.13 Setting a tracepoint on page 3-89.
3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.
3.12 Pending breakpoints and watchpoints on page 3-87.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.
5.1 Examining the target execution environment on page 5-136.
5.2 Examining the call stack on page 5-137.
11.2 ARM Asm Info view on page 11-265.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.4 Breakpoints view

Use the **Breakpoints** view to display the breakpoints, watchpoints, and tracepoints you have set in your program.

It also enables you to:

- Disable, enable, or delete breakpoints, watchpoints, and tracepoints.
- Import or export a list of breakpoints and watchpoints.
- Display the source file containing the line of code where the selected breakpoint is set.
- Display the disassembly where the selected breakpoint is set.
- Display the memory where the selected watchpoint is set.
- Delay breakpoint activation by setting properties for the breakpoint.
- Control the handling and output of messages for all Unix signals and processor exception handlers.
- Change the access type for the selected watchpoint.

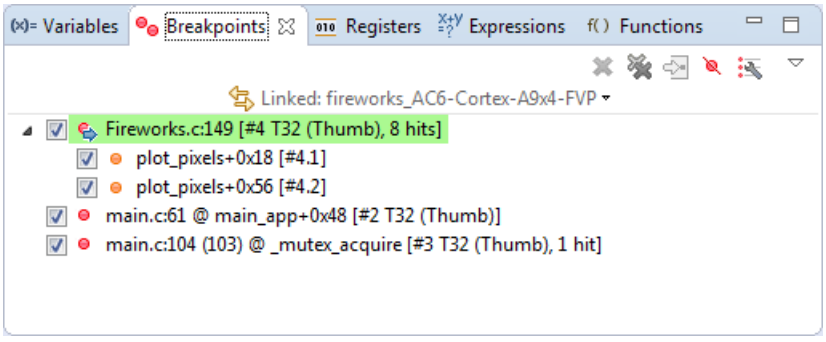


Figure 11-4 Breakpoints view showing breakpoints and sub-breakpoints

Syntax of a breakpoint entry

A breakpoint entry has the following syntax:

```
source_file:linenum @ function+offset address [#ID instruction_set, ignore = num/
count, nHits hits, (condition)]
```

where:

source_file:linenum
: If the source file is available, the file name and line number in the file where the breakpoint is set, for example `main.c:44`.

function+offset
: The name of the function in which the breakpoint is set and the number of bytes from the start of the function. For example, `main_app+0x12` shows that the breakpoint is 18 bytes from the start of the `main_app()` function.

address
: The address at which the breakpoint is set.

ID
: The breakpoint ID number, `#N`. In some cases, such as in a **`for`** loop, a breakpoint might comprise a number of sub-breakpoints. These are identified as `N.n`, where `N` is the number of the parent. The syntax of a sub-breakpoint entry is:

```
function+offset address [#ID]
```

instruction_set
: The instruction set of the instruction at the address of the breakpoint, `A32 (ARM)` or `T32 (Thumb)`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

`ignore = num/count`
: An `ignore` count, if set, where:

  num equals `count` initially, and decrements on each pass until it reaches zero.

  count is the value you have specified for the `ignore` count.

nHits `hits`
: A counter that increments each time the breakpoint is hit. This is not displayed until the first hit. If you set an `ignore` count, `hits` count does not start incrementing until the `ignore` count reaches zero.

condition
: The stop condition you have specified.

Syntax of a watchpoint entry

A watchpoint entry has the following syntax:

```
name type @ address [#ID]
```

where:

name
: The name of the variable where the watchpoint is set.

type
: The access type of the watchpoint.

address
: The address at which the watchpoint is set.

ID
: The watchpoint ID number.

Syntax of a tracepoint entry

A tracepoint entry has the following syntax:

```
source_file:linenum
```

where:

source_file:*linenum*
: If the source file is available, the file name and line number in the file where the tracepoint is set.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *context*
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively, you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Delete
: Removes the selected breakpoints, watchpoints, and tracepoints.

Delete All
: Removes all breakpoints, watchpoints, and tracepoints.

Go to File
: Displays the source file containing the line of code where the selected breakpoint or tracepoint is set. This option is disabled for a watchpoint.

Skip All Breakpoints
: Deactivates all currently set breakpoints or watchpoints. The debugger remembers the enabled and disabled state of each breakpoint or watchpoint, and restores that state when you reactivate them again.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Show in Disassembly
Displays the disassembly where the selected breakpoint is set. This option is disabled for a tracepoint.

Show in Memory
Displays the memory where the selected watchpoint is set. This option is disabled for a tracepoint.

Resolve
Re-evaluates the address of the selected breakpoint or watchpoint. If the address can be resolved, the breakpoint or watchpoint is set, otherwise it remains pending.

Enable Breakpoints
Enables the selected breakpoints, watchpoints, and tracepoints.

Disable Breakpoints
Disables the selected breakpoints, watchpoints, and tracepoints.

Copy
Copies the selected breakpoints, watchpoints, and tracepoints. You can also use the standard keyboard shortcut to do this.

Paste
Pastes the copied breakpoints, watchpoints, and tracepoints. They are enabled by default. You can also use the standard keyboard shortcut to do this.

Select all
Selects all breakpoints, watchpoints, and tracepoints. You can also use the standard keyboard shortcut to do this.

Properties...
Displays the Properties dialog box for the selected breakpoint, watchpoint or tracepoint. This enables you to control activation or change the access type for the selected watchpoint.

View Menu
The following **View Menu** options are available:

New Breakpoints View
Displays a new instance of the **Breakpoints** view.

Import Breakpoints
Imports a list of breakpoints and watchpoints from a file.

Export Breakpoints
Exports the current list of breakpoints and watchpoints to a file.

Alphanumeric Sort
Sorts the list alphanumerically based on the string displayed in the view.

Ordered Sort
Sorts the list in the order they have been set.

Auto Update Breakpoint Line Numbers
Automatically updates breakpoint line numbers in the **Breakpoints** view when changes occur in the source file.

Manage Signals
Displays the Manage Signals dialog box.

Related concepts

6.8 About debugging multi-threaded applications on page 6-152.
6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.
6.11 About debugging TrustZone enabled targets on page 6-160.

Related references

3.13 Setting a tracepoint on page 3-89.
3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.12 Pending breakpoints and watchpoints on page 3-87.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.
5.1 Examining the target execution environment on page 5-136.
5.2 Examining the call stack on page 5-137.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.5 C/C++ editor

Use the **C/C++ editor** to view and edit C and C++ source code. It provides syntax highlighting, code formatting, and content assist (**Ctrl+Space**) for auto-completion.

This editor also enables you to:

- View interactive help when hovering over C library functions.
- Set, remove, enable or disable a breakpoint.
- Set or remove a trace start or stop point.

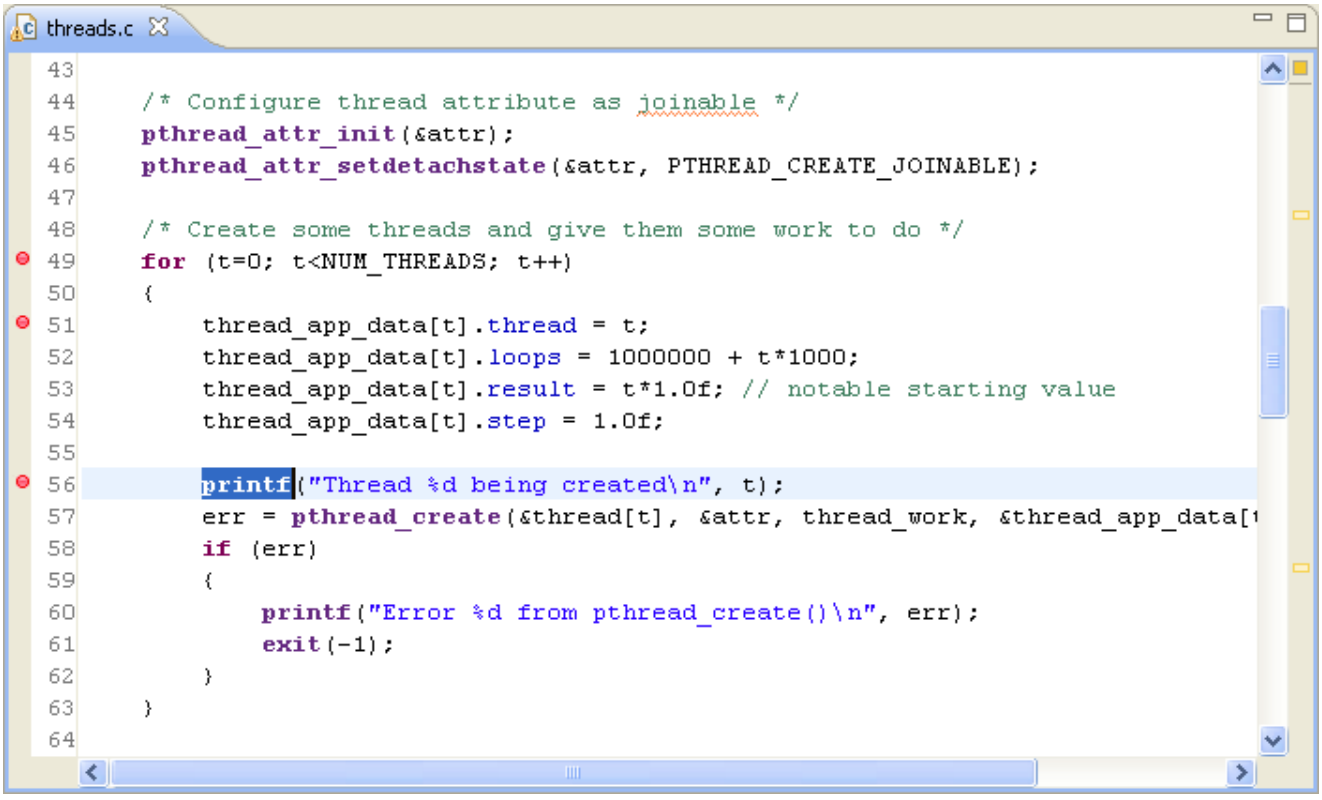


Figure 11-5 C/C++ editor

In the left-hand margin of each editor tab you can find a marker bar that displays view markers associated with specific lines in the source code.

To set a breakpoint, double-click in the marker bar at the position where you want to set the breakpoint. To delete a breakpoint, double-click on the breakpoint marker.

Note

If you have sub-breakpoints to a parent breakpoint then double-clicking on the marker also deletes the related sub-breakpoints.

Action context menu options

Right-click in the marker bar, or the line number column if visible, to display the action context menu for the C/C++ editor. The options available include:

DS-5 Breakpoints menu

The following breakpoint options are available:

Toggle Breakpoint

Sets or removes a breakpoint at the selected address.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Toggle Hardware Breakpoint
Sets or removes a hardware breakpoint at the selected address.

Resolve Breakpoint
Resolves a pending breakpoint at the selected address.

Enable Breakpoint
Enables the breakpoint at the selected address.

Disable Breakpoint
Disables the breakpoint at the selected address.

Toggle Trace Start Point
Sets or removes a trace start point at the selected address.

Toggle Trace Stop Point
Sets or removes a trace stop point at the selected address.

Toggle Trace Trigger Point
Starts a trace trigger point at the selected address.

Breakpoint Properties...
Displays the Breakpoint Properties dialog box for the selected breakpoint. This enables you to control breakpoint activation.

Default Breakpoint Type
The default type causes the top-level context menu entry, **Toggle Breakpoint** and the double-click action in the marker bar to toggle either CDT Breakpoints or DS-5 Breakpoints. When using DS-5 Debugger you must select **DS-5 C/C++ Breakpoint**. DS-5 breakpoint markers are red to distinguish them from the blue CDT breakpoint markers.

Show Line Numbers
Shows or hides line numbers.

For more information on the other options not listed here, see the dynamic help.

Editor context menu

Right-click on any line of source to display the editor context menu for the C/C++ editor. The following options are enabled when you connect to a target:

Set PC to Selection
Sets the PC to the address of the selected source line.

Run to Selection
Runs to the selected source line.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Show in Disassembly

This option:

1. Opens a new instance of the **Disassembly** view.
2. Highlights the addresses and instructions associated with the selected source line. A vertical bar and shaded highlight shows the related disassembly.

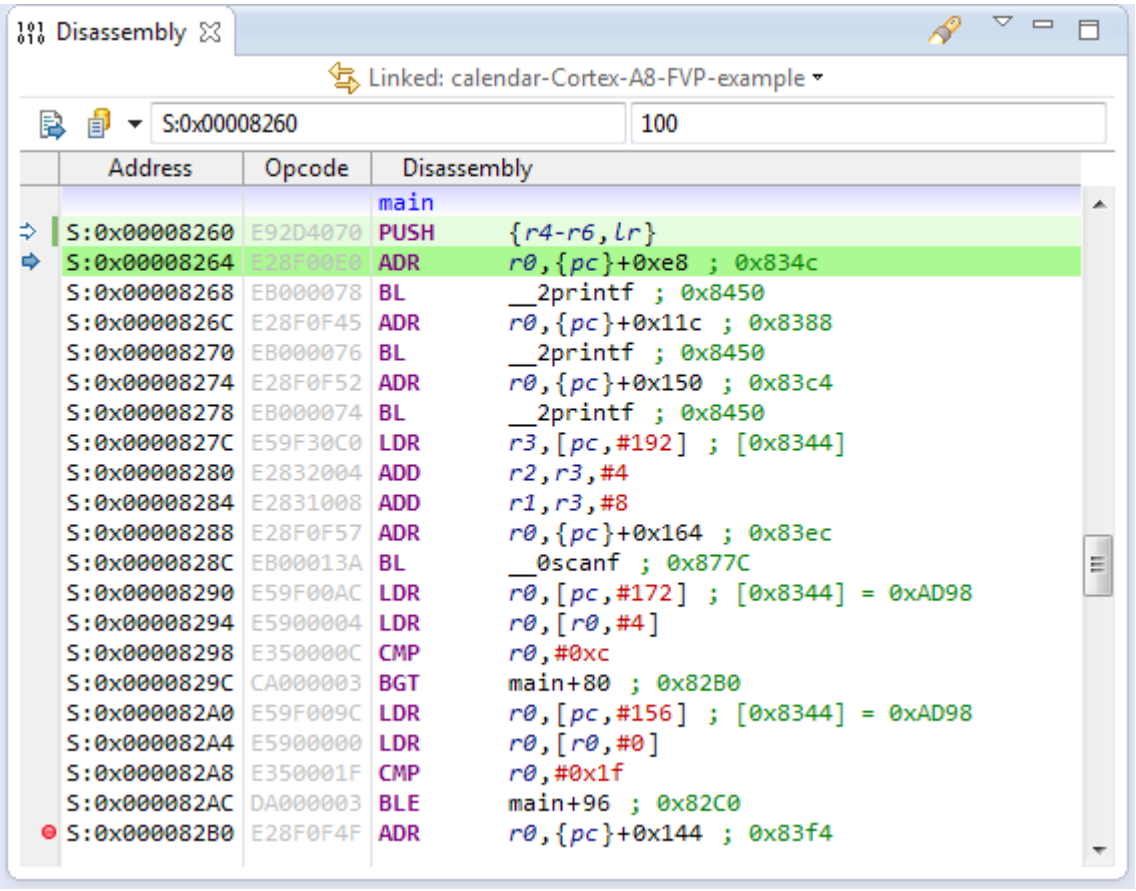


Figure 11-6 Show disassembly for selected source line

For more information on the other options not listed here, see the dynamic help.

Related references

3.13 Setting a tracepoint on page 3-89.
3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.
3.12 Pending breakpoints and watchpoints on page 3-87.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.6 Commands view

Use the **Commands** view to display DS-5 Debugger commands and the messages output by the debugger. It enables you to enter commands, run a command script, and save the contents of the view to a text file.

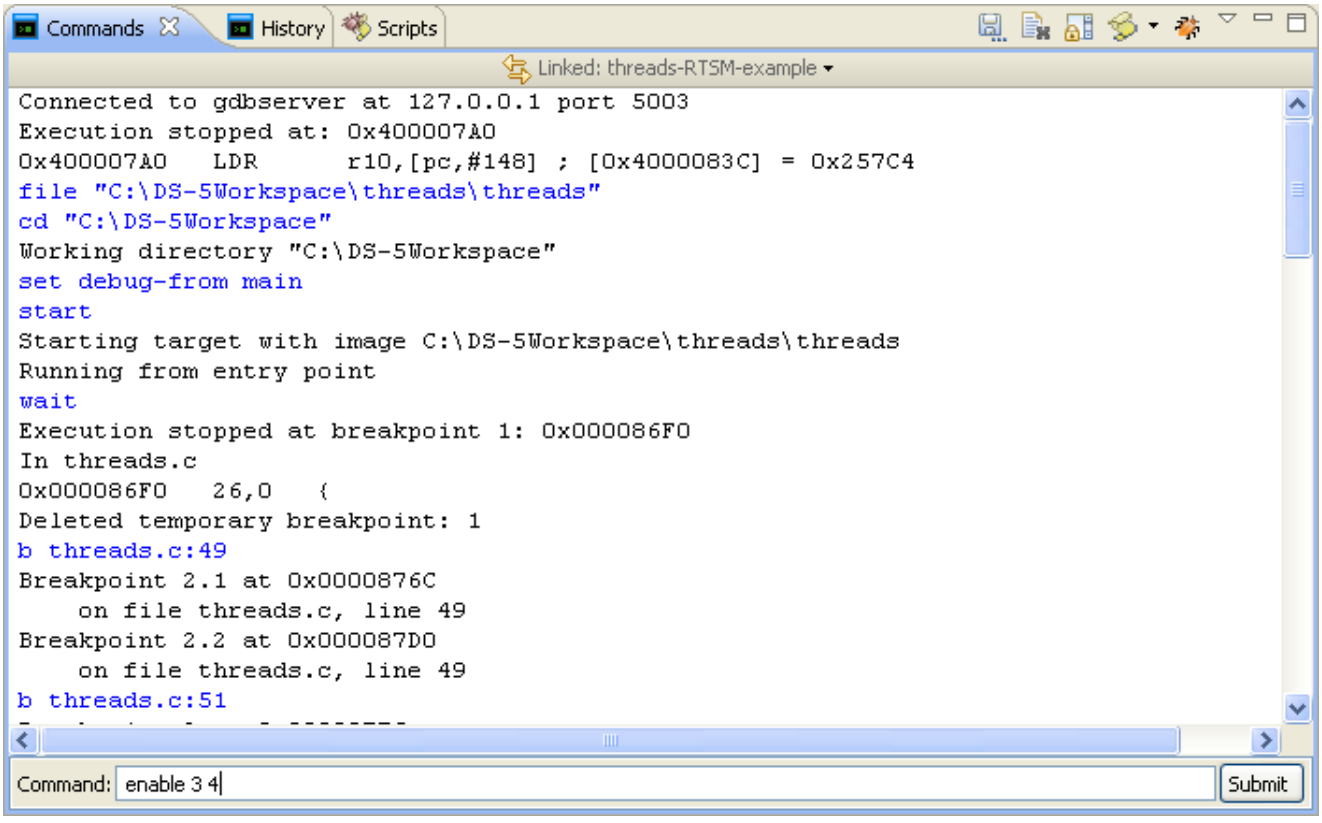


Figure 11-7 Commands view

You can execute DS-5 Debugger commands by entering the command in the field provided, then click **Submit**.

Note

This feature is not available until you connect to a target.

You can also use content assist keyboard combinations provided by Eclipse to display a list of DS-5 Debugger commands. Filtering is also possible by entering a partial command. For example, enter `pr` followed by the content assist keyboard combination to search for the `print` command.

To display sub-commands, you must filter on the top level command. For example, enter `info` followed by the content assist keyboard combination to display all the `info` sub-commands.

See DS-5 Debug perspective keyboard shortcuts in the Related reference section for details about specific content assist keyboard combinations available in DS-5 Debugger.

Note

Default settings for this view are controlled by a DS-5 Debugger setting in the Preferences dialog box. For example, default locations for script files or the maximum number of lines to display. You can access these settings by selecting **Preferences** from the **Window** menu.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: `context`
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Save Console Buffer
: Saves the contents of the **Commands** view to a text file.

Clear Console
: Clears the contents of the **Commands** view.

Toggles Scroll Lock
: Enables or disables the automatic scrolling of messages in the **Commands** view.

Script menu
: A menu of options that enable you to manage and run command scripts:

  <Recent scripts list>
  : A list of the recently run scripts.

  <Recent favorites list>
  : A list of the scripts you have added to your favorites list.

  Run Script File...
  : Displays the Open dialog box to select and run a script file.

  Organize Favorites...
  : Displays the **Scripts** view, where you can organize your scripts.

Show Command History View
: Displays the **History** view.

Copy
: Copies the selected commands. You can also use the standard keyboard shortcut to do this.

Paste
: Pastes the command that you have previously copied into the Command field. You can also use the standard keyboard shortcut to do this.

Select all
: Selects all output in the **Commands** view. You can also use the standard keyboard shortcut to do this.

Save selected lines as a script...
: Displays the Save As dialog box to save the selected commands to a script file.

  When you click **Save** on the Save As dialog box, you are given the option to add the script file to your favorites list. Click **OK** to add the script to your favorites list. Favorites are displayed in the **Scripts** view.

Execute selected lines
: Runs the selected commands.

New Commands View
: Displays a new instance of the **Commands** view.

Related concepts

6.8 About debugging multi-threaded applications on page 6-152.
6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.
6.11 About debugging TrustZone enabled targets on page 6-160.

Related references

16.2 DS-5 Debug perspective keyboard shortcuts on page 16-496.
3.13 Setting a tracepoint on page 3-89.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.
3.12 Pending breakpoints and watchpoints on page 3-87.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.7 Debug Control view

Use the **Debug Control** view to display target connections with a hierarchical layout of running cores, threads, or user-space processes.

This view enables you to:

- Connect to and disconnect from a target.
- View a list of running cores, threads, or user-space processes as applicable.
- Load an application image onto the target.
- Load debug information when required by the debugger.
- Look up stack information.
- Start, run, and stop the application.
- Continue running the application after a breakpoint is hit or the target is suspended.
- Control the execution of an image by sequentially stepping through an application at the source or instruction level.
- Modify the search paths used by the debugger when it executes any of the commands that look up and display source code.
- Set the current working directory.
- Reset the target.

Some of the views in the DS-5 Debug perspective are associated with currently selected execution context. Each associated view is synchronized depending on your selection.

On Linux Kernel connections, the hierarchical nodes **Active Threads** and **All Threads** are displayed. **Active Threads** shows each thread that is currently scheduled on a processor. **All Threads** shows every thread in the system, including those presently scheduled on a processor.

On `gdbserver` connections, the hierarchical nodes **Active Threads** and **All Threads** are displayed, but the scope is limited to the application under debug. **Active Threads** shows only application threads that are currently scheduled. **All Threads** shows all application threads, including ones that are currently scheduled.

Connection execution states are identified with different icons and background highlighting and are also displayed in the status bar.

When working with threads, note that the current active thread is always highlighted, as shown in the following figure:

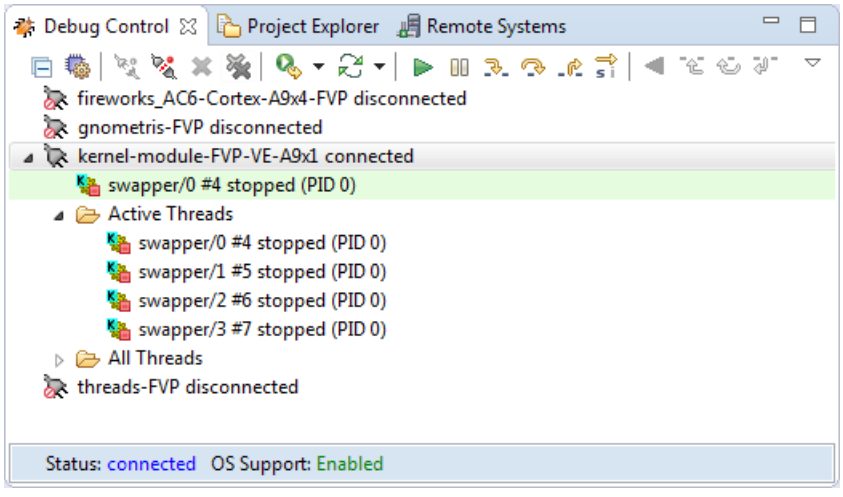


Figure 11-8 Debug Control view

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Collapse All
Collapses all expanded items.

Display Cores/Display Threads
Click to toggle between viewing cores or threads. This option is only active for bare-metal connections with OS awareness enabled.

Connect to Target
Connects to the selected target using the same launch configuration settings as the previous connection.

Disconnect from Target
Disconnects from the selected target.

Remove Connection
Removes the selected target connection from the **Debug Control** view.

Remove All Connections
Removes all target connections from the **Debug Control** view, except any that are connected to the target.

Debug from menu
This menu lists the different actions that you can perform when a connection is established.

Reset menu
This menu lists the different types of reset that are available on your target.

Continue
Continues running the target.

Note

A **Connect only** connection might require setting the PC register to the start of the image before running it.

Interrupt
Interrupts the target and stops the current application.

Step Source Line
Step Instruction
This option depends on the stepping mode selected:
- If source line mode is selected, steps at the source level including stepping into all function calls where there is debug information.
- If instruction mode is selected, steps at the instruction level including stepping into all function calls.

Step Over Source Line
Step Over Instruction
This option depends on the stepping mode selected:
- If source line mode is selected, steps at the source level but stepping over all function calls.
- If instruction mode is selected, steps at the instruction level but stepping over all function calls.

Step Out
Continues running to the next instruction after the selected stack frame finishes.

Stepping by Source Line (press to step by instruction)
Stepping by Instruction (press to step by source line)
Toggles the stepping mode between source line and instruction.

The **Disassembly** view and the source editor view are automatically displayed when you step in instruction mode.

The source editor view is automatically displayed when you step in source line mode. If the target stops in code such as a shared library, and the corresponding source is not available, then the source editor view is not displayed.

Reverse Continue
Continues running backwards through the code.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Reverse Step Source Line
Reverse Step Instruction

This option depends on the stepping mode selected:

- If source line mode is selected, steps backwards at the source level including stepping into all function calls where there is debug information.
- If instruction mode is selected, steps backwards at the instruction level including stepping into all function calls.

Reverse Step Over Source Line
Reverse Step Over Instruction

This option depends on the stepping mode selected:

- If source line mode is selected, steps backwards at the source level but stepping over all function calls.
- If instruction mode is selected, steps backwards at the instruction level but stepping over all function calls.

Reverse Step Out

Continues running backwards to the instruction before the start of the selected stack frame.

Debug Configurations...

Displays the **Debug Configurations** dialog box, with the configuration for the selected connection displayed.

Launch in background

If this option is disabled, the **Progress Information** dialog box is displayed when the application launches.

Show in Stack

Opens the **Stack** view, and displays the stack information for the selected execution context.

Reset DS-5 views to 'Linked'

Resets DS-5 views to link to the selected connection in the **Debug Control** view.

View CPU Caches

Displays the **Cache Data** view for a connected configuration.

View Menu

The following options are available:

Add Configuration (without connecting)...

Displays the **Add Launch Configuration** dialog box. The dialog box lists any configurations that are not already listed in the **Debug Control** view.

Select one or more configurations, then click **OK**. The selected configurations are added to the **Debug Control** view, but remain disconnected.

Load...

Displays a dialog box where you can select whether to load an image, debug information, an image and debug information, or additional debug information. This option might be disabled for targets where this functionality is not supported.

Set Working Directory...

Displays the **Current Working Directory** dialog box. Enter a new location for the current working directory, then click **OK**.

Path Substitution...

Displays the **Path Substitution** and **Edit Substitute Path** dialog box.

Use the **Edit Substitute Path** dialog box to associate the image path with a source file path on the host. Click **OK**. The image and host paths are added to the **Path Substitution** dialog box. Click **OK** when finished.

Threads Presentation

Displays either a flat or hierarchical presentation of the threads in the stack trace.

DTSL options

Opens the **DTSL Configuration Editor** dialog to specify the DTSL options for the target connection.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related concepts

6.8 About debugging multi-threaded applications on page 6-152.
6.10.3 About debugging Linux kernel modules on page 6-158.
6.10.2 About debugging a Linux kernel on page 6-156.
6.9 About debugging shared libraries on page 6-153.

Related references

11.8 Stack view on page 11-282.
11.6 Commands view on page 11-275.
16.2 DS-5 Debug perspective keyboard shortcuts on page 16-496.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.8 Stack view

Use the **Stack** view to display stack information for the currently active connection in the **Debug Control** view. You can view stack information for cores, threads, or processes depending on the selected execution context.

To view stack information:

1. In the **Debug Control** view, right-click the core, thread, or process that you want stack information for, and select **Show in Stack**. This displays the stack information for the selected execution context.

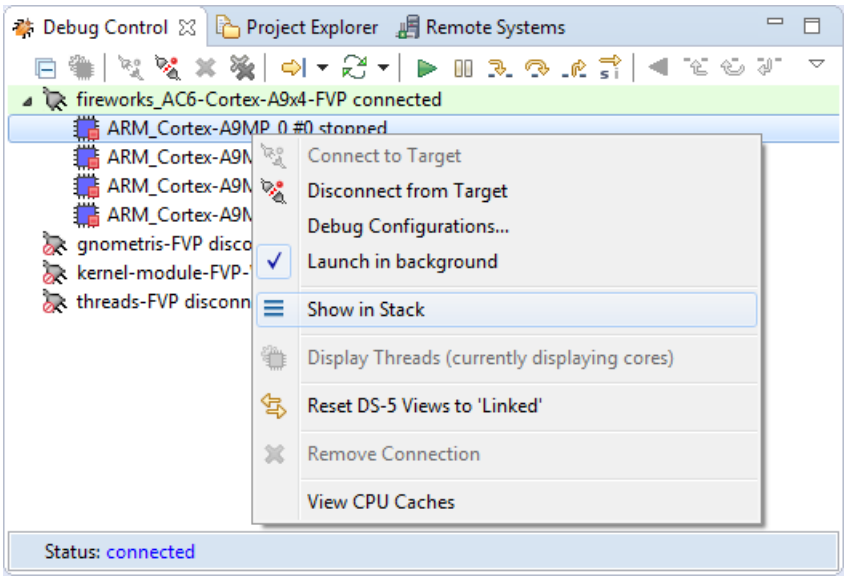


Figure 11-9 Show in Stack option

2. Stack information is gathered when the system is stopped.

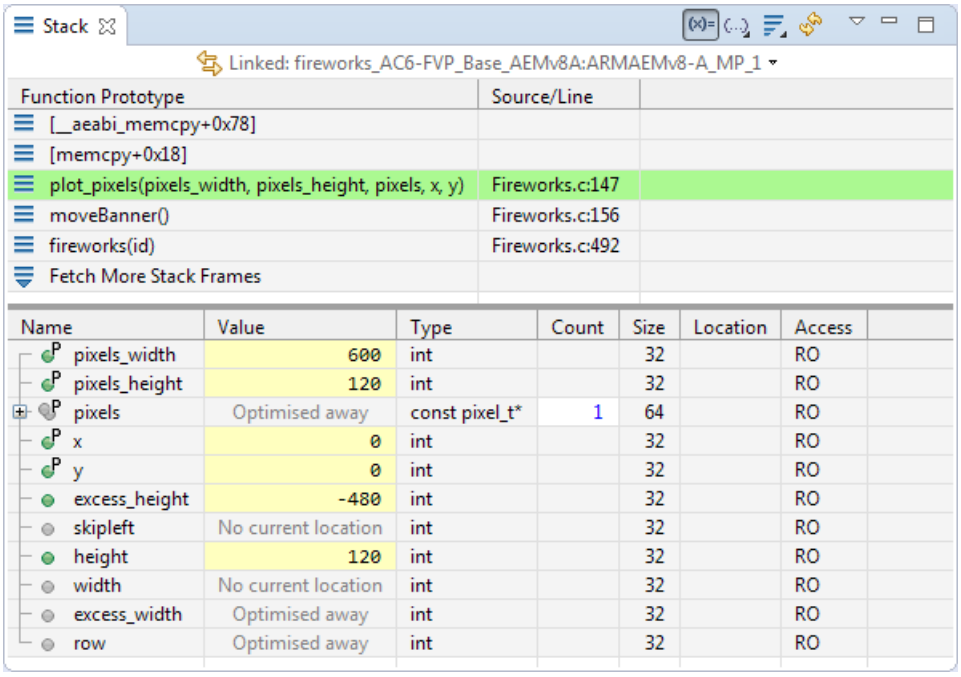


Figure 11-10 Stack view showing information for a selected core

Some of the views in the DS-5 Debug perspective are associated with the currently selected stack frame. Each associated view is synchronized accordingly.

You can also:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Lock Stack view information display to a specific execution context

You can restrict **Stack** view information display to a specific execution context in your current active connection. In the **Stack** view, click **Linked:** ***context*** and select the execution context to lock. For example, in the below figure, **Stack** view is locked to the selected thread.

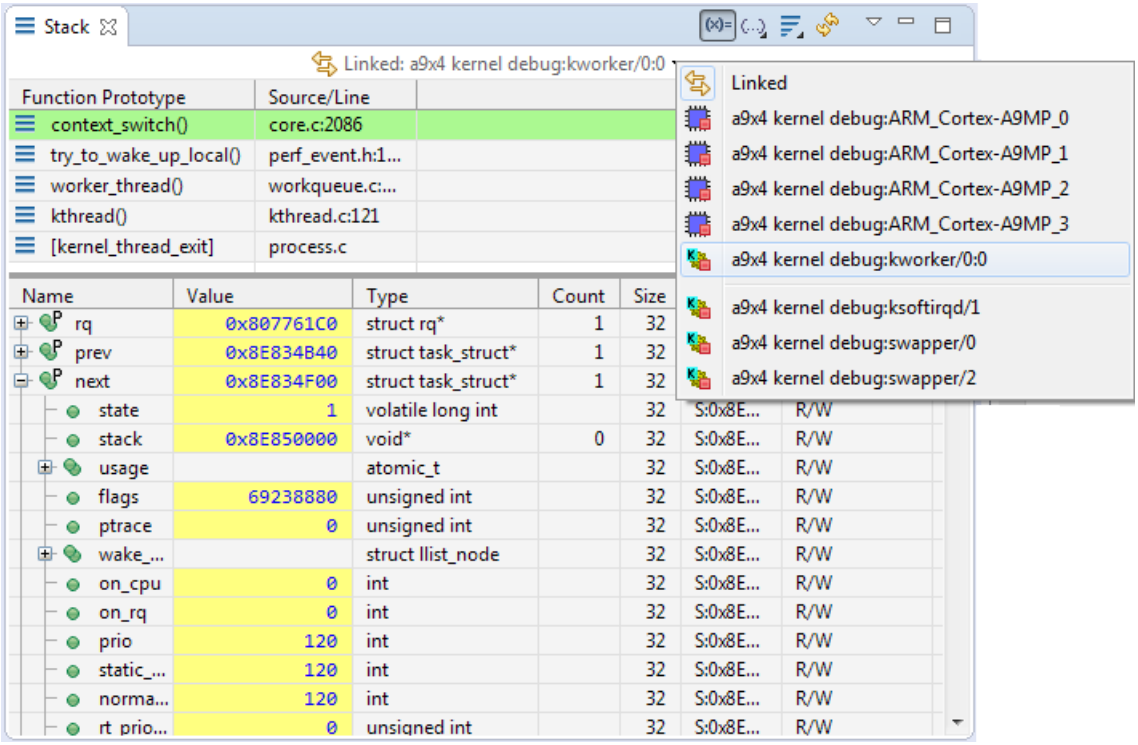


Figure 11-11 Stack view locked to a selected context

Show or hide the Local Variables panel

Click to show or hide the **Local Variables** panel. You can interact with local variables as you would in the **Variables** view. See *11.28 Variables view* on page 11-337 for more information about working with variables.

Set function prototype display options

Click to set the function prototype display options. You can choose to show or hide function parameter types or values.

Note

Displaying a large number of function parameter values might slow the debugger performance.

View more stack frames

To see more stack frames, click **Fetch More Stack Frames** to view the next set of stack frames.

By default, the **Stack** view displays five stack frames, and each additional fetch displays the next five available frames.

To increase the default depth of the stack frames to view, on the **Stack** view menu, click and select the required stack depth. If you need more depth than the listed options, click **Other** and enter the depth you require.

Note

Increasing the number of displayed stack frames might slow the debugger performance.

Refresh the view

To refresh or update the values in the view, click .

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Show in Disassembly
Right-click a stack frame and select **Show in Disassembly** to open the **Disassembly** view and locate the current instruction for that stack frame.

Show in Memory
Right-click a stack frame and select **Show in Memory** to open the **Memory** view and display the memory location used to store that stack frame.

Step Out to This Frame
Right-click a stack frame and select **Step Out to This Frame** to run to the current instruction at the selected stack frame.

Toolbar options

The following **View Menu** options are available:

New Stack View
Displays a new instance of the **Stack** view.

Freeze Data
Freezes data to the currently selected execution context. This works as a toggle.

Update View When Hidden
Updates the view when it is hidden behind other views. By default, this view does not update when hidden.

Related references

11.7 Debug Control view on page 11-278.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.9 Disassembly view

Use the **Disassembly** view to display a disassembly of the code in the running application.

It also enables you to:

- Specify the start address for the disassembly. You can use expressions in this field, for example `$r3`, or drag and drop a register from the **Registers** view into the **Disassembly** view to see the disassembly at the address in that register.
- Select the instruction set for the view.
- Create, delete, enable or disable a breakpoint or watchpoint at a memory location.
- Freeze the selected view to prevent the values being updated by a running target.

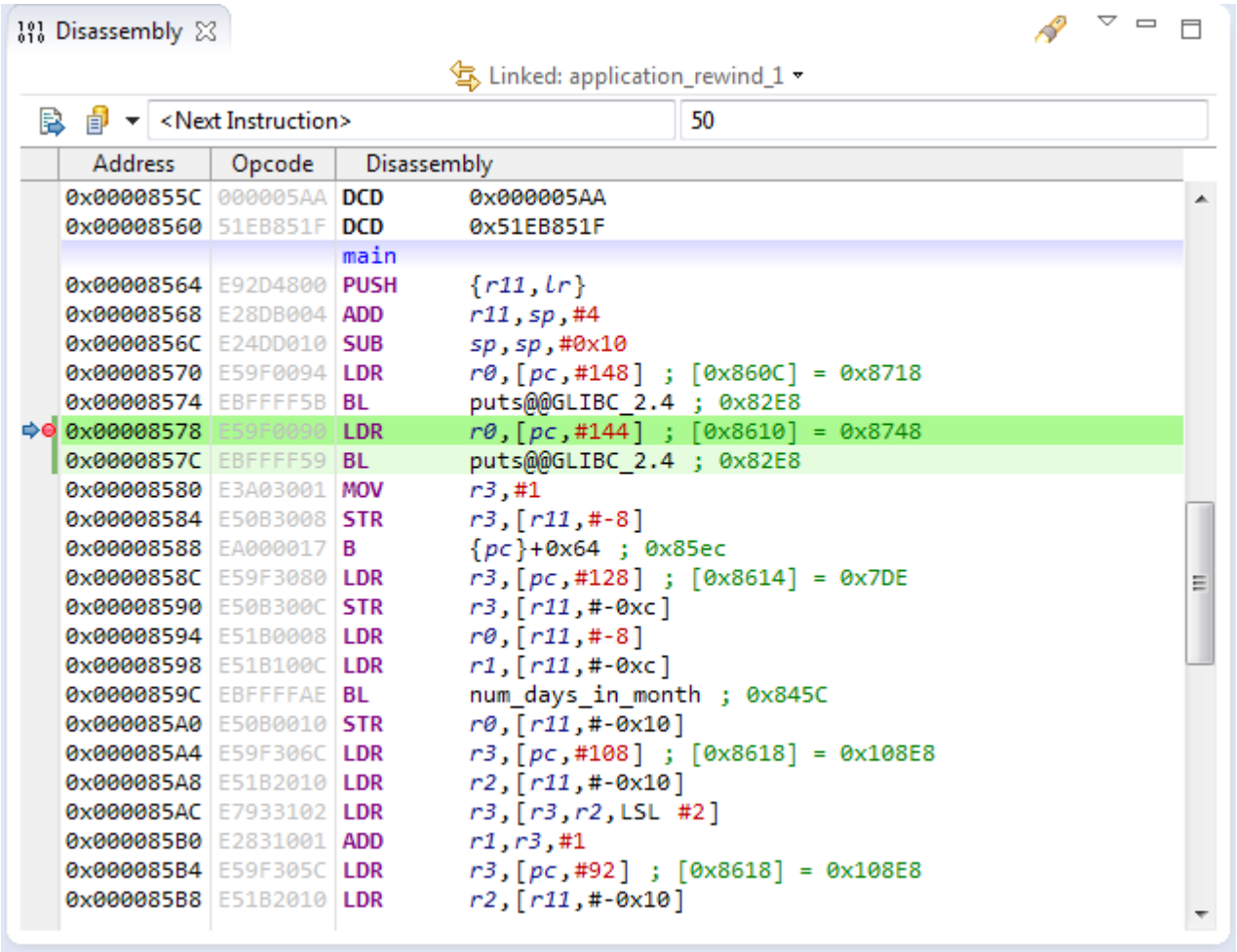


Figure 11-12 Disassembly view

Gradient shading in the **Disassembly** view shows the start of each function.

Solid shading in the **Disassembly** view shows the instruction at the address of the current PC register followed by any related instructions that correspond to the current source line.

In the left-hand margin of the **Disassembly** view you can find a marker bar that displays view markers associated with specific locations in the disassembly code.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

To set a breakpoint, double-click in the marker bar at the position where you want to set the breakpoint. To delete a breakpoint, double-click on the breakpoint marker.

Note

If you have sub-breakpoints to a parent breakpoint then double-clicking on the marker also deletes the related sub-breakpoints.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *`context`*
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Next Instruction
: Shows the disassembly for the instruction at the address of the program counter.

History
: Addresses and expressions you specify in the Address field are added to the drop down box, and persist until you clear the history list or exit Eclipse. If you want to keep an expression for later use, add it to the **Expressions** view.

Address field
: Enter the address for which you want to view the disassembly. You can specify the address as a hex number or as an expression, for example `$PC+256`, `$lr`, or `main`.

  Context menu options are available for editing this field.

Size field
: The number of instructions to display before and after the location specified in the Address field.

  Context menu options are available for editing this field.

Search
: Searches through debug information for symbols.

View Menu
: The following **View Menu** options are available:

  New Disassembly View
  : Displays a new instance of the **Disassembly** view.

  Instruction Set
  : The instruction set to show in the view by default. Select one of the following:

    [Auto]
    : Auto detect the instruction set from the image.

    A32 (ARM)
    : ARM instruction set.

    T32 (Thumb)
    : Thumb instruction set.

    T32EE (ThumbEE)
    : ThumbEE instruction set.

  Byte Order
  : Selects the byte order of the memory. The default is **Auto (LE)**.

  Clear History
  : Clears the list of addresses and expressions in the History drop-down box.

  Update View When Hidden
  : Enables the updating of the view when it is hidden behind other views. By default this view does not update when hidden.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Refresh
Refreshes the view.

Freeze Data
Toggles the freezing of data in the current view. This also disables and enables the Size and Type fields and the **Refresh** option.

Action context menu
When you right-click in the left margin, the corresponding address and instruction is selected and this context menu is displayed. The available options are:

Copy
Copies the selected address.

Paste
Pastes into the Address field the last address that you copied.

Select All
Selects all disassembly in the range specified by the Size field.

If you want to copy the selected lines of disassembly, you cannot use the **Copy** option on this menu. Instead, use the copy keyboard shortcut for your host, Ctrl+C on Windows.

Run to Selection
Runs to the selected address

Set PC to Selection
Sets the PC register to the selected address.

Show in Source
If source code is available:

1. Opens the corresponding source file in the C/C++ source editor view, if necessary.
2. Highlights the line of source associated with the selected address.

Show in Registers
If the memory address corresponds to a register, then displays the **Registers** view with the related register selected.

Show in Functions
If the memory address corresponds to a function, then displays the **Functions** view with the related function selected.

Translate Address <address>
Displays the **MMU** view and translates the selected address.

Toggle Watchpoint
Sets or removes a watchpoint at the selected address.

Toggle Breakpoint
Sets or removes a breakpoint at the selected address.

Toggle Hardware Breakpoint
Sets or removes a hardware breakpoint at the selected address.

Toggle Trace Start Point
Sets or removes a trace start point at the selected address.

Toggle Trace Stop Point
Sets or removes a trace stop point at the selected address.

Toggle Trace Trigger Point
Starts a trace trigger point at the selected address.

Editing context menu options
The following options are available on the context menu when you select the Address field or Size field for editing:

Cut
Copies and deletes the selected text.

Copy
Copies the selected text.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Paste
Pastes text that you previously cut or copied.

Delete
Deletes the selected text.

Select All
Selects all the text.

Related concepts

6.8 About debugging multi-threaded applications on page 6-152.
6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.
6.11 About debugging TrustZone enabled targets on page 6-160.

Related references

3.13 Setting a tracepoint on page 3-89.
3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.
3.12 Pending breakpoints and watchpoints on page 3-87.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.10 Events view

Use the **Events** view to view the output generated by the *System Trace Macrocell* (STM) and *Instruction Trace Macrocell* (ITM) events.

Data is captured from your application when it runs. However, no data appears in the **Events** view until you stop the application.

To stop the target, either click the **Interrupt** icon in the **Debug Control** view, or use the `stop` command in the **Commands** view. When your application stops, any captured logging information is automatically appended to the open views.

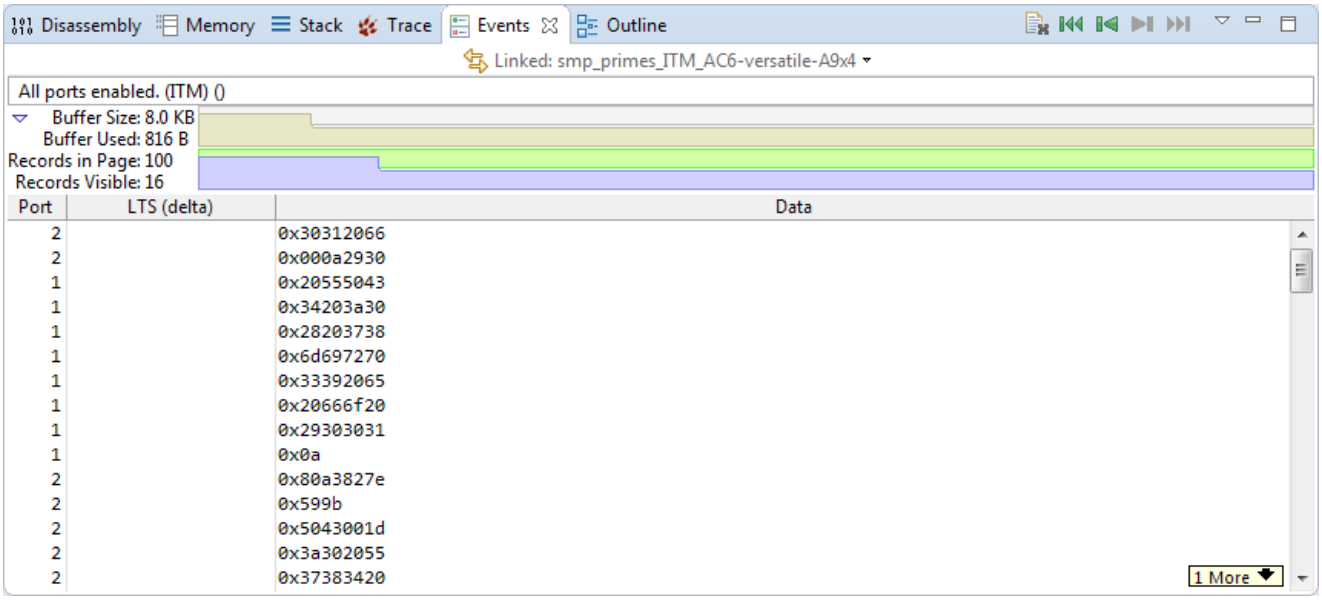


Figure 11-13 Events view (Shown with all ports enabled for an ETB:ITM trace source)

Note

Use the **Event Viewer Settings** dialog to select a **Trace Source** as well as to set up **Ports** (if ITM is the trace source) or **Masters** (if STM is the trace source) to display in the view.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *`context`*
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list, you might have to select it first in the **Debug Control** view.

Clear Trace
: Clears the debug hardware device buffer and all trace sources. The views might retain data, but after clearing trace, refreshing the views clears them as well.

Start of page
: Displays events from the beginning of the trace buffer.

Page back
: Moves one page back in the trace buffer.

Page forward
: Moves one page forward in the trace buffer.

End of page
: Displays events from the end of the trace buffer.

View Menu

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

The following **View Menu** options are available:

New Events View
Displays a new instance of the **Events** view.

Find Global Timestamp...
Displays the **Search by Timestamp** dialog which allows you to search through the entire trace buffer. The search results opens up the page where the timestamp is found and selects the closest timestamp.

Update View When Hidden
Enables the updating of the view when it is hidden behind other views. By default this view does not update when hidden.

Refresh
Refreshes the view.

Freeze Data
Toggles the freezing of data in the current view.

Events Settings...
Displays the **Settings** dialog where you can select a trace source and set options for the selected trace source.

Open Trace Control View
Opens the **Trace Control** view.

DTSL Options...
Opens the ***DTSL Configuration Editor*** on page 11-372 dialog box.

Events context menu

Advance / Go back local timestamp amount
Displays the **Advance / Go back local timestamp** dialog box which allows you to move forward or backward from the current record by a local timestamp amount. A negative number indicates a movement backward. The search moves forward or backward from the current record until the sum of intervening local timestamps is equal to or exceeds the specified value.

Global Timestamps
Timestamps represent the approximate time when events are generated.

Synchronize Timestamps
Synchronizes all **Trace** and **Events** views to display data around the same timestamp.

Set Timestamp Origin
Sets the selected event record as the timestamp origin.

Note

For a given connection, the timestamp origin is global for all **Trace** and **Events** views.

Clear Timestamp Origin
Clears the timestamp origin.

Timestamp Format: Numeric
Sets the timestamp in numeric format. This is the raw timestamp value received from the ITM/STM protocol.

Timestamp Format: (h:m:s)
Sets the timestamp in **hours:minutes:seconds** format.

Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.
11.11 Event Viewer Settings dialog box on page 11-291.

Related information

CoreSight™ Components Technical Reference Manual.
CoreSight™ System Trace Macrocell Technical Reference Manual.
ARMv7-M Architecture Reference Manual Documentation.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.11 Event Viewer Settings dialog box

Use the **Event Viewer Settings** dialog to select a **Trace Source** as well as to set up **Ports** (if ITM is the trace source) or **Masters** (if STM is the trace source) to display in the **Events** view.

General settings

Select a Trace Source
Selects the required trace source from the list.

Height
The number of lines to display per results page. The default is 100 lines.

Width
The number of characters to display per line. The default is 80 characters.

Import
Imports an existing **Event Viewer Settings** configuration file. This file contains details about the **Trace Source** and **Ports** (in the case of ITM trace) or **Masters** and **Channels** (in the case of STM trace) used to create the configuration.

Export
Exports the currently displayed **Event Viewer Settings** configuration to use with a different **Events** view.

OK
Reorganizes the current channels into a canonical form, saves the settings, and closes the dialog box.

Cancel
Enables you to cancel unsaved changes.

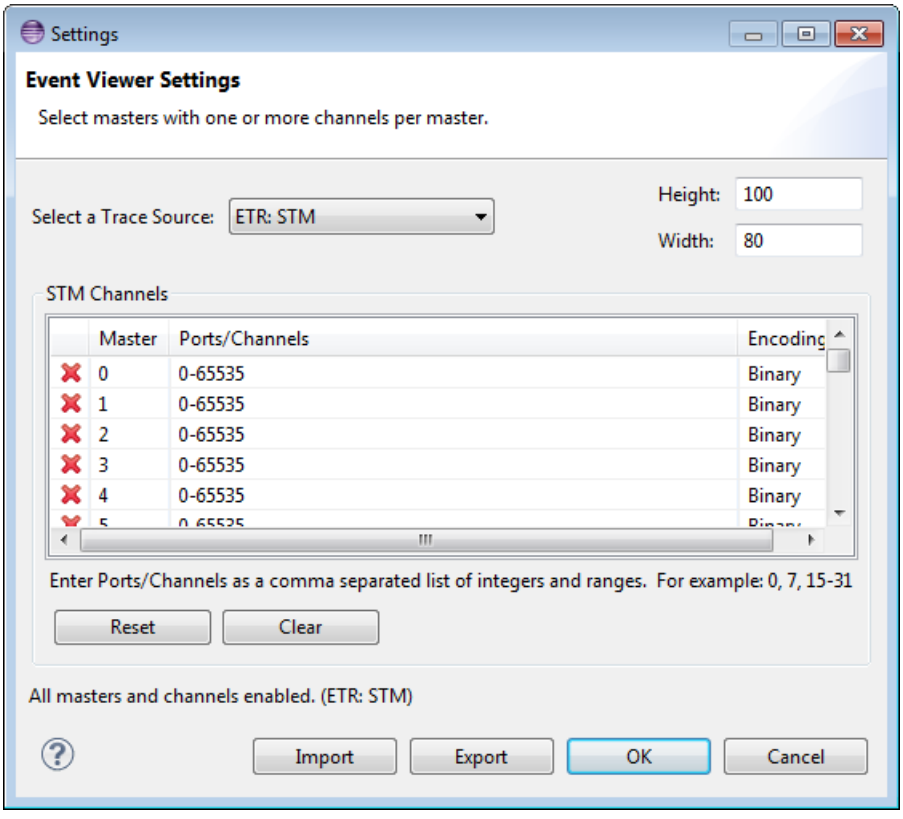


Figure 11-14 Event Viewer Settings (Shown with all Masters and Channels enabled for an ETR:STM trace source)

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

For ITM trace sources

Ports
Click to add or delete a **Port**.

Encoding
Select the type of encoding you want for the data associated with the port. The options available are **Binary**, **Text**, and **TAE**.

Reset
Click **Reset** to display and enable all available **Ports** for the selected ITM trace source.

Note

This clears any custom settings.

Clear
Click to clear all **Ports**.

Show local timestamps
Select to display local timestamps. Local timestamps are expressed as an interval since the last local timestamp. Local timestamps are available for CoreSight ITM trace and M-profile ITM trace.

Show global timestamps (M-profile only)
Select to display global timestamps. Global timestamps are expressed as a 48-bit or 64-bit counter value.

Show event counter wrapping (M-profile only)
Select to display event counter wrapping packets from the M-profile *Data Watchpoint and Trace* (DWT) unit.

Show exception tracing (M-profile only)
Select to display exception trace packets from the M-profile DWT unit.

Show PC sampling (M-profile only)
Select to display PC sampling packets from the M-profile DWT unit.

Show data tracing (M-profile only)
Select to display data trace packets from the M-profile DWT unit.

For STM trace sources

Masters
Click to add or delete **Masters** and **Channels** that you want to display in the **Events** view.

Note

Masters are only available for STM trace.

Encoding
Select the type of encoding you want for the data associated with the channels. The options available are **Binary** and **Text**.

Reset
Click **Reset** to display and enable all available **Masters** and **Channels** for the selected STM trace source.

Note

This clears any custom settings.

Clear
Click to clear all **Masters** and **Channels**.

Related references

11.10 Events view on page 11-289.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related information

CoreSight™ Components Technical Reference Manual.

CoreSight™ System Trace Macrocell Technical Reference Manual.

ARMv7-M Architecture Reference Manual Documentation.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.12 Expressions view

Use the **Expressions** view to create and work with expressions.

(x)= Variables | Breakpoints | Registers | Expressions | f() Functions

Linked: kernel-module-FVP-VE-A9x1

Name	Value	Type	Count	Size	Location	Acc
(struct thread_info*)($SP_SVC & ~0x1FFF)	2152669184	struct thread_info*	1	32		RO
flags	0	long unsigned int		32	S:0x804F2000	R/W
preempt_count	0	int		32	S:0x804F2004	R/W
addr_limit	0	mm_segment_t		32	S:0x804F2008	R/W
task	2152762776	struct task_struct*	1	32	S:0x804F200C	R/W
exec_domain	2152776764	struct exec_domain*	1	32	S:0x804F2010	R/W
cpu	0	__u32		32	S:0x804F2014	R/W
cpu_domain	21	__u32		32	S:0x804F2018	R/W
cpu_context		struct cpu_context_save		384	S:0x804F201C	R/W
syscall	0	__u32		32	S:0x804F204C	R/W
used_cp	""	__u8[]	16	128	S:0x804F2050	R/W
tp_value	0	long unsigned int		32	S:0x804F2060	R/W
crunchstate		struct crunch_state		1472	S:0x804F2064	R/W
fpstate		union fp_state		1120	S:0x804F2120	R/W
vfpstate		union vfp_state		2240	S:0x804F21B0	R/W
restart_block		struct restart_block		320	S:0x804F22C8	R/W

Figure 11-15 Expressions view

You can:

Add expressions

Enter your expression in the **Enter new expression here** field and press Enter on your keyboard. This adds the expression to the view and displays its value.

Note

If your expression contains side-effects when evaluating the expression, the results are unpredictable. Side-effects occur when the state of one or more inputs to the expression changes when the expression is evaluated.

For example, instead of `x++` or `x+=1` you must use `x+1`.

Edit expressions

You can edit the values of expressions in the **Value** field. Select the value and edit it.

Delete expressions

In the **Expressions** view, select the expression you want to remove from view, and click to remove the selected expression. If you want to remove all expressions, click .

Tip

You can also use the **Delete** key on your keyboard to delete the currently selected expression.

Refresh view

To refresh or update the values in the view, click .

Toggle between numerical and hexadecimal values

Click the 0x button to change all numeric values to hexadecimal values. This works as a toggle and your preference is saved across sessions.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Example 11-1 Expression examples

When debugging the Linux kernel, to view its internal thread structure, use these expressions:

For ARMv7 in SVC mode, with 8K stack size:

```
(struct thread_info*)($SP_SVC & ~0x1FFF)
```

For ARMv8 AArch64 in EL1, with 16K stack size:

```
(struct thread_info*)($SP_EL1 & ~0x3FFF)
```

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *`context`*
Links this view to the selected connection in the Debug Control view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Remove Selected Expression
Removes the selected expression from the list.

Remove All Expressions
Removes all expressions from the list.

Cut
Copies and removes the selected expression.

Copy
Copies the selected expression.

To copy an expression for use in the **Disassembly** view or **Memory** view, first select the expression in the **Name** field.

Paste
Pastes expressions that you have previously cut or copied.

Delete
Deletes the selected expression.

Select All
Selects all expressions.

Show in Registers
If the expression corresponds to a register, this displays the **Registers** view with that register selected.

Show in Memory
Where enabled, this displays the **Memory** view with the address set to either:

- The value of the selected expression, if the value translates to an address, for example the address of an array, `&name`
- The location of the expression, for example the name of an array, `name`.

The memory size is set to the size of the expression, using the **`sizeof`** keyword.

Show Dereference in Memory
If the selected expression is a pointer, this displays the **Memory** view with the address set to the value of the expression.

Show in Disassembly
Where enabled, this displays the **Disassembly** view with the address set to the location of the expression.

Show Dereference in Disassembly
If the selected expression is a pointer, this displays the **Disassembly** view, with the address set to the value of the expression.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Translate Variable Address
Displays the **MMU** view and translates the address of the variable.

Toggle Watchpoint
Displays the **Add Watchpoint** dialog to set a watchpoint on the selected variable, or removes the watchpoint if one has been set.

Enable Watchpoint
Enables the watchpoint, if a watchpoint has been set on the selected variable.

Disable Watchpoint
Disables the watchpoint, if a watchpoint has been set on the selected variable.

Resolve Watchpoint
If a watchpoint has been set on the selected variable, this re-evaluates the address of the watchpoint. If the address can be resolved the watchpoint is set, otherwise it remains pending.

Watchpoint Properties
Displays the **Watchpoint Properties** dialog box. This enables you to control watchpoint activation.

Send to
Enables you to add register filters to an **Expressions** view. Displays a sub menu that enables you to add to a specific **Expressions** view.

<Format list>
A list of formats you can use for the expression value.

View Menu
The following **View Menu** options are available:

New Expressions View
Displays a new instance of the **Expressions** view.

Update View When Hidden
Enables the updating of the view when it is hidden behind other views. By default, this view does not update when hidden.

Freeze Data
Toggles the freezing of data in the current view. This also disables and enables the **Refresh** option.

Adding a new column header

Right-click on the column headers to select the columns that you want displayed:

Name
An expression that resolves to an address, such as `main+1024`, or a register, for example `$R1`.

Value
The value of the expression. You can modify a value that has a white background. A yellow background indicates that the value has changed. This might result from you either performing a debug action such as stepping or by you editing the value directly.

If you freeze the view, then you cannot change a value.

Type
The type associated with the value at the address identified by the expression.

Count
The number of array or pointer elements. You can edit a pointer element count.

Size
The size of the expression in bits.

Location
The address in hexadecimal identified by the expression, or the name of a register, if the expression contains only a single register name.

Access
The access type of the expression.

All columns are displayed by default.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

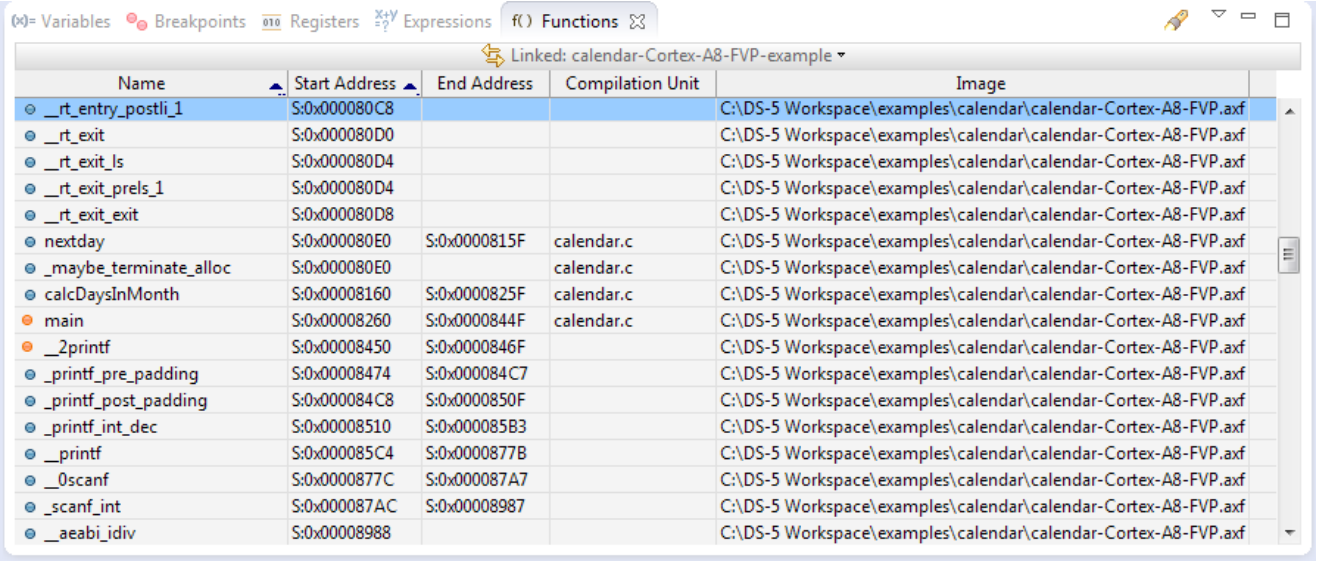
Related references

3.13 Setting a tracepoint on page 3-89.
3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.
3.12 Pending breakpoints and watchpoints on page 3-87.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.13 Functions view

Use the **Functions** view to display the ELF data associated with function symbols for the loaded images. You can freeze the view to prevent the information being updated by a running target.



Name	Start Address	End Address	Compilation Unit	Image
__rt_entry_postli_1	S:0x000080C8			C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
__rt_exit	S:0x000080D0			C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
__rt_exit_ls	S:0x000080D4			C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
__rt_exit_prels_1	S:0x000080D4			C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
__rt_exit_exit	S:0x000080D8			C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
nextday	S:0x000080E0	S:0x0000815F	calendar.c	C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
_maybe_terminate_alloc	S:0x000080E0		calendar.c	C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
calcDaysInMonth	S:0x00008160	S:0x0000825F	calendar.c	C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
main	S:0x00008260	S:0x0000844F	calendar.c	C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
__2printf	S:0x00008450	S:0x0000846F		C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
_printf_pre_padding	S:0x00008474	S:0x000084C7		C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
_printf_post_padding	S:0x000084C8	S:0x0000850F		C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
_printf_int_dec	S:0x00008510	S:0x000085B3		C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
__printf	S:0x000085C4	S:0x0000877B		C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
__0scanf	S:0x0000877C	S:0x000087A7		C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
_scanf_int	S:0x000087AC	S:0x00008987		C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf
__aeabi_idiv	S:0x00008988			C:\DS-5 Workspace\examples\calendar\calendar-Cortex-A8-FVP.axf

Figure 11-16 Functions view

Right-click on the column headers to select the columns that you want displayed:

Name
The name of the function.

Mangled Name
The C++ mangled name of the function.

Base Address
The function entry point.

Start Address
The start address of the function.

End Address
The end address of the function.

Size
The size of the function in bytes.

Compilation Unit
The name of the compilation unit containing the function.

Image
The location of the ELF image containing the function.

Show All Columns
Displays all columns.

Reset Columns
Resets the columns displayed and their widths to the default. The `Name`, `Start Address`, `End Address`, `Compilation Unit`, and `Image` columns are displayed by default.

In the **Functions** view, the functions are represented as:

Table 11-1 Function icons

Icon	Description	Icon	Description
	Function		Function with a breakpoint set
	Static function		Static function with a breakpoint set

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *context*
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Search
: Searches the data in the current view for a function.

Copy
: Copies the selected functions.

Select All
: Selects all the functions in the view.

Run to Selection
: Runs to the selected address.

Set PC to Selection
: Sets the PC register to the start address of the selected function.

Show in Source
: If source code is available:
1. Opens the corresponding source file in the C/C++ editor view, if necessary.
2. Highlights the line of source associated with the selected address.

Show in Memory
: Displays the **Memory** view starting at the address of the selected function.

Show in Disassembly
: Displays the **Disassembly** view starting at the address of the selected function.

Toggle Breakpoint
: Sets or removes a breakpoint at the selected address.

Toggle Hardware Breakpoint
: Sets or removes a hardware breakpoint at the selected address.

Toggle Trace Start Point
: Sets or removes a trace start point at the selected address.

Toggle Trace Stop Point
: Sets or removes a trace stop point at the selected address.

Toggle Trace Trigger Point
: Starts a trace trigger point at the selected address.

View Menu
: The following **View Menu** options are available:

  New Functions View
  : Displays a new instance of the **Functions** view.

  Update View When Hidden
  : Enables the updating of the view when it is hidden behind other views. By default this view does not update when hidden.

  Refresh
  : Refreshes the view.

  Freeze Data
  : Toggles the freezing of data in the current view. This also disables or enables the **Refresh** option.

  Filters...
  : Displays the Functions Filter dialog box. This enables you to filter the functions displayed in the view.

Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.14 History view

Use the **History** view to display a list of the commands generated during the current debug session.

It also enables you to:

- Clear its contents.
- Select commands and save them as a script file. You can add the script file to your favorites list when you click **Save**. Favorites are displayed in the **Scripts** view.
- Enable or disable the automatic scrolling of messages.

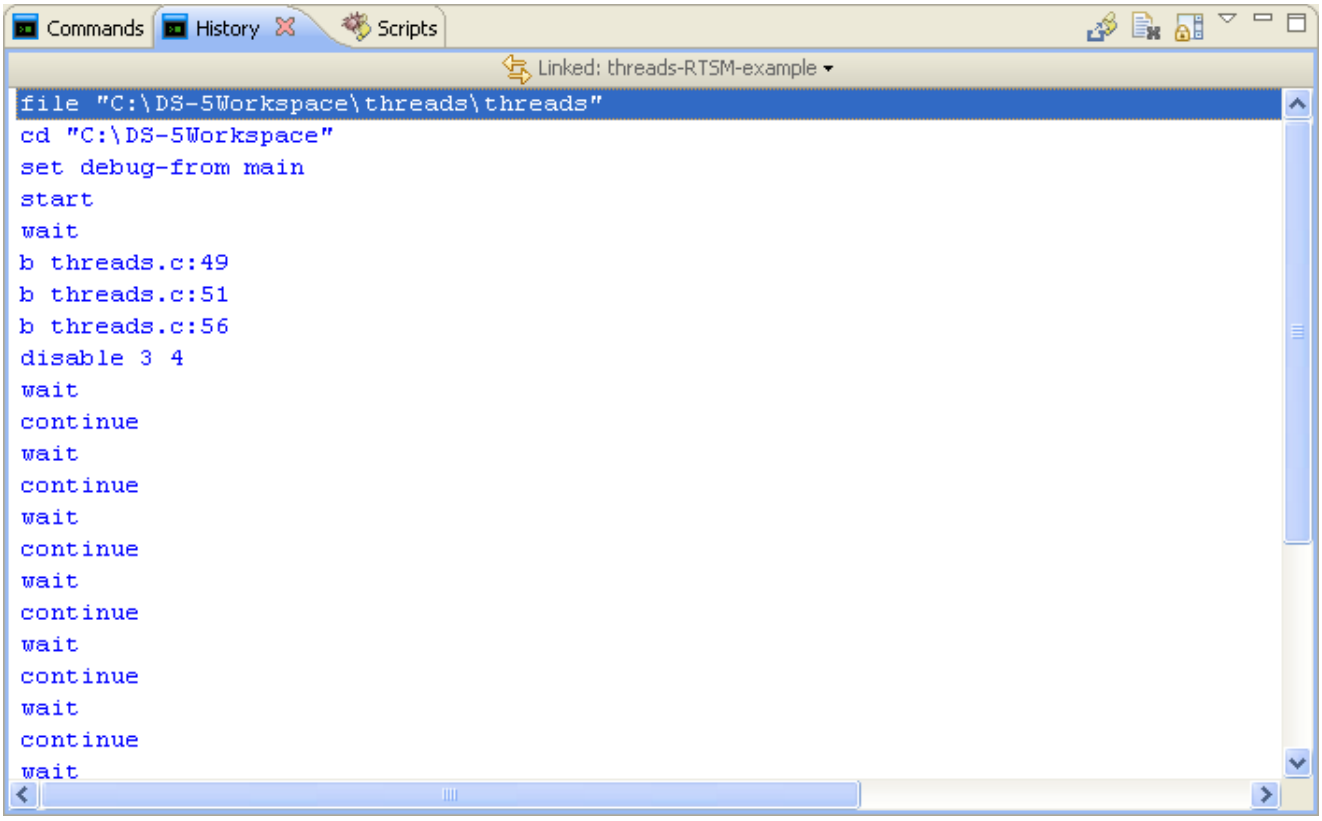


Figure 11-17 History view

Note

Default settings for this view are controlled by a DS-5 Debugger setting in the Preferences dialog box. For example, the default location for script files. You can access these settings by selecting **Preferences** from the **Window** menu.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *`context`*

Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Exports the selected lines as a script
Displays the Save As dialog box to save the selected commands to a script file.

When you click **Save** on the Save As dialog box, you are given the option to add the script file to your favorites list. Click **OK** to add the script to your favorites list. Favorites are displayed in the **Scripts** view.

Clear Console
Clears the contents of the **History** view.

Toggles Scroll Lock
Enables or disables the automatic scrolling of messages in the **History** view.

Copy
Copies the selected commands.

Select All
Selects all commands.

Save selected lines as a script...
Displays the Save As dialog box to save the selected commands to a script file.

When you click **Save** on the Save As dialog box, you are given the option to add the script file to your favorites list. Click **OK** to add the script to your favorites list. Favorites are displayed in the **Scripts** view.

Execute selected lines
Runs the selected commands.

New History View
Displays a new instance of the **History** view.

Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.15 Memory view

Use the **Memory** view to display and modify the contents of memory.

This view enables you to:

- Specify the start address for the view, either as an absolute address or as an expression, for example `$pc+256`. You can also specify an address held in a register by dragging and dropping the register from the **Registers** view into the **Memory** view.
- Specify the display size of the **Memory** view in bytes, as an offset value from the start address.
- Specify the format of the memory cell values. The default is hexadecimal.
- Set the width of the memory cells in the **Memory** view. The default is 4 bytes.
- Display the ASCII character equivalent of the memory values.
- Freeze the view to prevent it from being updated by a running target.

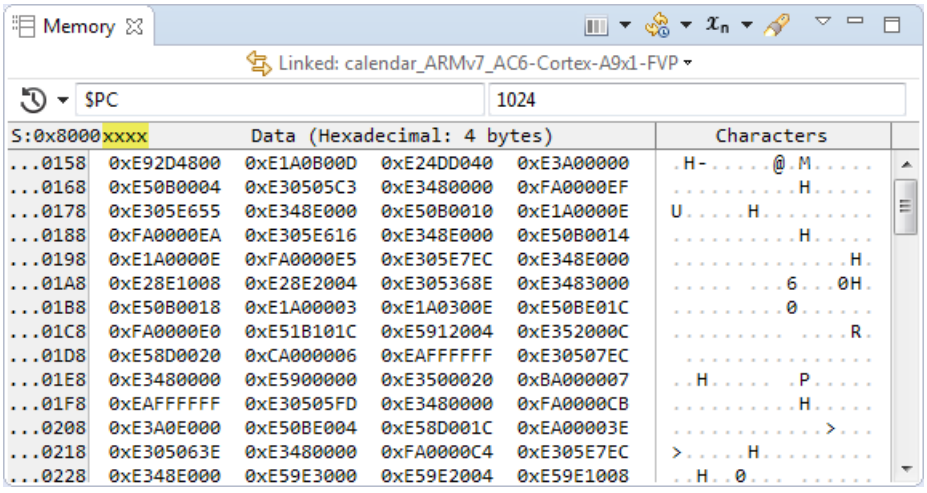


Figure 11-18 Memory view

The **Memory** view only provides the facility to modify how memory is displayed in this view. It does not enable you to change the access width for the memory region. To control the memory access width, you can use:

- The *`memory`* command to configure access widths for a region of memory, followed by the `x` command to read memory according to those access widths and display the contents.
- The *`memory set`* command to write to memory with an explicit access width.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *`context`*

Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

History

Addresses and expressions you specify in the **Address** field are added to the list, and persist until you clear the history list. If you want to keep an expression for later use, add it to the **Expressions** view.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Number of columns

The options enable you to resize the number of columns shown in the **Memory** view.
Fit to view - Select to resize the number of columns automatically.
2, 4, 8, 16 - Select the number of columns to display in the **Memory** view in a 2, 4, 8, or 16-column layout.
Custom - Select and specify the custom column layout you require.
To specify these values as default, set them under **Window** > **Preferences** > **DS-5** > **Debugger** > **Memory View**.

Timed auto refresh

Use the **Timed Auto-Refresh** option to specify an auto-refresh of the values in the view.
Start - Starts the timed auto-refresh.
Stop - Stops the timed auto-refresh.
Update Interval - Specifies the auto refresh interval in seconds.
Update When - Specifies when to refresh the view:

- **Running** - Refreshes the view only while the target is running.
- **Stopped** - Refreshes the view only while the target is stopped.
- **Always** - Always refreshes the view.

Note

When you select `Running` or `Always`, the **Memory** and **Screen** views are only updated if the target supports access to that memory when running. For example, some CoreSight targets support access to physical memory at any time through the *Debug Access Port* (DAP) to the *Advanced High-performance Bus Access Port* (AHB-AP) bridge. In those cases, add the `AHB:` prefix to the address selected in the **Memory** or **Screen** views. This type of access bypasses any cache on the processor core, so the memory content returned might be different to the value that the core reads.

Properties - Displays the *Timed Auto-Refresh Properties* on page 11-343 dialog box where you can specify these options as default.

Format

Click to cycle through the memory cell formats and cell widths, or select a format from the drop-down menu. The default is hexadecimal with a display width of 4 bytes.

Use the **Hide Base Prefix** option to hide base prefixes where applicable.

For example:

- For hexadecimal values, this option hides the preceding **0x**. So the value **0xEA000016** is shown as **EA000016**.
- For binary values, this option hides the preceding **0b**. So the value **0b00010110** is shown as **00010110**.
- For octal values, this option hides the preceding **0**. So the value **035200000026** is shown as **35200000026**.

Search

Searches through debug information for symbols.

Address field

Enter the address where you want to start viewing the target memory. Alternatively, you can enter an expression that evaluates to an address.

Addresses and expressions you specify are added to the drop-down history list, and persist until you clear the view history. If you want to keep an expression for later use, add it to the **Expressions** view.

Size field

The number of bytes to display.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

View Menu

The following **View Menu** options are available:

New Memory View
Displays a new instance of the **Memory** view.

Show Tooltips
Toggles the display of tooltips on memory cell values.

Auto Alignment
Aligns the memory view to the currently selected data width.

Show Compressed Addresses
Shows the least significant bytes of the address that are not repeating.

Show Cache
Shows how the core views the memory from the perspective of the different caches on the target. This is disabled by default. When showing cache, the view is auto-aligned to the cache-line size. When showing cache, the memory view shows a column for each cache. If populated, the cache columns display the state of each cache using the Modified/Owned/Exclusive/Shared/Invalid (MOESI) cache coherency protocol notation.
Click on a cache column header or select a cache from the **Cache Data** menu to display the data as viewed from that cache. The `Memory (non-cached)` option from the **Cache Data** menu shows the data in memory, as if all caches are disabled.

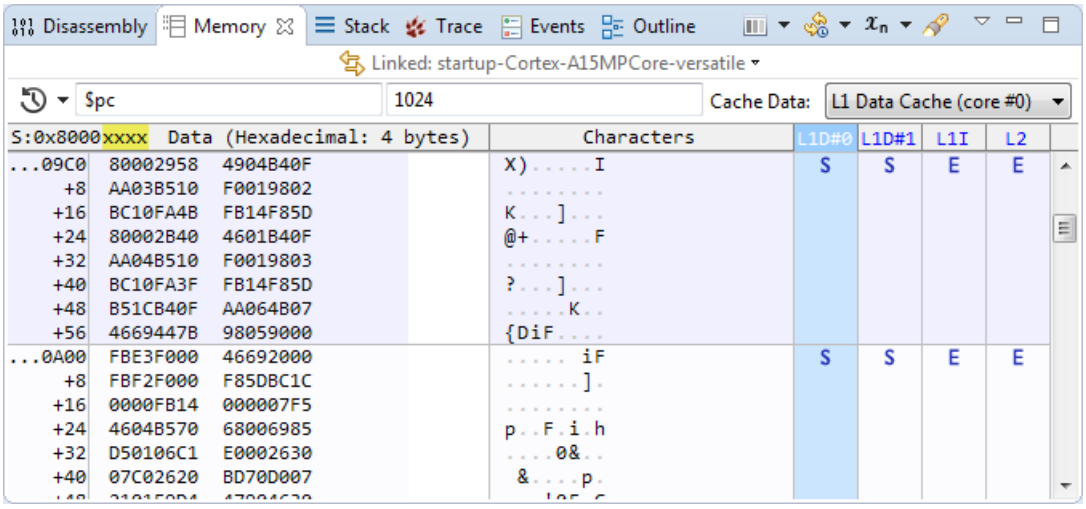


Figure 11-19 Memory view with Show Cache option enabled

Note

In multiprocessor systems, it is common to have caches dedicated to particular cores. For example, a dual-core system might have per-core L1 caches, but share a single L2 cache. Cache snooping is a hardware feature that allows per-core caches to be accessed from other cores. In such cases the **Cache Data** field shows all the caches that are accessible to each core, whether directly or through snooping.

Byte Order
Selects the byte order of the memory. The default is **Auto (LE)**.

Clear History
Clears the list of addresses and expressions in the **History** drop-down list.

Import Memory
Reads data from a file and writes it to memory.

Export Memory
Reads data from memory and writes it to a file.

Fill Memory
Writes a specific pattern of bytes to memory

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Update View When Hidden
Enables the updating of the view when it is hidden behind other views. By default, this view does not update when hidden.

Refresh
Refreshes the view.

Freeze Data
Toggles the freezing of data in the current view. This also disables or enables the **Address** and **Size** fields and the **Refresh** option.

Editing context menu options
The context menu of the column header enables you to toggle the display of the individual columns.

Reset Columns
Displays the default columns.

Characters
Displays the **Characters** column.

The following options are available on the context menu when you select a memory cell value, the **Address** field, or the **Size** field for editing:

Cut
Copies and deletes the selected value.

Copy
Copies the selected value.

Paste
Pastes a value that you have previously cut or copied into the selected memory cell or field.

Delete
Deletes the selected value.

Select All
Selects all the addresses.

The following additional options are available on the context menu when you select a memory cell value:

Toggle Watchpoint
Sets or removes a watchpoint at the selected address. After a watchpoint is set, you can:
- **Enable Watchpoint** - If disabled, enables the watchpoint at the selected address.
- **Disable Watchpoint** - Disables the watchpoint at the selected address.
- **Remove Watchpoint** - Removes the watchpoint at the selected address.
- **Watchpoint Properties** - Displays and lets you change the watchpoint properties.

Translate Address <address>
Displays the **MMU** view and translates the address of the selected value in memory.

Memory view default preferences

You can specify default preferences to apply to the **Memory** view. Specifying default options ensure that your preferences are applied across all debug connections.

To specify default options for the **Memory** view, set them under **Window** > **Preferences** > **DS-5** > **Debugger** > **Memory View**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

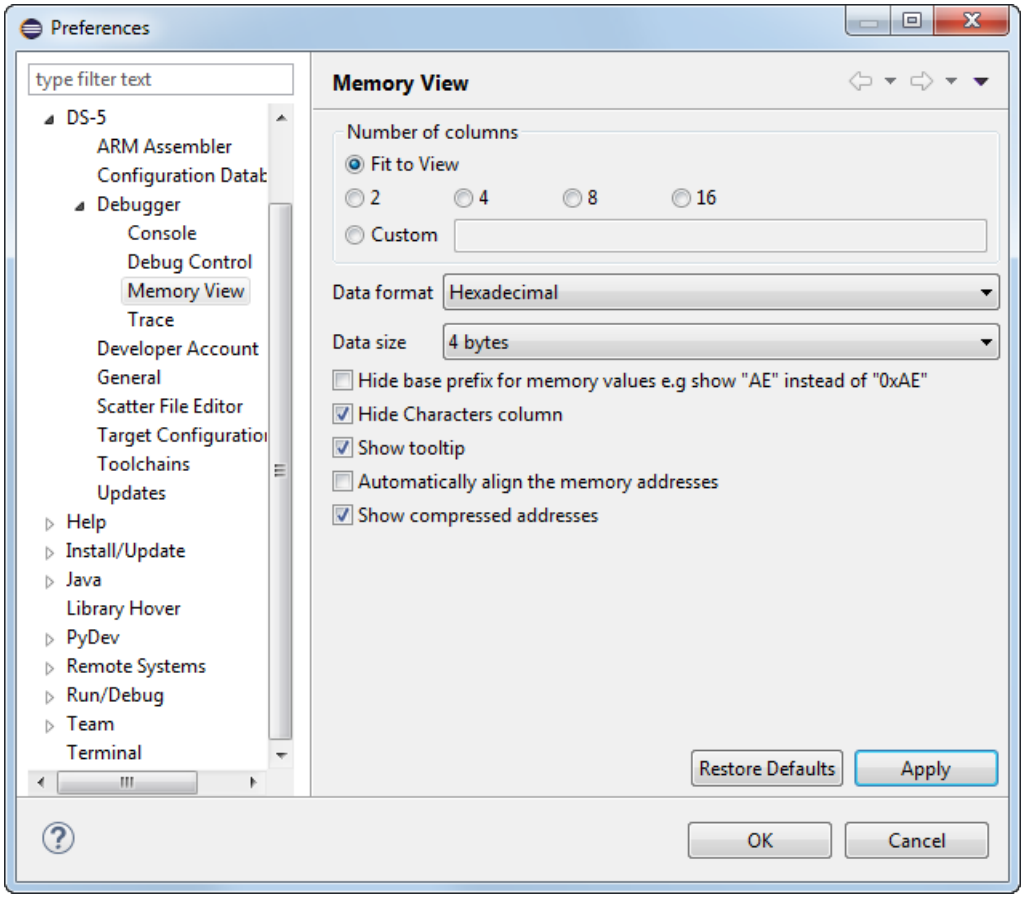


Figure 11-20 Memory view preferences

Number of columns

The options enable you to resize the number of columns shown in the **Memory** view.

Fit to view - Select to resize the number of columns automatically.

2, 4, 8, 16 - Select the number of columns to display in the **Memory** view in a 2, 4, 8, or 16-column layout.

Custom - Select and specify the custom column layout you require.

Data format

Specify the format of the memory cell values. The default is hexadecimal.

Data size

Set the width of the memory cells in the **Memory** view. The default is 4 bytes.

Hide base prefix for memory values

Select to hide the base prefix where applicable.

For example:

- For hexadecimal values, this option hides the preceding **0x**. So the value **0xEA000016** is shown as **EA000016**.
- For binary values, this option hides the preceding **0b**. So the value **0b00010110** is shown as **00010110**.
- For octal values, this option hides the preceding **0**. So the value **035200000026** is shown as **35200000026**.

Hide Characters column

Select to the hide the **Characters** column in the **Memory** view.

Show tooltip

Select to control the display of tooltips on memory cell values.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Automatically align the memory addresses
Aligns the memory view to the currently selected data width.

Show compressed addresses
Shows the least significant bytes of the address that are not repeating.

Related concepts

6.8 About debugging multi-threaded applications on page 6-152.
6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.
6.11 About debugging TrustZone enabled targets on page 6-160.

Related references

3.13 Setting a tracepoint on page 3-89.
3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.
3.12 Pending breakpoints and watchpoints on page 3-87.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.16 MMU view

Use the **MMU** view to perform address translations or for an overview of the translation tables and virtual memory map.

This view enables you to:

- Perform simple virtual to physical address translation.
- Perform simple physical to virtual address translation.
- Perform MMU page table walks.
- See an overview of the virtual memory map.
- Freeze the view to prevent it from being updated by a running target.

MMU Translation tab

The **Translation** tab enables you to translate:

- Virtual address to physical address.
- Physical address to one or more virtual addresses.

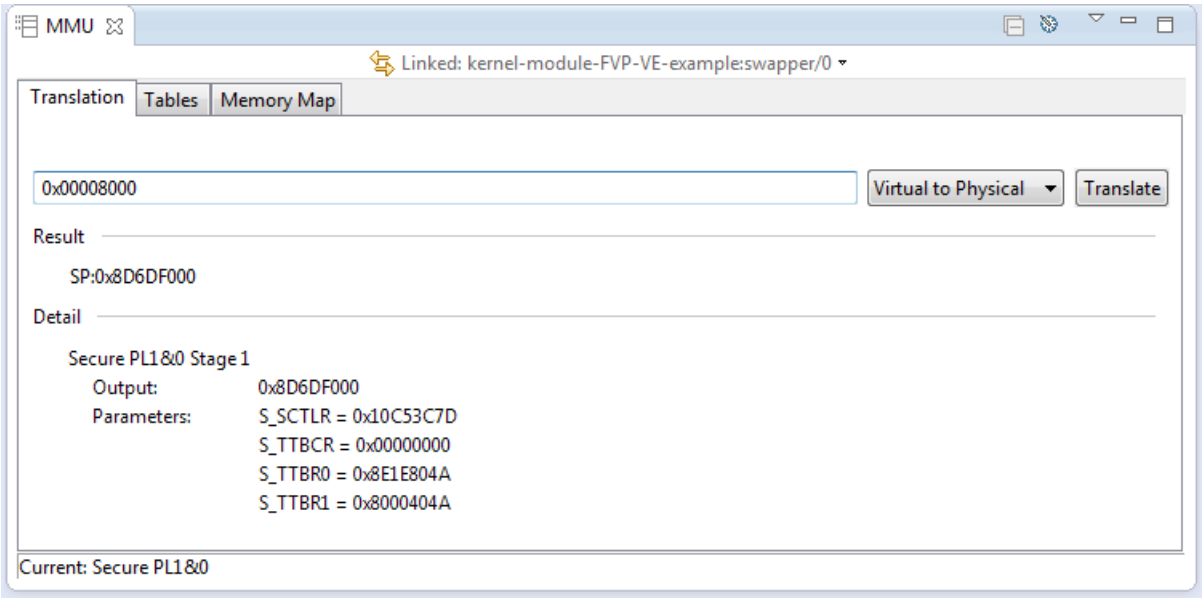


Figure 11-21 MMU Translation tab view

To perform an address translation in the **Translation** tab:

1. Enter a physical or virtual address in the address field. You can also enter an expression that evaluates to an address.
2. Select **Physical to Virtual** or **Virtual to Physical** depending on the translation type.
3. Click **Translate** to perform the address translation.

The **Result** shows the output address after the translation. The view also shows the details of the translation regime and parameters. You can customize these parameters using the **MMU Settings** dialog.

MMU Tables tab

Use the Tables tab to see the translation tables used by the selected translation regime. You can change the translation regime using the **MMU Settings** dialog.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

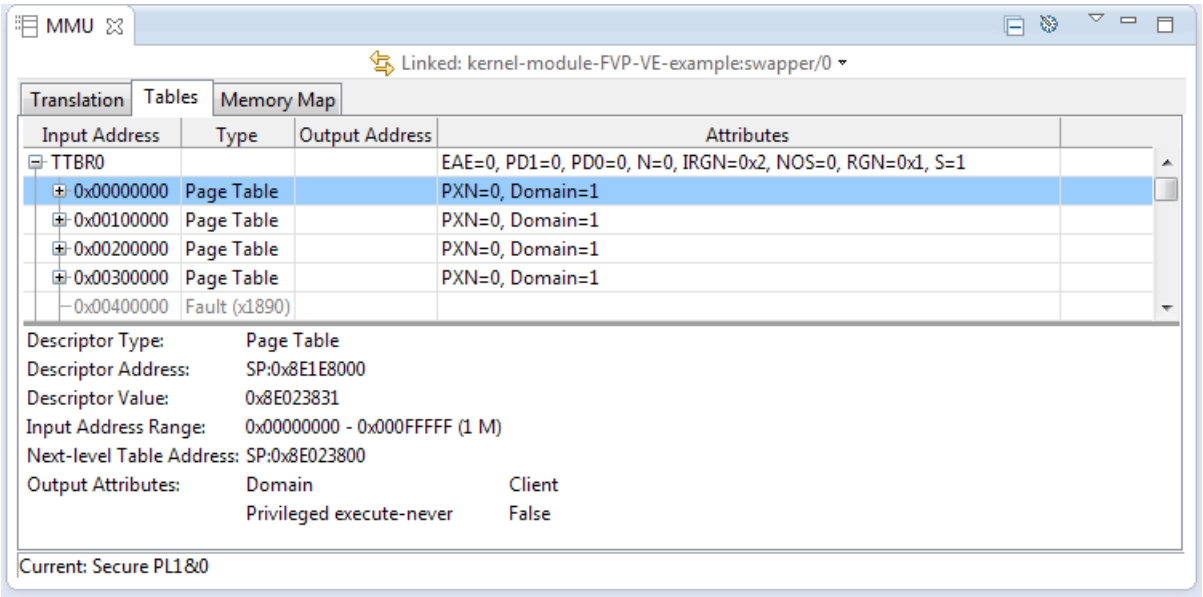


Figure 11-22 MMU Tables tab view

The **Tables** tab contains the following columns:

Input Address
Specifies the input address to the translation table. This is usually the virtual address, but it can also be an intermediate physical address.

Type
Specifies the type of entry in the translation table, for example Page Table, Section, Super Section, Small Page, or Large Page.

Output Address
Specifies the output address from the translation table. This is usually the physical address, but it can also be an intermediate physical address.

Attributes
Specifies the memory attributes for the memory region.

The Tables tab also provides additional information for each row of the translation table:

Descriptor Address
Specifies the address of the selected translation table location.

Descriptor Value
Specifies the content of the selected translation table location.

Input Address Range
Specifies the range of input addresses that are mapped by the selected translation table location.

Next-level Table Address
Specifies the Descriptor Address for the next level of lookup in the translation table.

Memory Map tab

The Memory Map provides a view of the virtual memory layout by combining translation table entries that map to contiguous regions of physical memory with common memory type, cacheability, shareability, and access attributes.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

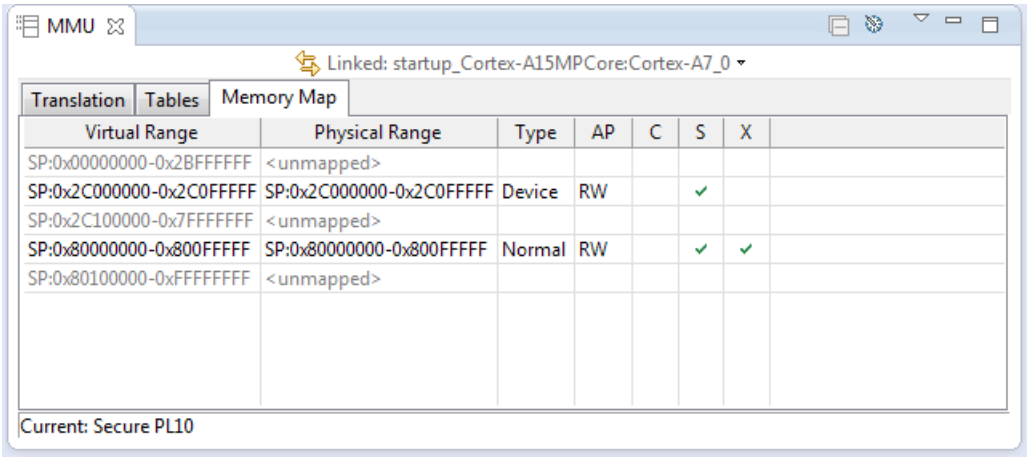


Figure 11-23 Memory Map tab view

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *`context`*
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

MMU settings
: This enables you to change the translation regime and input parameters. It contains:

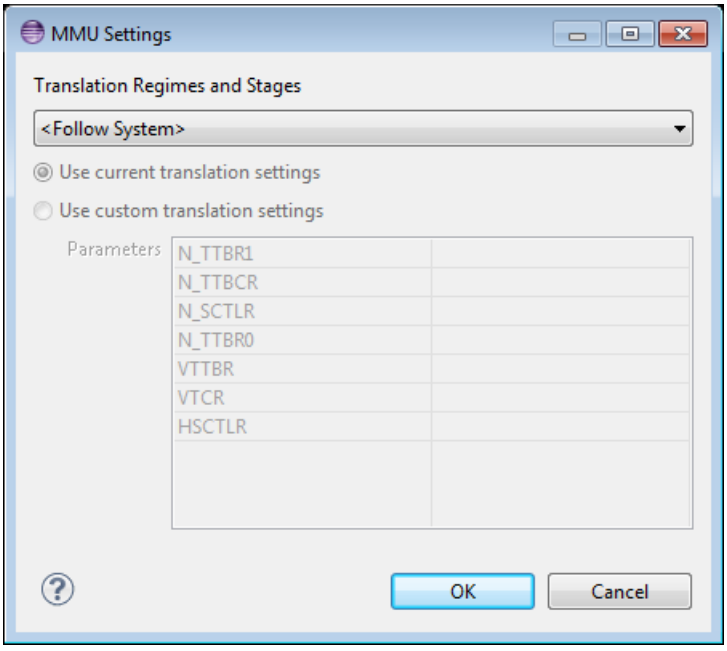


Figure 11-24 MMU settings

The **MMU Settings** dialog contains:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Translation Regimes and Stages

Use this to select the translation you want the debugger to use. The field lists the translation regimes and stages that the debugger is aware of. See the *ARM Architecture Reference Manual* for more information on the translation regimes.

Select **<Follow System>** to let the debugger follow the current system state. If the current system state has more than one translation stage, then DS-5 Debugger combines the translation stages when using <**Follow System**>.

Use current translation settings

Use this to instruct the debugger to use the current translation settings for the selected translation.

Use custom translation settings

Use this to instruct the debugger to override the current translation settings.

Parameters

Use this to specify override values for custom settings. For example you can change the address in TTBR0 or TTBR1.

View Menu

The following **View Menu** options are available:

New MMU View

Displays a new instance of the **MMU** view.

Update View When Hidden

Enables the updating of the view when it is hidden behind other views. By default this view does not update when hidden.

Refresh

Refreshes the view.

Freeze Data

Toggles the freezing of data in the current view. This also disables or enables the **Refresh** option.

Coalesce Invalid Entries

Condenses the contiguous rows of faulty or invalid input addresses into a single row in the **Tables** tab.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.17 Modules view

Use the **Modules** view to display a tabular view of the shared libraries and dynamically loaded *Operating System* (OS) modules used by the application. It is only populated when connected to a Linux target.

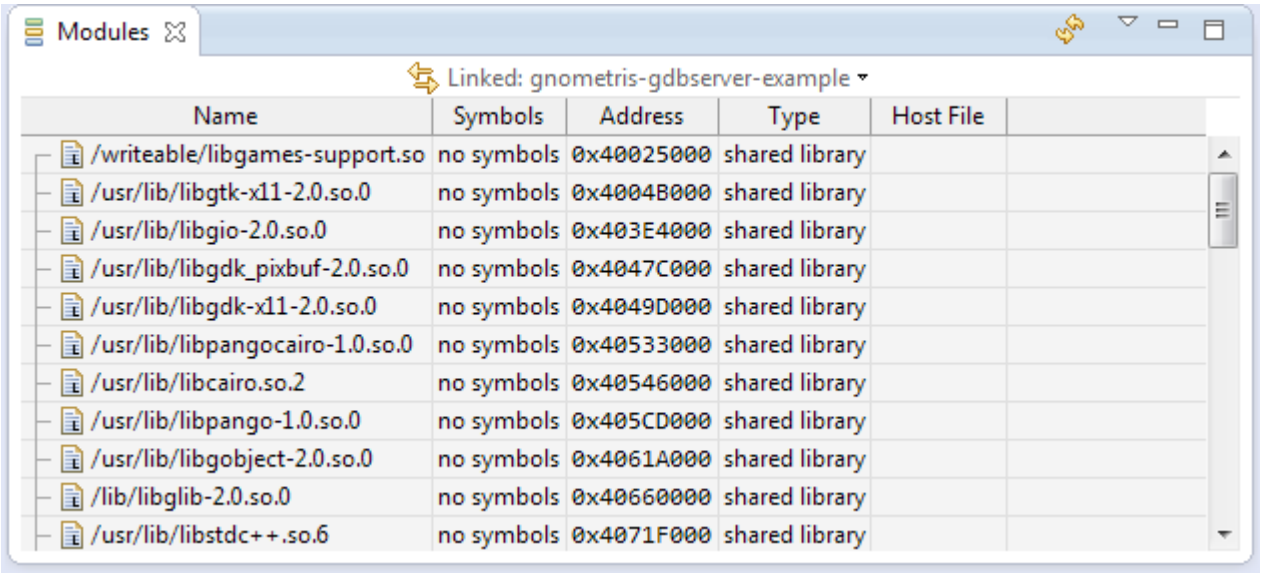


Figure 11-25 Modules view showing shared libraries

Note

A connection must be established and OS support enabled within the debugger before a loadable module can be detected. OS support is automatically enabled when a Linux kernel image is loaded into the debugger. However, you can manually control this by using the `set os` command.

Right-click on the column headers to select the columns that you want displayed:

Name
: Displays the name and location of the component on the target.

Symbols
: Displays whether the symbols are currently loaded for each object.

Address
: Displays the load address of the object.

Size
: Displays the size of the object.

Type
: Displays the component type. For example, shared library or OS module.

Host File
: Displays the name and location of the component on the host workstation.

Show All Columns
: Displays all columns.

Reset Columns
: Resets the columns displayed and their widths to the default.

The `Name`, `Symbols`, `Address`, `Type`, and `Host File` columns are displayed by default.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Linked: `context`
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Copy
: Copies the selected data.

Select All
: Selects all the displayed data.

Load Symbols
: Loads debug information into the debugger from the source file displayed in the Host File column. This option is disabled if the host file is unknown before the file is loaded.

Add Symbol File...
: Opens a dialog box where you can select a file from the host workstation containing the debug information required by the debugger.

Discard Symbols
: Discards debug information relating to the selected file.

Show in Memory
: Displays the **Memory** view starting at the load address of the selected object.

Show in Disassembly
: Displays the **Disassembly** view starting at the load address of the selected object.

View Menu
: The following **View Menu** options are available:

  Update View When Hidden
  : Enables the updating of the view when it is hidden behind other views. By default this view does not update when hidden.

  Refresh
  : Refreshes the view.

Related concepts

6.8 About debugging multi-threaded applications on page 6-152.
6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.
6.11 About debugging TrustZone enabled targets on page 6-160.

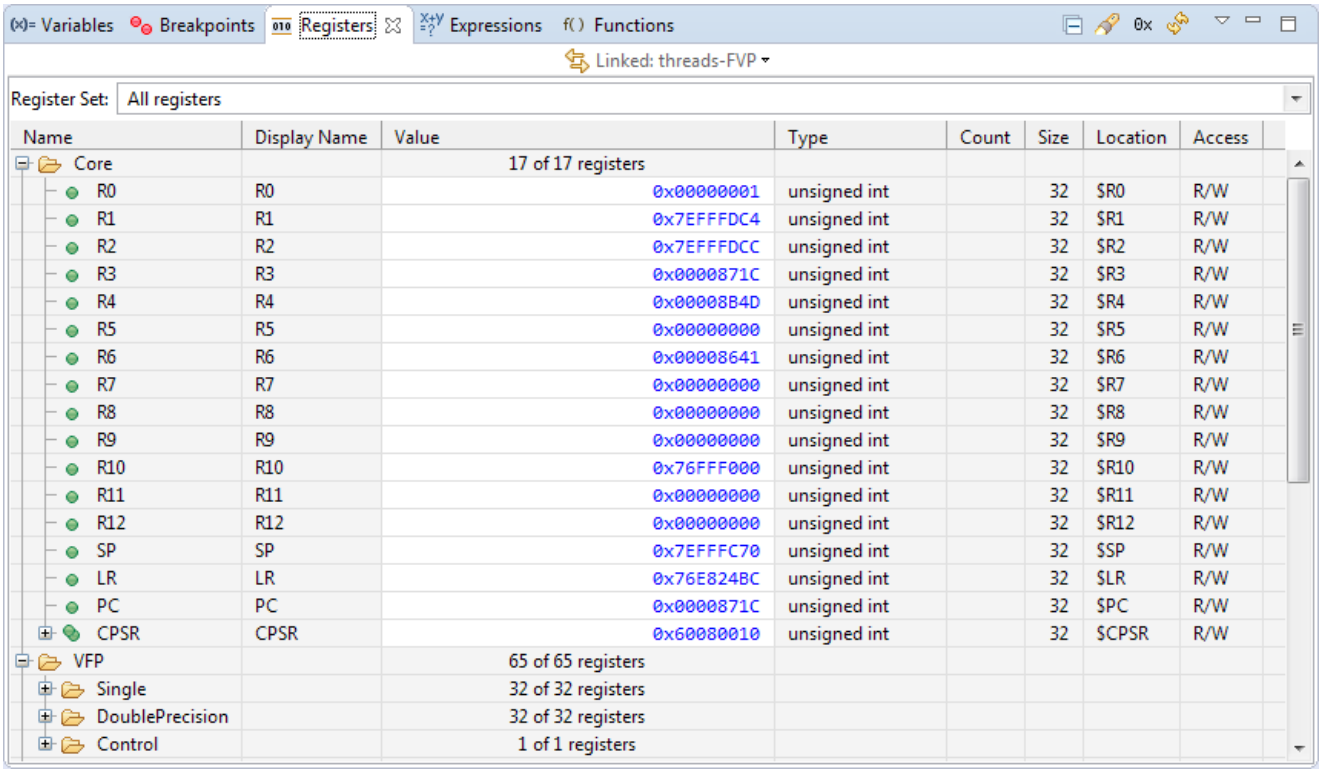
Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.18 Registers view

Use the **Registers** view to work with the contents of processor and peripheral registers available on your target.



Name	Display Name	Value	Type	Count	Size	Location	Access
Core		17 of 17 registers					
R0	R0	0x00000001	unsigned int		32	$R0	R/W
R1	R1	0x7EFFFDC4	unsigned int		32	$R1	R/W
R2	R2	0x7EFFFDCC	unsigned int		32	$R2	R/W
R3	R3	0x0000871C	unsigned int		32	$R3	R/W
R4	R4	0x00008B4D	unsigned int		32	$R4	R/W
R5	R5	0x00000000	unsigned int		32	$R5	R/W
R6	R6	0x00008641	unsigned int		32	$R6	R/W
R7	R7	0x00000000	unsigned int		32	$R7	R/W
R8	R8	0x00000000	unsigned int		32	$R8	R/W
R9	R9	0x00000000	unsigned int		32	$R9	R/W
R10	R10	0x76FFF000	unsigned int		32	$R10	R/W
R11	R11	0x00000000	unsigned int		32	$R11	R/W
R12	R12	0x00000000	unsigned int		32	$R12	R/W
SP	SP	0x7EFFFC70	unsigned int		32	$SP	R/W
LR	LR	0x76E824BC	unsigned int		32	$LR	R/W
PC	PC	0x0000871C	unsigned int		32	$PC	R/W
CPSR	CPSR	0x60080010	unsigned int		32	$CPSR	R/W
VFP		65 of 65 registers					
Single		32 of 32 registers					
DoublePrecision		32 of 32 registers					
Control		1 of 1 registers					

Figure 11-26 Registers view (with all columns displayed)

You can:

Browse registers available on your target

The **Registers** view displays all available processor registers on your target. Click and expand individual register groups to view specific registers.

Click to collapse the registers tree.

If you want to refresh the **Registers** view, from the view menu click .

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Search for a specific register

You can use the search feature in the **Registers** view to search for a specific register or group.

If you know the name of the specific register or group you want to view, click to display the search bar. Then, enter the name of the register or group you are looking for in the search bar. This lists the registers and groups that match the text you entered.
For example, enter the text `CP` to view registers and groups with the text `CP` in their name.
Press `Enter` on your keyboard, or double-click the register or group in the search results to select it in the **Register** view.

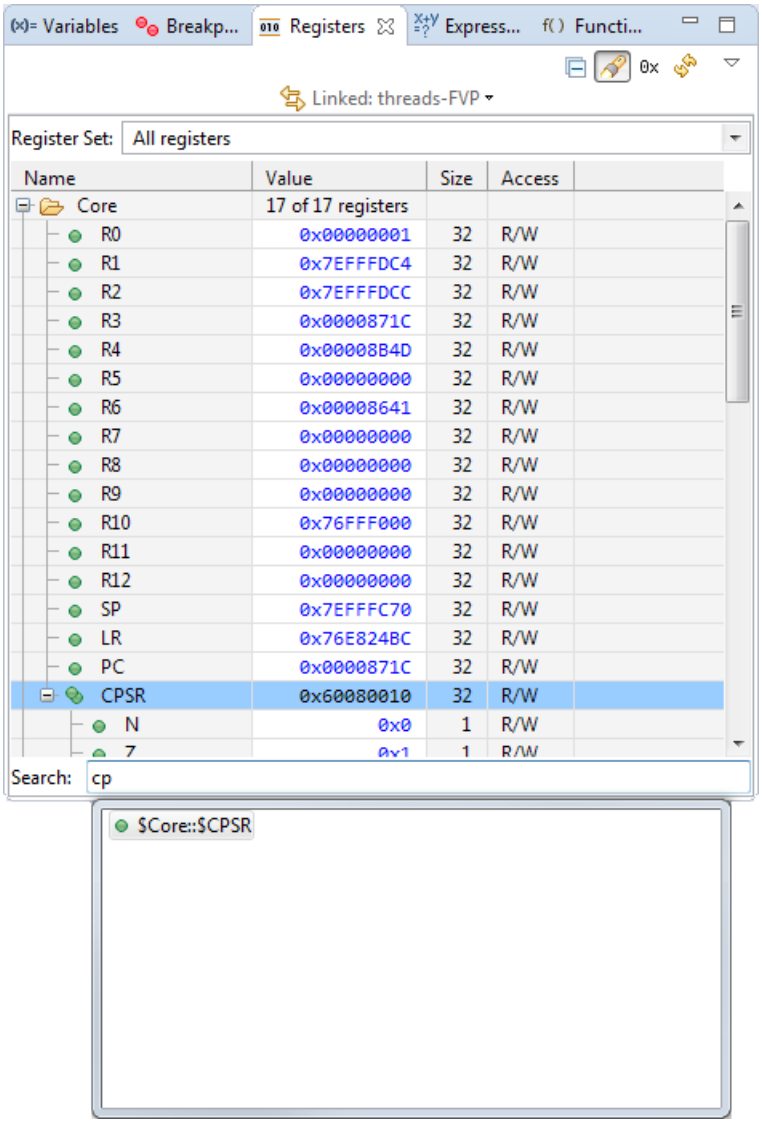


Figure 11-27 Search for registers

Tip

You can also use `CTRL+F` on your keyboard to enable the search bar. You can use the `ESC` key on your keyboard to close the search bar.

Toggle between numerical and hexadecimal values

Click the `0x` button to change all numeric values to hexadecimal values. This works as a toggle and your preference is saved across sessions.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Create and manage register sets

You can use register sets to collect individual registers into specific custom groups.To create a register set:

1. In the **Registers** view, under **Register Set**, click **All Registers** and select **Create** .
2. In the **Create or Modify Register Set** dialog box:
   - Give the register set a name in **Set Name**, for example `Core registers`. You can create multiple register groups if needed.
   - Select the registers you need in **All registers**, and click **Add**. Your selected registers appear under **Chosen registers**.
   - Click **OK**, to confirm your selection and close the dialog box.
3. The **Registers** view displays the specific register group you selected.
4. To switch between various register groups, click **All Registers** and select the group you want.

To manage a register set:

1. In the **Registers** view, under **Register Set**, click **All Registers** and select **Manage** .
2. In the **Manage Register Sets** dialog box:
   - If you want to create a new register set, click **New** and create a new register set.
   - If you want to edit an existing register set, select a register set, and click **Edit**.
   - If you want to delete an existing register set, select a register set and click **Remove**.
3. Click **OK** to confirm your changes.

Modify the value of write access registers

You can modify the values of registers with write access by clicking in the **Value** column for the register and entering a new value. Enable the **Access** column to view access rights for each register.

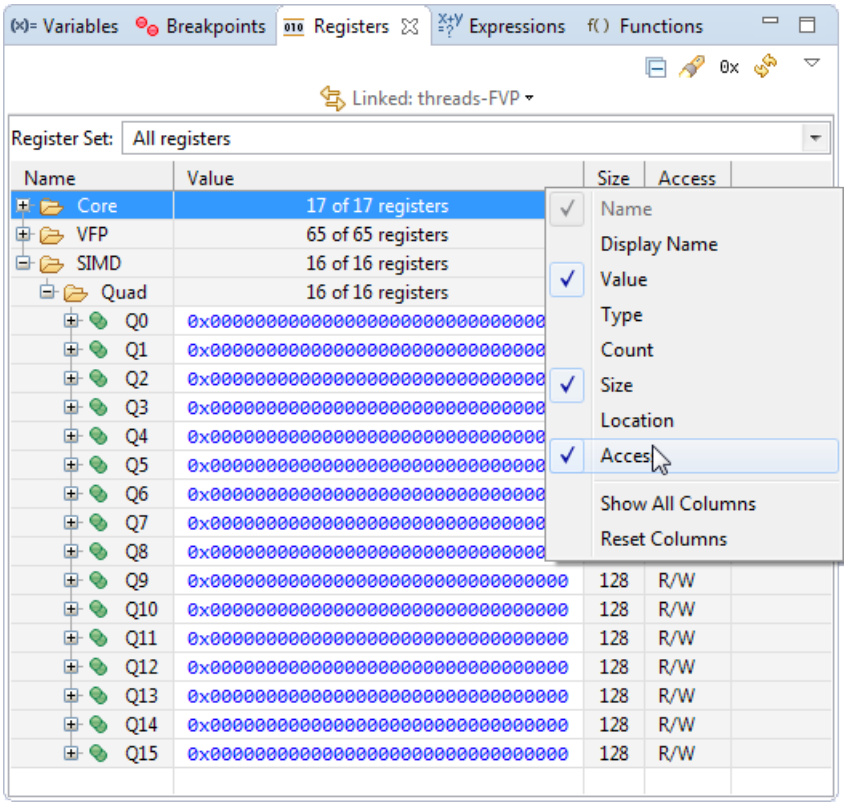


Figure 11-28 Registers access rights

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Drag and drop an address held in a register from the Registers view to other views
Drag and drop an address held in a register from this view into either the **Memory** view to see the memory at that address, or into the **Disassembly** view to disassemble from that address.

Change the display format of register values
You can set the format of individual bits for *Program Status Registers* (PSRs).

Freeze the selected view to prevent the values being updated by a running target
Select **Freeze Data** from the view menu to prevent values updating automatically when the view refreshes.

Toolbar and context menu options

The following options are available from the view or context menu:

Linked: ***`context`***
Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Copy
Copies the selected registers. If a register contains bitfields, you must expand the bitfield to copy the individual bitfield values.

It can be useful to copy registers to a text editor in order to compare the values when execution stops at another location.

Select All
Selects all registers currently expanded in the view.

Show Memory Pointed to By <register name>
Displays the **Memory** view starting at the address held in the register.

Show Disassembly Pointed to By <register name>
Displays the **Disassembly** view starting at the address held in the register.

Translate Address in <register name>
Displays the **MMU** view and translates the address held in the register.

Send to <selection>
Displays a sub menu that enables you to add register filters to a specific **Expressions** view.

<Format list>
A list of formats you can use for the register values.

View Menu
The following **View Menu** options are available:

New Registers View
Creates a new instance of the **Registers** view.

Freeze Data
Toggles the freezing of data in the current view. This also disables or enables the **Refresh** option.

Editing context menu options
The following options are available on the context menu when you select a register value for editing:

Undo
Reverts the last change you made to the selected value.

Cut
Copies and deletes the selected value.

Copy
Copies the selected value.

Paste
Pastes a value that you have previously cut or copied into the selected register value.

Delete
Deletes the selected value.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Select All
Selects the whole value.

Adding a new column header

Right-click on the column headers to select the columns that you want displayed:

Name
The name of the register.

Use `$register_name` to reference a register. To refer to a register that has bitfields, such as a PSR, specify `$register_name.bitfield_name`. For example, to print the value of the `M` bitfield of the `CPSR`, enter the following command in the **Commands** view:

```
print $CPSR.M
```

Value
The value of the register. A yellow background indicates that the value has changed. This might result from you either performing a debug action such as stepping or by you editing the value directly.

If you freeze the view, then you cannot change a register value.

Type
The type of the register value.

Count
The number of array or pointer elements.

Size
The size of the register in bits.

Location
The name of the register or the bit range for a bitfield of a PSR. For example, bitfield M of the CPSR is displayed as `$CPSR[4..0]`.

Access
The access mode for the register.

Show All Columns
Displays all columns.

Reset Columns
Resets the columns displayed and their widths to the default.

The `Name`, `Value`, `Size`, and `Access` columns are displayed by default.

Related concepts

6.8 About debugging multi-threaded applications on page 6-152.
6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.
6.11 About debugging TrustZone enabled targets on page 6-160.

Related references

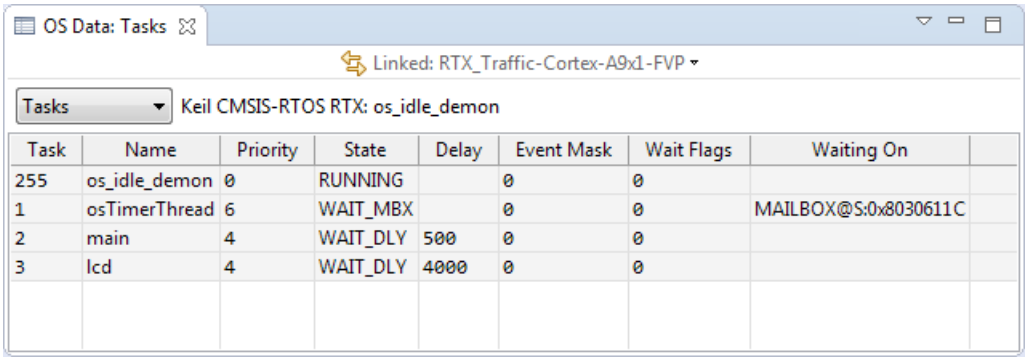
3.13 Setting a tracepoint on page 3-89.
3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.
3.12 Pending breakpoints and watchpoints on page 3-87.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.19 OS Data view

Use the **OS Data** view to display information about the operating system, for example, tasks, semaphores, mutexes, and mailboxes.

To view the information, select a table from the list.



Task	Name	Priority	State	Delay	Event Mask	Wait Flags	Waiting On
255	os_idle_demon	0	RUNNING		0	0	
1	osTimerThread	6	WAIT_MBX		0	0	MAILBOX@S:0x8030611C
2	main	4	WAIT_DLY	500	0	0	
3	lcd	4	WAIT_DLY	4000	0	0	

Figure 11-29 OS Data view (showing Keil CMSIS-RTOS RTX Tasks)

Note

Data in the **OS Data** view is dependent on the selected data source.

Toolbar and context menu options

Linked: *context*
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Show linked data in other Data views
: Shows selected data in a view that is linked to another view.

View Menu
: This menu contains the following option:

  New OS Data View
  : Displays a new instance of the **OS Data** view.

  Update View When Hidden
  : Enables the updating of the view when it is hidden behind other views. By default, this view does not update when hidden.

  Refresh
  : Refreshes the view.

  Freeze Data
  : Toggles the freezing of data in the current view. Also, the value of a variable cannot change if the data is frozen.

Editing context menu options
: The following options are available on the context menu when you select a variable value for editing:

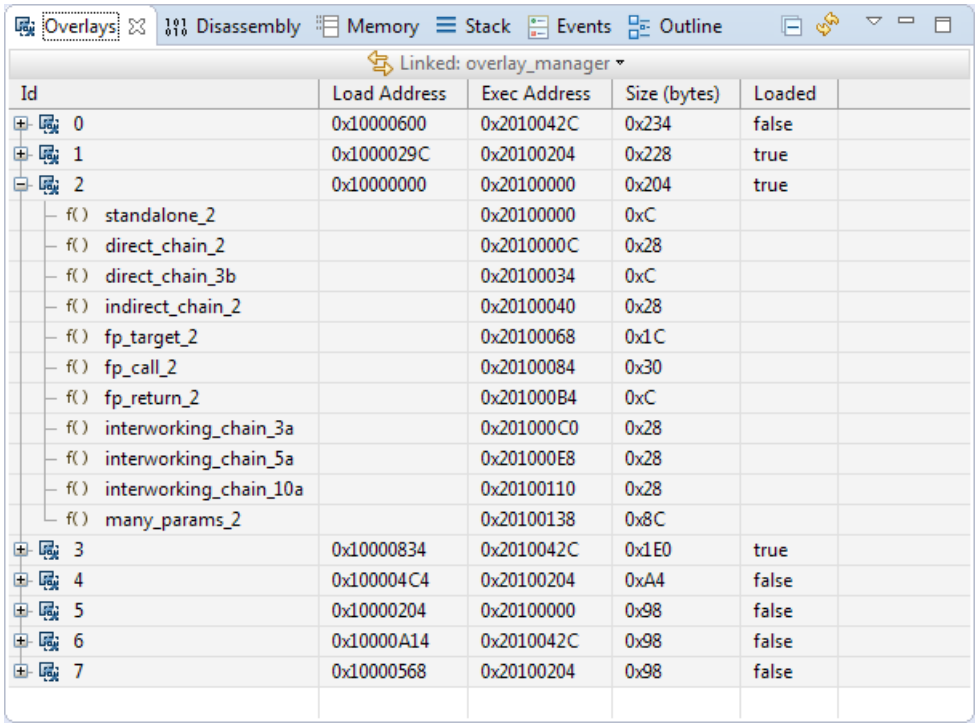
  Copy
  : Copies the selected value.

  Select All
  : Selects all text.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.20 Overlays view

Use the **Overlays** view to interact with the currently loaded overlaid application.



Id	Load Address	Exec Address	Size (bytes)	Loaded
0	0x10000600	0x2010042C	0x234	false
1	0x1000029C	0x20100204	0x228	true
2	0x10000000	0x20100000	0x204	true
f() standalone_2		0x20100000	0xC	
f() direct_chain_2		0x2010000C	0x28	
f() direct_chain_3b		0x20100034	0xC	
f() indirect_chain_2		0x20100040	0x28	
f() fp_target_2		0x20100068	0x1C	
f() fp_call_2		0x20100084	0x30	
f() fp_return_2		0x201000B4	0xC	
f() interworking_chain_3a		0x201000C0	0x28	
f() interworking_chain_5a		0x201000E8	0x28	
f() interworking_chain_10a		0x20100110	0x28	
f() many_params_2		0x20100138	0x8C	
3	0x10000834	0x2010042C	0x1E0	true
4	0x100004C4	0x20100204	0xA4	false
5	0x10000204	0x20100000	0x98	false
6	0x10000A14	0x2010042C	0x98	false
7	0x10000568	0x20100204	0x98	false

Figure 11-30 Overlays view

Using the **Overlays** view, you can:

View information about overlays
The **Overlays** view shows the **ID** and functions, the **Load Address**, **Exec Address**, and **Size** for each overlay. It also shows if the overlay is **Loaded** or not.

Locate the function in the source
To locate the function in the source code and move to the **Code Editor** view, double-click a function.

Toolbar options

The following **View Menu** options are available:

New Overlays View
Displays a new instance of the **Overlays** view.

Freeze Data
Freezes data to the currently selected execution context. This option works as a toggle.

Related concepts

6.17 About DS-5 Debugger support for overlays on page 6-170.

Related information

DS-5 Debugger command: info overlays.

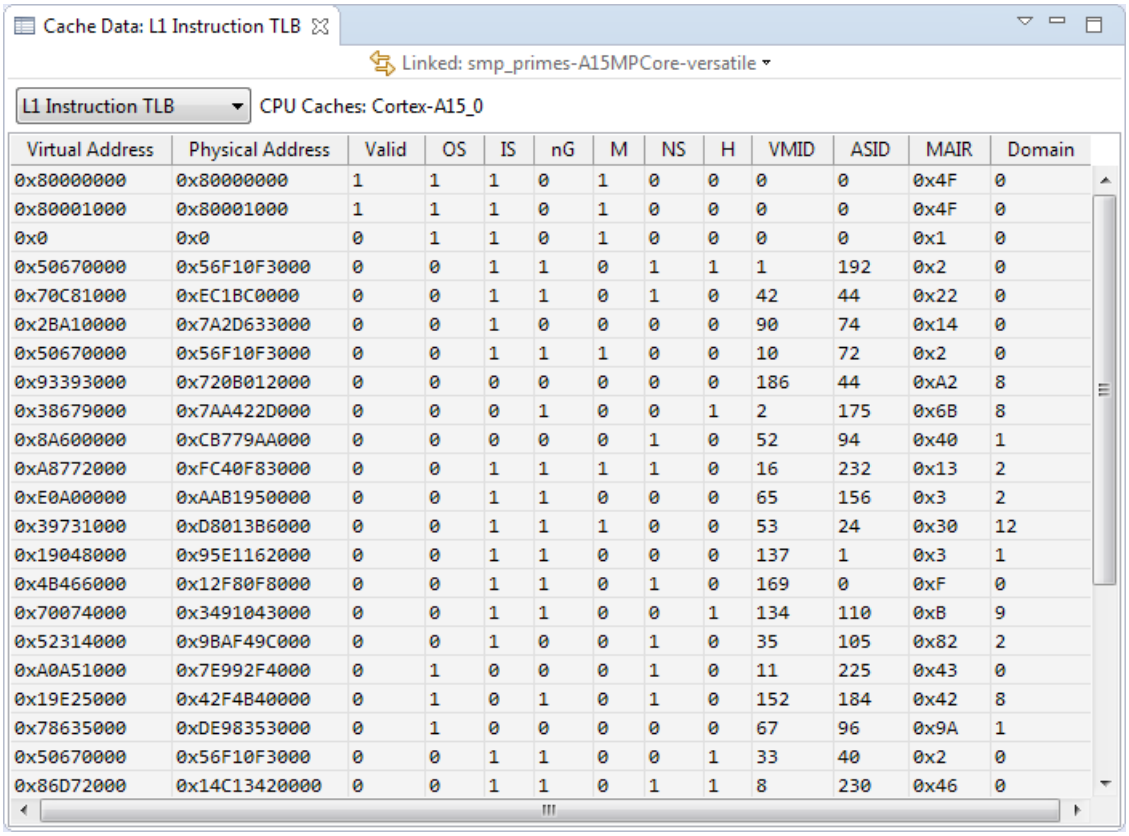
DS-5 Debugger command: set overlays enabled.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.21 Cache Data view

Use the **Cache Data** view to examine the contents of the caches in your system. For example, L1 cache or TLB cache. You must enable **Cache debug mode** in the DTSL Configuration Editor dialog.

Select the cache you want to view from the **CPU Caches** menu.



Virtual Address	Physical Address	Valid	OS	IS	nG	M	NS	H	VMID	ASID	MAIR	Domain
0x80000000	0x80000000	1	1	1	0	1	0	0	0	0	0x4F	0
0x80001000	0x80001000	1	1	1	0	1	0	0	0	0	0x4F	0
0x0	0x0	0	1	1	0	1	0	0	0	0	0x1	0
0x50670000	0x56F10F3000	0	0	1	1	0	1	1	1	192	0x2	0
0x70C81000	0xEC1BC0000	0	0	1	1	0	1	0	42	44	0x22	0
0x2BA10000	0x7A2D633000	0	0	1	0	0	0	0	90	74	0x14	0
0x50670000	0x56F10F3000	0	0	1	1	1	0	0	10	72	0x2	0
0x93393000	0x720B012000	0	0	0	0	0	0	0	186	44	0xA2	8
0x38679000	0x7AA422D000	0	0	0	1	0	0	1	2	175	0x6B	8
0x8A600000	0xCB779AA000	0	0	0	0	0	1	0	52	94	0x40	1
0xA8772000	0xFC40F83000	0	0	1	1	1	1	0	16	232	0x13	2
0xE0A00000	0xAAB1950000	0	0	1	1	0	0	0	65	156	0x3	2
0x39731000	0xD8013B6000	0	0	1	1	1	0	0	53	24	0x30	12
0x19048000	0x95E1162000	0	0	1	1	0	0	0	137	1	0x3	1
0x4B466000	0x12F80F8000	0	0	1	1	0	1	0	169	0	0xF	0
0x70074000	0x3491043000	0	0	1	1	0	0	1	134	110	0xB	9
0x52314000	0x9BAF49C000	0	0	1	0	0	1	0	35	105	0x82	2
0xA0A51000	0x7E992F4000	0	1	0	0	0	1	0	11	225	0x43	0
0x19E25000	0x42F4B40000	0	1	0	1	0	1	0	152	184	0x42	8
0x78635000	0xDE98353000	0	1	0	0	0	0	0	67	96	0x9A	1
0x50670000	0x56F10F3000	0	0	1	1	0	0	1	33	40	0x2	0
0x86D72000	0x14C13420000	0	0	1	1	0	1	1	8	230	0x46	0

Figure 11-31 Cache Data view (showing L1 TLB cache)

Alternatively, you can use the `cache list` and `cache print` commands in the **Commands** view to show information about the caches.

Note

Cache awareness is dependent on the exact device and connection method.

Toolbar and context menu options

Linked: *`context`*
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively, you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Show linked data in other Data views
: Shows selected data in a view that is linked to another view.

View Menu
: This menu contains the following options:

New Cache Data View
: Displays a new instance of the **Cache Data** view.

Update View When Hidden
: Enables the updating of the view when it is hidden behind other views. By default this view does not update when hidden.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Refresh
Refreshes the view.

Freeze Data
Toggles the freezing of data in the current view. The value of a variable cannot change if the data is frozen.

Editing context menu options
The following options are available on the context menu when you right-click a value:

Copy
Copies the selected value.

Select All
Selects all text.

Related concepts

6.16 About debugging caches on page 6-167.

Related references

11.46 DTSL Configuration Editor dialog box on page 11-372.
11.15 Memory view on page 11-302.

Related information

DS-5 Debugger cache commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.22 Screen view

Use the **Screen** view to display the contents of the screen buffer.

This view enables you to:

- Configure when view updates should occur and the interval between updates.
- Freeze the view to prevent it being updated by the running target when it next updates.
- Set the screen buffer parameters appropriate for the target:

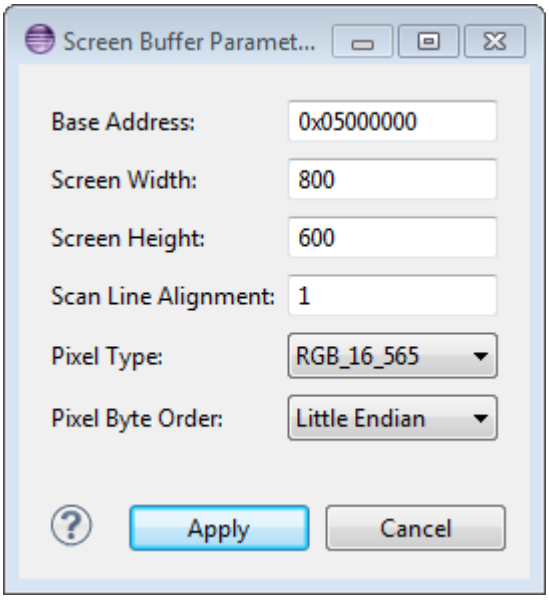


Figure 11-32 Screen buffer parameters

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

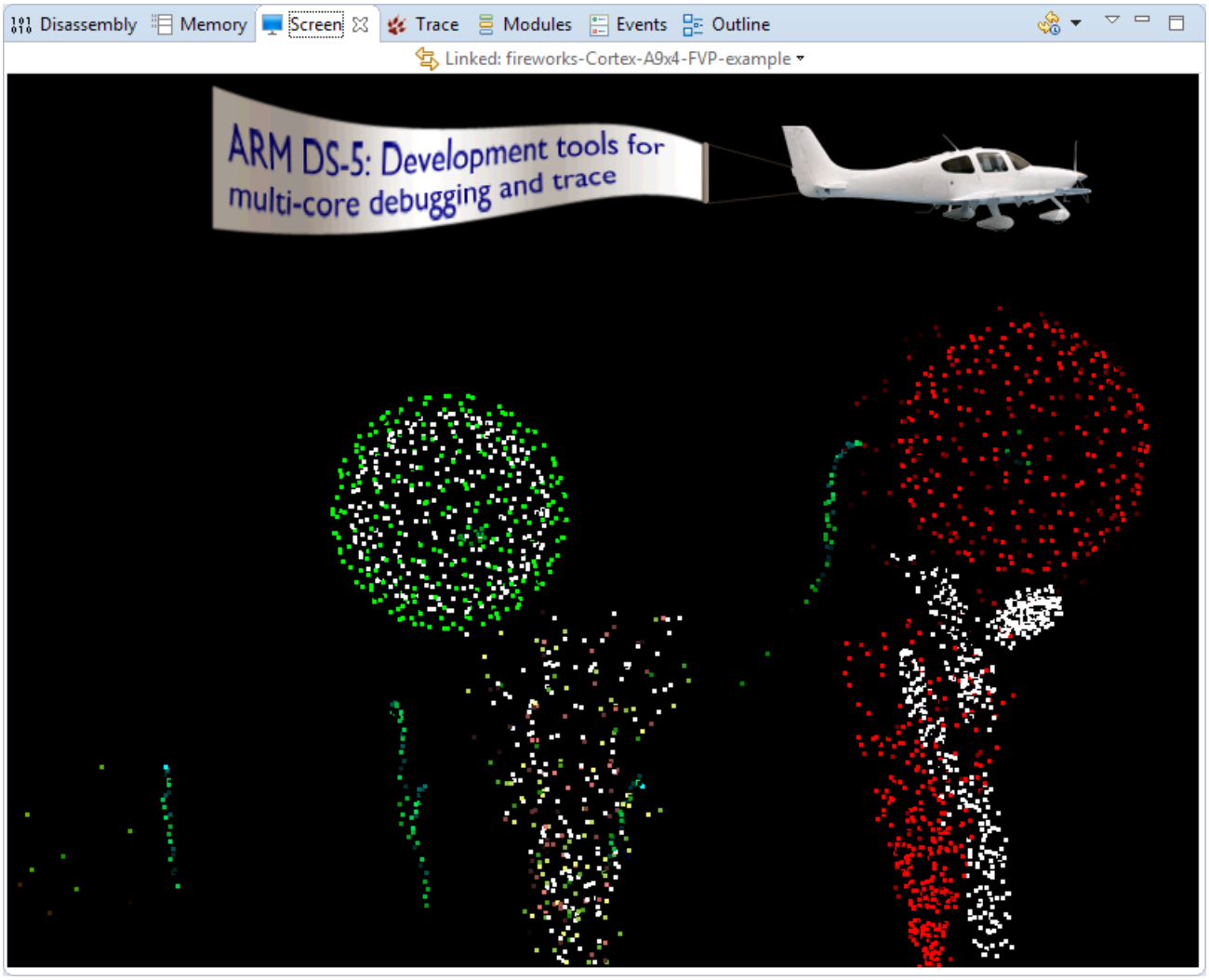


Figure 11-33 Screen view

Toolbar options

The following toolbar options are available:

Linked: *`context`*
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Timed auto refresh is off
Cannot update
:
- If Timed auto-refresh is off mode is selected, the auto refresh is off.
- If the Cannot update mode is selected, the auto refresh is blocked.

Start
: Starts auto-refreshing.

Stop
: Stops auto-refreshing.

Update Interval
: Specifies the auto-refresh interval, in seconds or minutes.

Update When
: Specifies whether updates should occur only when the target is running or stopped, or always.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Properties
Displays the Timed Auto-Refresh Properties dialog box.

New Screen View
Creates a new instance of the **Screen** view.

Set screen buffer parameters
Displays the Screen Buffer Parameters dialog box. The dialog box contains the following parameters:

Base Address
Sets the base address of the screen buffer.

Screen Width
Sets the width of the screen in pixels.

Screen Height
Sets the height of the screen in pixels.

Scan Line Alignment
Sets the byte alignment required for each scan line.

Pixel Type
Selects the pixel type.

Pixel Byte Order
Selects the byte order of the pixels within the data.

Click **Apply to save the settings and close the dialog box**.

Click **Cancel** to close the dialog box without saving.

Update View When Hidden
Enables the updating of the view when it is hidden behind other views. By default this view does not update when hidden.

Refresh
Refreshes the view.

Freeze Data
Toggles the freezing of data in the current view. This also disables or enables the **Refresh** option.

The Screen view is not visible by default. To add this view:

1. Ensure that you are in the DS-5 Debug perspective.
2. Select **Window** > **Show View** to open the Show View dialog box.
3. Select **Screen** view.

Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.23 Scripts view

Use the **Scripts** view to work with scripts in DS-5. You can create, run, edit, delete, and configure parameters for the various types of scripts supported by DS-5.

Note

- Scripts are dependent on a debug connection. To work with scripts, first create a debug configuration for your target and select it in the **Debug Control** view.
- Debugger views are not updated when commands issued in a script are executed.

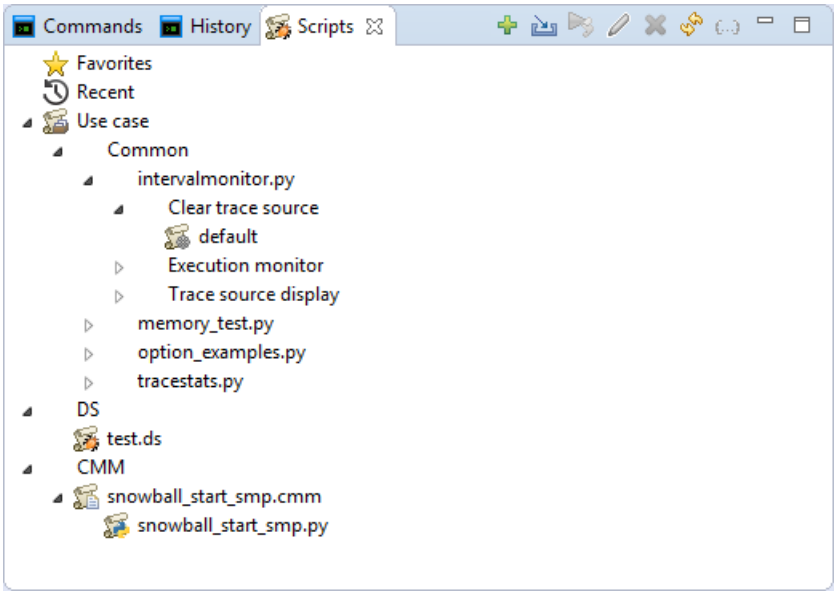


Figure 11-34 Scripts view

Using the **Scripts** view, you can:

Create a script

To create a script, click to display the **Save As** dialog box. Give your script a name and select the type of script you want. You can choose any of the following types:

- Debugger Script (*.ds)
- Jython script (*.py)
- Text file (*.txt)

The script opens in the editor when you save it.

Import scripts

Click to view options for importing scripts.

Import a DS-5 or Jython script

To import a DS-5 or Jython script, click Import a DS or Jython script and browse and select your file.

Import and translate a CMM script

To *import and translate* on page 7-175 a CMM script:

1. Click Import and translate a CMM script and browse and select your file.
2. Click **Open**.
3. In the **Translation Save Location** dialog, choose a location to store the translated file.
4. Click **OK** to translate the file and save it at the selected location.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Add additional use case script directories

To add more use case script directories, click Add use case script directory and either enter the folder location or click **Browse** to the script folder location.

Note

To change the location for other scripts that are supported in DS-5 Debugger, from the main menu, select **Window** > **Preferences** > **DS-5** > **Debugger** > **Console**. Then, select the **Use a default script folder** option, and either enter the folder location or click **Browse** to the script folder location.

Execute your script

After connecting to your target, select your script and click to execute your script. You can also double-click a script to run it.

Note

When working with use case scripts, you must select the use case configuration to run your script.

Edit your script

Select your script and click to open the script in the editor.

Delete your script

Select the script that you want to delete and click . Confirm if you want to delete the script from the view, or if you want to delete from the disk, and click **OK**.

Refresh the script view

Click to refresh the view.

Configure script options

Select a script, and click to configure script options.

Related concepts

7.10 Use case scripts on page 7-187.

Related references

Chapter 7 Debugging with Scripts on page 7-171.
Chapter 8 Running DS-5 Debugger from the operating system command-line or from a script on page 8-202.
7.4 Support for importing and translating CMM scripts on page 7-175.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.24 Target Console view

Use the **Target Console** view to display messages from the target setup scripts.

Note

Default settings for this view are controlled by DS-5 Debugger options in the Preferences dialog box. For example, the default location for the console log. You can access these settings by selecting **Preferences** from the **Window** menu.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: `context`
: Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Save Console Buffer
: Saves the contents of the **Target Console** view to a text file.

Clear Console
: Clears the contents of the **Target Console** view.

Toggles Scroll Lock
: Enables or disables the automatic scrolling of messages in the **Target Console** view.

View Menu
: This menu contains the following options:

  New Target Console View
  : Displays a new instance of the **Target Console** view.

  Bring to Front for Write
  : If enabled, the debugger automatically changes the focus to this view when a target script prompts for input.

Copy
: Copies the selected text.

Paste
: Pastes text that you have previously copied.

Select All
: Selects all text.

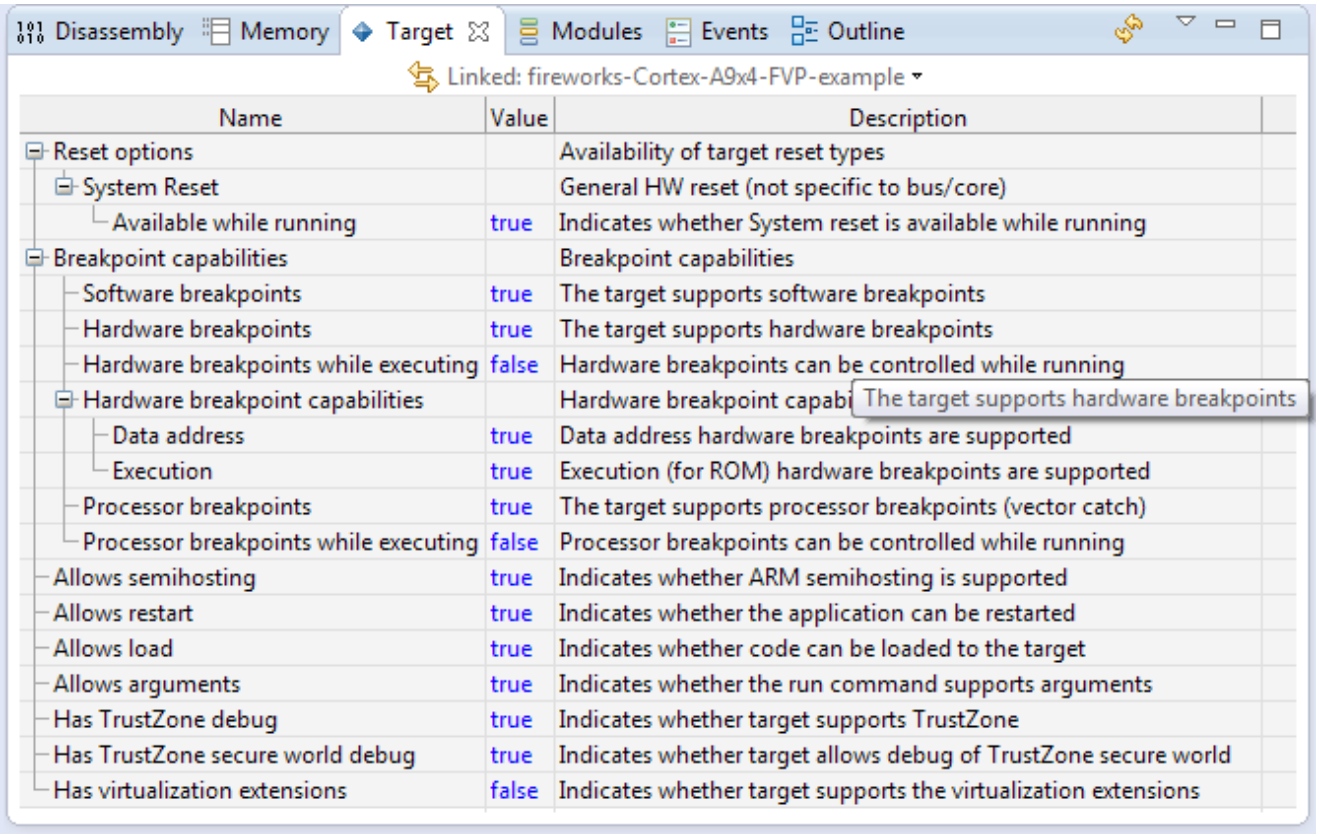
Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.25 Target view

Use the **Target** view to display the debug capabilities of the target, for example the types of breakpoints it supports. It does not allow you to modify the capabilities.



Name	Value	Description
Reset options		Availability of target reset types
System Reset		General HW reset (not specific to bus/core)
Available while running	true	Indicates whether System reset is available while running
Breakpoint capabilities		Breakpoint capabilities
Software breakpoints	true	The target supports software breakpoints
Hardware breakpoints	true	The target supports hardware breakpoints
Hardware breakpoints while executing	false	Hardware breakpoints can be controlled while running
Hardware breakpoint capabilities		Hardware breakpoint capabi
Data address	true	Data address hardware breakpoints are supported
Execution	true	Execution (for ROM) hardware breakpoints are supported
Processor breakpoints	true	The target supports processor breakpoints (vector catch)
Processor breakpoints while executing	false	Processor breakpoints can be controlled while running
Allows semihosting	true	Indicates whether ARM semihosting is supported
Allows restart	true	Indicates whether the application can be restarted
Allows load	true	Indicates whether code can be loaded to the target
Allows arguments	true	Indicates whether the run command supports arguments
Has TrustZone debug	true	Indicates whether target supports TrustZone
Has TrustZone secure world debug	true	Indicates whether target allows debug of TrustZone secure world
Has virtualization extensions	false	Indicates whether target supports the virtualization extensions

Figure 11-35 Target view

Right-click on the column headers to select the columns that you want displayed:

Name
The name of the target capability.

Value
The value of the target capability.

Key
The name of the target capability. This is used by some commands in the **Commands** view.

Description
A brief description of the target capability.

Show All Columns
Displays all columns.

Reset Columns
Resets the columns displayed and their widths to the default.

The `Name`, `Value`, and `Description` columns are displayed by default.

The **Target** view is not visible by default. To add this view:

1. Ensure that you are in the DS-5 Debug perspective.
2. Select **Window** > **Show View** > **Target**.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Linked: `context`

Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Refresh the Target Capabilities

Refreshes the view.

View Menu

This menu contains the following option:

New Target View

Displays a new instance of the **Target** view.

Copy

Copies the selected capabilities. To copy the capabilities in a group such as `Breakpoint capabilities`, you must first expand that group.

This is useful if you want to copy the capabilities to a text editor to save them for future reference.

Select All

Selects all capabilities currently expanded in the view.

Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.26 Trace view

Use the **Trace** view to display a graphical navigation chart that shows function executions with a navigational timeline. In addition, the disassembly trace shows function calls with associated addresses and if selected, instructions. Clicking on a specific time in the chart synchronizes the **Disassembly** view.

When a trace has been captured, the debugger extracts the information from the trace stream and decompresses it to provide a full disassembly, with symbols, of the executed code.

The left-hand column of the chart shows the percentages of the total trace for each function. For example, if a total of 1000 instructions are executed and 300 of these instructions are associated with `myFunction()` then this function is displayed with 30%.

In the navigational timeline, the color coding is a heat map showing the executed instructions and the number of instructions each function executes in each timeline. The darker red color shows more instructions and the lighter yellow color shows fewer instructions. At a scale of 1:1 however, the color scheme changes to display memory access instructions as a darker red color, branch instructions as a medium orange color, and all the other instructions as a lighter green color.

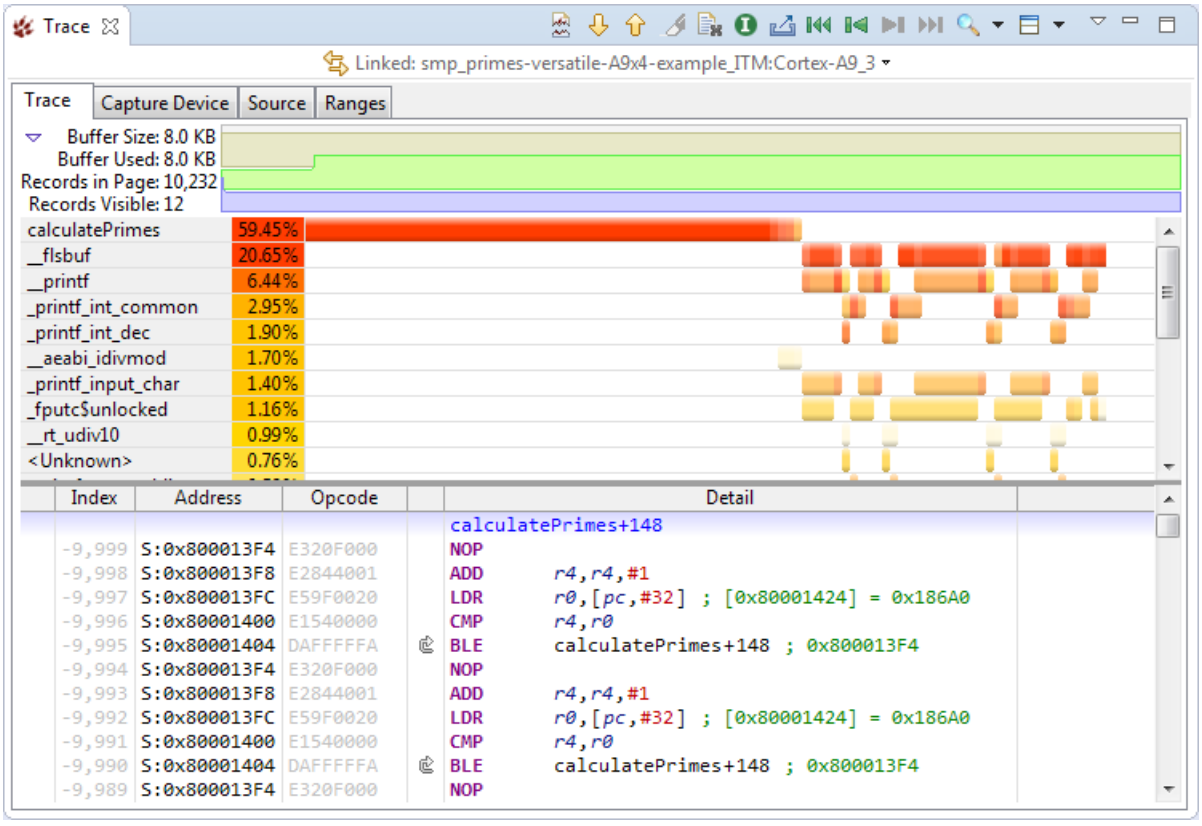


Figure 11-36 Trace view with a scale of 100:1

The **Trace** view might not be visible by default. To add this view:

1. Ensure that you are in the DS-5 Debug perspective.
2. Select **Window** > **Show View** > **Trace**.

The **Trace** view navigation chart contains several tabs:

- **Trace** tab shows the graphical timeline and disassembly.
- **Capture Device** tab gives information about the trace capture device and the trace buffer, and allows you to configure the trace capture.
- **Source** tab gives information about the trace source.
- **Ranges** tab allows you to limit the trace capture to a specific address range.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

The **Trace** tab also shows:

Buffer Size
Size of the trace buffer to store trace records. This is determined by the trace capture device. The trace records can be instruction records or non-instruction records.

Buffer Used
Amount of the trace buffer that is already used for trace records.

Records in Page
The total number of instruction records and non-instruction records in the current **Trace** view.

Records Visible
The number of trace records visible in the disassembly area of the **Trace** view.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: `context`
Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection or processor in a *Symmetric MultiProcessing* (SMP) connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Updating view when hidden
Not updating view when hidden
Toggles the updating of the view when it is hidden behind other views. By default the view does not update when it is hidden, which might cause loss of trace data.

Show Next Match
Moves the focus of the navigation chart and disassembly trace to the next matching occurrence for the selected function or instruction.

Show Previous Match
Moves the focus of the navigation chart and disassembly trace to the previous matching occurrence for the selected function or instruction.

Don’t mark other occurrences - click to start marking
Mark other occurrences - click to stop marking
When function trace is selected, marks all occurrences of the selected function with a shaded highlight. This is disabled when instruction trace is selected.

Clear Trace
Clears the raw trace data that is currently contained in the trace buffer and the trace view.

Showing instruction trace - click to switch to functions
Showing function trace - click to switch to instructions
Toggles the disassembly trace between instructions and functions.

Export Trace Report
Displays the Export Trace Report dialog box to save the trace data to a file.

Home
Where enabled, moves the trace view to the beginning of the trace buffer. Changes might not be visible if the trace buffer is too small.

Page Back
Where enabled, moves the trace view back one page. You can change the page size by modifying the **Set Maximum Instruction Depth** setting.

Page Forward
Where enabled, moves the trace view forward one page. You can change the page size by modifying the **Set Maximum Instruction Depth** setting.

End
Where enabled, moves the trace view to the end of the trace buffer. Changes might not be visible if the trace buffer is too small.

Switch between navigation resolutions
Changes the timeline resolution in the navigation chart.

Switch between alternate views
Changes the view to display the navigation chart, disassembly trace or both.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Focus Here

At the top of the list, displays the function being executed in the selected time slot. The remaining functions are listed in the order in which they are executed after the selected point in time. Any functions that do not appear after that point in time are placed at the bottom and ordered by total time.

Order By Total Time

Displays the functions ordered by the total time spent within the function. This is the default ordering.

View Menu

The following **View Menu** options are available:

New Trace View

Displays a new instance of the **Trace** view.

Set Trace Page Size...

Displays a dialog box in which you can enter the maximum number of instructions to display in the disassembly trace. The number must be within the range of 1,000 to 1,000,000 instructions.

Find Trace Trigger Event

Enables you to search for trigger events in the trace capture buffer.

Find Timestamp...

Displays a dialog box in which you can enter either a numeric timestamp as a 64 bit value or in the h:m:s format.

Find Function...

Enables you to search for a function by name in the trace buffer.

Find Instruction by Address...

Enables you to search for an instruction by address in the trace buffer.

Find ETM data access in trace buffer...

Enables you to search for a data value or range of values in the trace buffer.

Find Instruction Index...

Enables you to search for an instruction by index. A positive index is relative to the start of the trace buffer and a negative index is relative to the end.

DTSL Options...

Displays a dialog box in which you can add, edit, or choose a DTSL configuration.

Note

This clears the trace buffer.

Open Trace Control View

Opens the **Trace Control View**.

Refresh

Discards all the data in the view and rereads it from the current trace buffer.

Freeze Data

Toggles the freezing of data in the current view.

Trace Filter Settings...

Displays a dialog box in which you can select the trace record types that you want to see in the **Trace** view.

Related tasks

8.5 Capturing trace data using the command-line debugger on page 8-213.

Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.27 Trace Control view

Use the **Trace Control** view to start or stop trace capture and clear the trace buffer on a specified trace capture device.

The **Trace Control** view additionally displays information about the trace capture device, the trace source used, the status of the trace, and the size of the trace buffer.

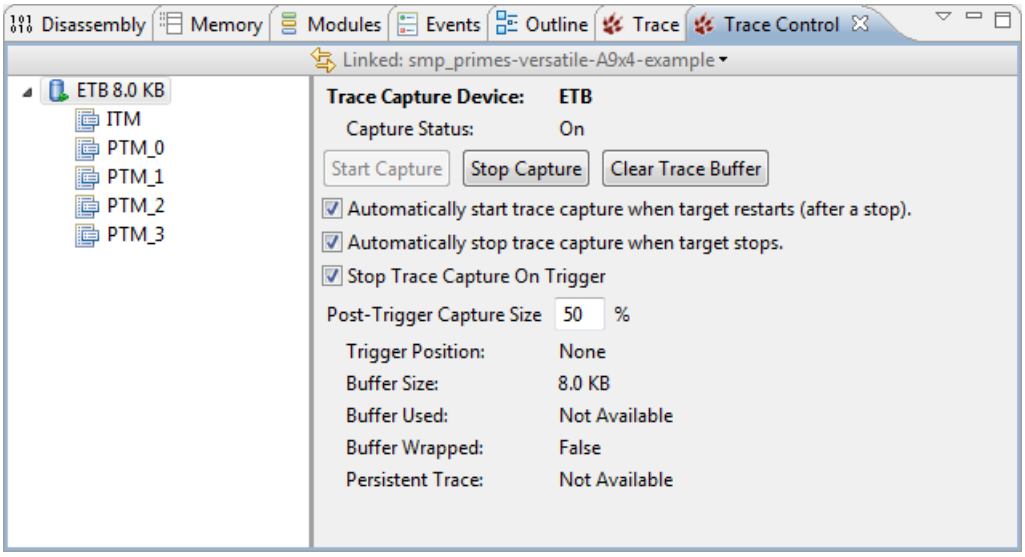


Figure 11-37 Trace Control view

The trace capture device and trace sources available in the trace capture device are listed on the left hand side of the view. Select any trace source to view additional information.

The following Trace Capture Device information is displayed in the view:

Trace Capture Device
The name of the trace capture device.

Capture Status
The trace capture status. **On** when capturing trace data, **Off** when not capturing trace data.

Trigger Position
The location of the trigger within the buffer.

Buffer Size
The capacity of the trace buffer.

Buffer Used
The amount of trace data currently in the buffer.

Buffer Wrapped
The trace buffer data wraparound status.

Persistent Trace
The persistent trace data status.

The following Trace Source information is displayed in the view:

Trace Source
The name of the selected trace source.

Source ID
The unique ID of the selected trace source.

Source Encoding
The trace encoding format.

Core
The core associated with the trace source.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Context IDs
The tracing context IDs availability status.

Cycle Accurate Trace
The cycle accurate trace support status.

Virtualization Extensions
The virtualization extensions availability status.

Timestamps
Timestamp availability status for the trace.

Timestamp Origin
Whether a timestamp origin for the trace is set or cleared. When set, timestamps are displayed as offsets from the origin.

Trace Triggers
Trace triggers support status.

Trace Start Points
Trace start points support status.

Trace Stop Points
Trace stop points support status.

Trace Ranges
Trace ranges support status.

Note

The information displayed varies depending on the trace source.

Trace Control view options

Start Capture
Click **Start Capture** to start trace capture on the trace capture device. This is the same as the `trace start` command.

Stop Capture
Click **Stop Capture** to stop trace capture on the trace capture device. This is the same as the `trace stop` command.

Clear Trace Buffer
Click **Clear Trace Buffer** to empty the trace buffer on the trace capture device. This is the same as the `trace clear` command.

Start trace capture when target restarts (after a stop)
Select this option to automatically start trace capture after a target restarts after a stop.

Stop trace capture when target stops
Select this option to automatically stop trace capture when a target stops.

Stop trace capture on trigger
Select this option to stop trace capture after a trace capture trigger has been hit.

Post-trigger capture size
Use this option to control the percentage of the trace buffer that should be reserved for after a trigger point is hit. The range is from 0 to 99.

Note

The `trace start` and `trace stop` commands and the automatic start and stop trace options act as master switches. Trace triggers cannot override them.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Linked: `context`

Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a specific connection or processor in a *Symmetric MultiProcessing* (SMP) connection. If the connection you want is not shown in the drop-down list, you might have to select it first in the **Debug Control** view.

Related references

Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.28 Variables view

Use the **Variables** view to work with the contents of local, file static, and global variables in your program.

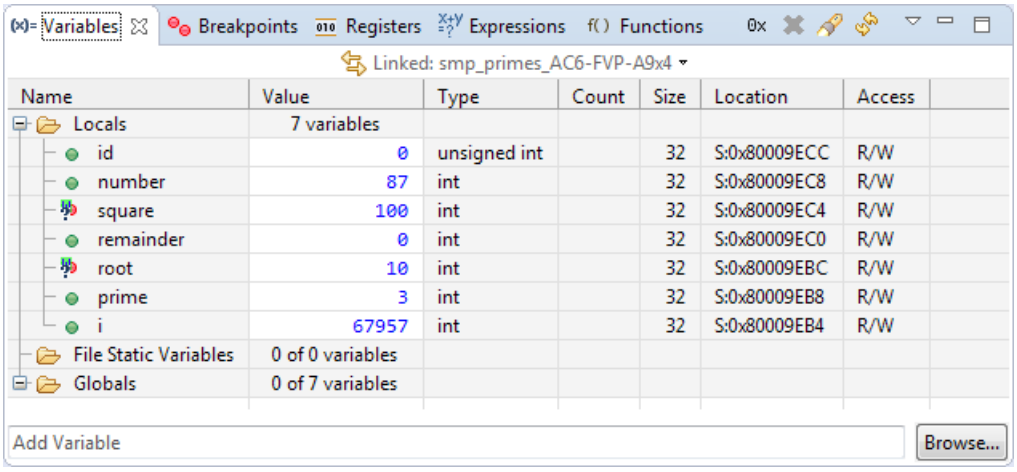


Figure 11-38 Variables view

You can:

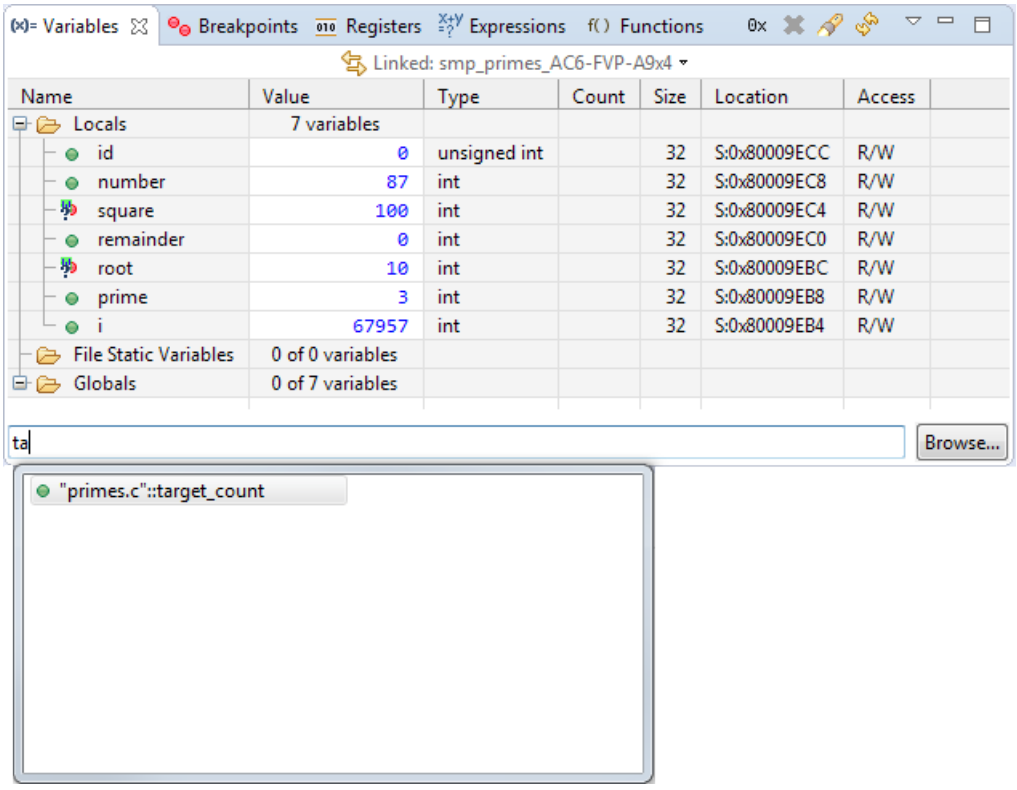
View the contents of variables that are currently in scope

By default, the **Variables** view displays all the local variables. It also displays the file static and global variable folder nodes. You can add or remove variables by selecting one or more variables. Keep the set of variables in the view to a minimum to maintain good debug performance.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Add a specific variable to the Variables view

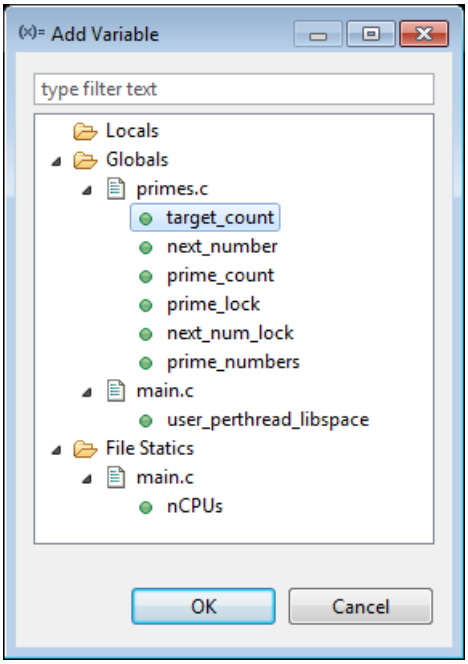
If you know the name of the specific variable you want to view, enter the variable name in the **Add Variable** field. This lists the variables that match the text you entered. For example, enter the text `ta` to view variables with the text `ta` in their name. Double-click the variable to add it to the **Variables** view.



Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Browse and select multiple variables

If you want to view all the available variables in your code, click **Browse** to display the **Add Variable** dialog. Expand the required folders and filenames to see the variables they contain. Then select one or more variables that you are interested in and click **OK** to add them to the **Variables** view. **Ctrl+A** selects all the variables that are visible in the dialog. Selecting a filename or folder does not automatically select its variables.



Delete variables

You can remove the variables, that you added, from the variables view. In the **Variables** view, select the variables you want to remove from the view, and click to remove the selected variables. If you want to reset the view to display the default variables again, then from the view menu, select **Reset to default**.

Tip

You can also use the **Delete** key on your keyboard to delete the variables.

Search for a specific variable

You can use the search feature in the **Variables** view to search for a specific variable in view.

If you know the name of the specific variable, click to display the **Search Variables** dialog box. Either enter the name of the variable you want or select it from the list.
Press `Enter` on your keyboard, or double-click the variable to select and view it in the **Variables** view.

Tip

You can also use `CTRL+F` on your keyboard to display the **Search Variables** dialog box.

Refresh view

To refresh or update the values in the view, click

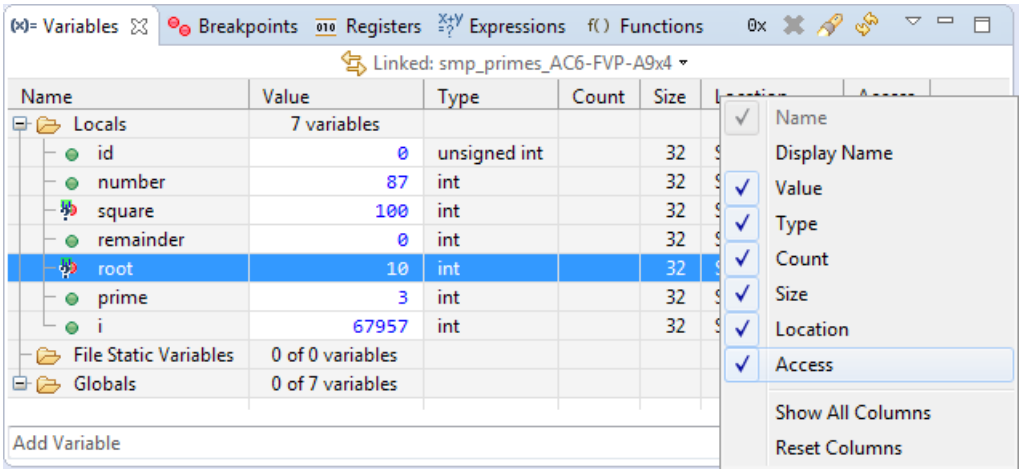
Toggle between numerical and hexadecimal values

Click the button to change all numeric values to hexadecimal values. This works as a toggle and your preference is saved across sessions.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Modify the value of write access variables

You can modify the values of variables with write access by clicking in the **Value** column for the variable and entering a new value. Enable the **Access** column to view access rights for each variable.



Freeze the view to prevent the values being updated by a running target

Select **Freeze Data** from the view menu to prevent values updating automatically when the view refreshes.

Drag and drop a variable from the Variables view to other views

Drag and drop a variable from this view into either the **Memory** view to see the memory at that address, or into the **Disassembly** view to disassemble from that address.

Toolbar and context menu options

The following options are available from the toolbar or context menu:

Linked: *`context`*

Links this view to the selected connection in the **Debug Control** view. This is the default. Alternatively you can link the view to a different connection. If the connection you want is not shown in the drop-down list you might have to select it first in the **Debug Control** view.

Copy

Copies the selected variables. To copy the contents of an item such as a structure or an array, you must first expand that item.

This can be useful if you want to copy variables to a text editor in order to compare the values when execution stops at another location.

Select All

Selects all variables currently expanded in the view.

Show in Memory

Where enabled, displays the **Memory** view with the address set to either:

- The value of the selected variable, if the variable translates to an address, for example the address of an array, `&name`
- The location of the variable, for example the name of an array, `name`.

The memory size is set to the size of the variable, using the **`sizeof`** keyword.

Show in Disassembly

Where enabled, displays the **Disassembly** view, with the address set to the location of the selected variable.

Show in Registers

If the selected variable is currently held in a register, displays the **Registers** view with that register selected.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Show Dereference in Memory
If the selected variable is a pointer, displays the **Memory** view with the address set to the value of the variable.

Show Dereference in Disassembly
If the selected variable is a pointer, displays the **Disassembly** view, with the address set to the value of the variable.

Translate Variable Address
Displays the **MMU** view and translates the address of the variable.

Toggle Watchpoint
Displays the **Add Watchpoint** dialog to set a watchpoint on the selected variable, or removes the watchpoint if one has been set.

Enable Watchpoint
Enables the watchpoint, if a watchpoint has been set on the selected variable.

Disable Watchpoint
Disables the watchpoint, if a watchpoint has been set on the selected variable.

Resolve Watchpoint
If a watchpoint has been set on the selected variable, re-evaluates the address of the watchpoint. If the address can be resolved the watchpoint is set, otherwise it remains pending.

Watchpoint Properties
Displays the **Watchpoint Properties** dialog box. This enables you to control watchpoint activation.

Send to <selection>
Enables you to add variable filters to an **Expressions** view. Displays a sub menu that enables you to specify an **Expressions** view.

<Format list>
A list of formats you can use for the variable value.

View Menu
The following **View Menu** options are available:

New Variables View
Displays a new instance of the **Variables** view.

Update View When Hidden
Enables the updating of the view when it is hidden behind other views. By default, this view does not update when hidden.

Reset to default variables
Resets the view to show only the default variables.

Freeze Data
Toggles the freezing of data in the current view. You cannot modify the value of a variable if the data is frozen. This option also disables or enables the **Refresh** option.

If you freeze the data before you expand an item for the first time, for example an array, the view might show `Pending...`. Unfreeze the data to expand the item.

Editing context menu options
The following options are available on the context menu when you select a variable value for editing:

Undo
Reverts the last change you made to the selected value.

Cut
Copies and deletes the selected value.

Copy
Copies the selected value.

Paste
Pastes a value that you have previously cut or copied into the selected variable value.

Delete
Deletes the selected value.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Select All
Selects the value.

Adding a new column header

Right-click on the column headers to select the columns that you want to display:

Name
The name of the variable.

Value
The value of the variable.
Read-only values are displayed with a grey background. A value that you can edit is initially shown with a white background. A yellow background indicates that the value has changed. This might result from you either performing a debug action such as stepping or by you editing the value directly.

Note

If you freeze the view, then you cannot change a value.

Type
The type of the variable.

Count
The number of array or pointer elements.

Size
The size of the variable in bits.

Location
The address of the variable.

Access
The access mode for the variable.

Show All Columns
Displays all columns.

Reset Columns
Resets the columns displayed and their widths to the default.

Related concepts

6.8 About debugging multi-threaded applications on page 6-152.
6.9 About debugging shared libraries on page 6-153.
6.10.2 About debugging a Linux kernel on page 6-156.
6.10.3 About debugging Linux kernel modules on page 6-158.
6.11 About debugging TrustZone enabled targets on page 6-160.

Related references

3.13 Setting a tracepoint on page 3-89.
3.8 Conditional breakpoints on page 3-81.
3.9 Assigning conditions to an existing breakpoint on page 3-82.
3.12 Pending breakpoints and watchpoints on page 3-87.
Chapter 11 DS-5 Debug Perspectives and Views on page 11-261.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.29 Timed Auto-Refresh Properties dialog box

Use the **Timed Auto-Refresh Properties** dialog box to modify the update interval settings.

Update Interval
Specifies the auto refresh interval in seconds.

Update When
Specifies when to refresh the view:

`Running`
Refreshes the view only while the target is running.

`Stopped`
Refreshes the view only while the target is stopped.

`Always`
Always refreshes the view.

Note

When you select `Running` or `Always`, the **Memory** and **Screen** views are only updated if the target supports access to that memory when running. For example, some CoreSight targets support access to physical memory at any time through the *Debug Access Port* (DAP) to the *Advanced High-performance Bus Access Port* (AHB-AP) bridge. In those cases, add the `AHB:` prefix to the address selected in the **Memory** or **Screen** views. This type of access bypasses any cache on the CPU core, so the memory content returned might be different to the value that the core reads.

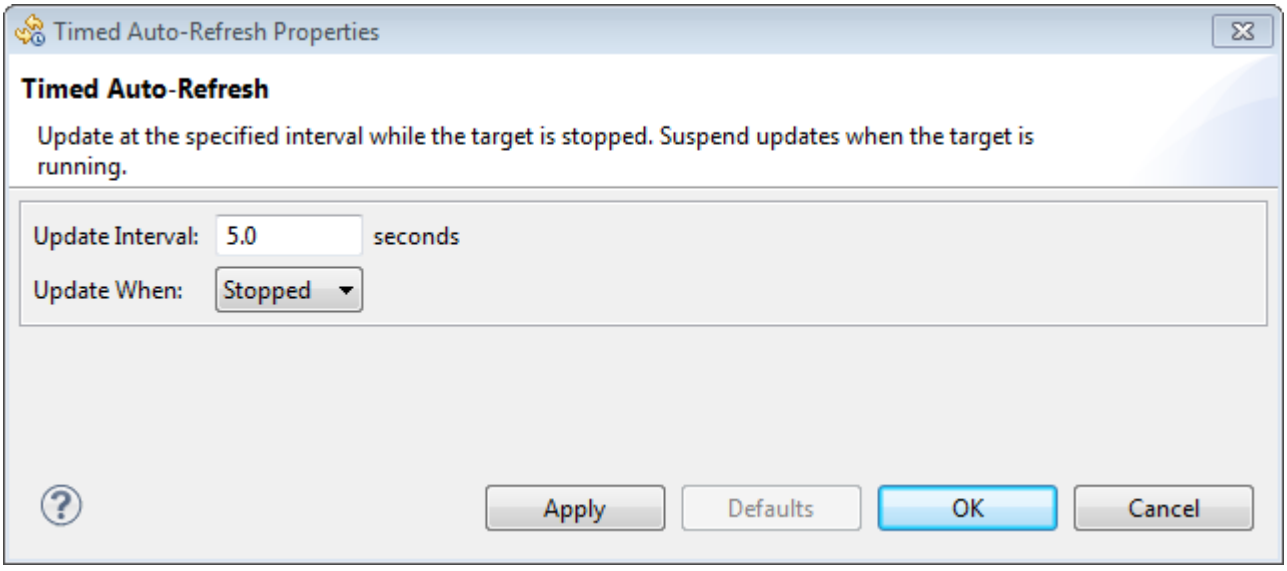


Figure 11-39 Timed Auto-Refresh Properties dialog box

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.30 Memory Exporter dialog box

Use the **Memory Exporter** dialog box to generate a file containing the data from a specific region of memory.

Memory Bounds

Specifies the memory region to export:

`Start Address`

Specifies the start address for the memory.

`End Address`

Specifies the inclusive end address for the memory.

`Length in Bytes`

Specifies the number of bytes.

Output Format

Specifies the output format:

- Binary. This is the default.
- Intel Hex-32.
- Motorola 32-bit (S-records).
- Byte oriented hexadecimal (Verilog Memory Model).

Export Filename

Enter the location of the output file in the field provided or click on:

- **File System...** to locate the output file in an external folder
- **Workspace...** to locate the output file in a workspace project.

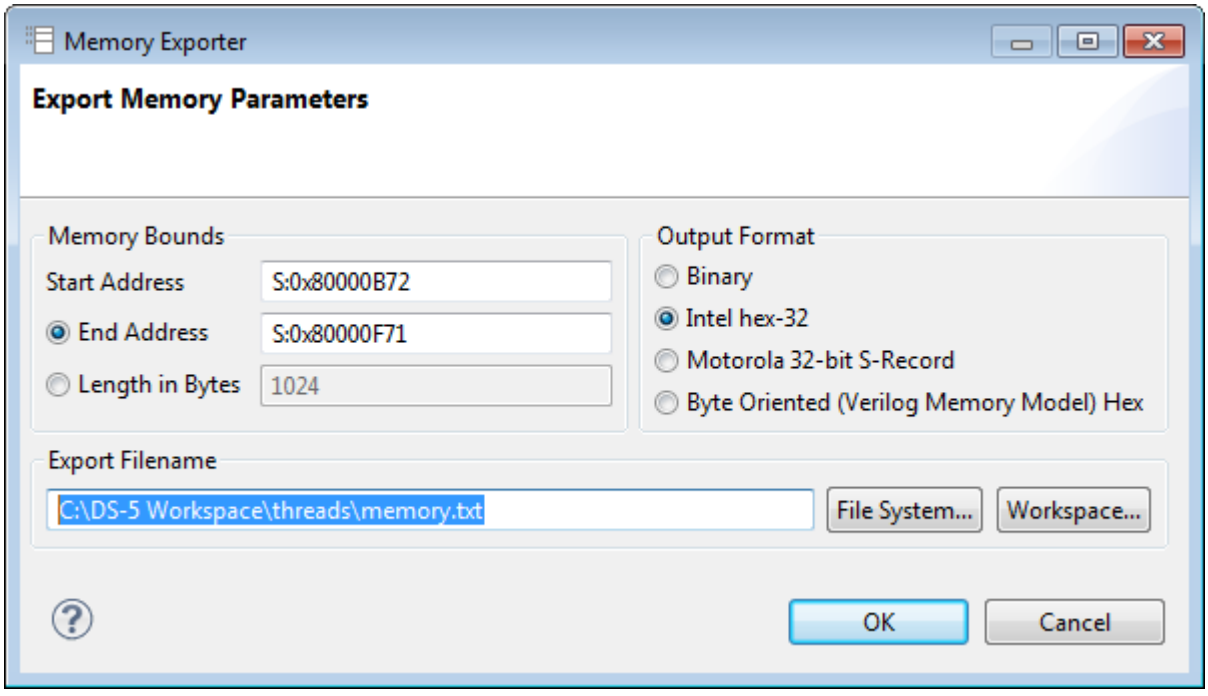


Figure 11-40 Memory Exporter dialog box

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.31 Memory Importer dialog box

Use the **Memory Importer** dialog box to import data from a file into memory.

Offset to Embedded Address

Specifies an offset that is added to all addresses in the image prior to importing it. Some image formats do not contain embedded addresses and in this case the offset is the absolute address to which the image is imported.

Memory Limit

Enables you to define a region of memory that you want to import to:

Limit to memory range

Specifies whether to limit the address range.

Start

Specifies the minimum address that can be written to. Any address prior to this is not written to. If no address is given then the default is address zero.

End

Specifies the maximum address that can be written to. Any address after this is not written to. If no address is given then the default is the end of the address space.

Import File Name

Select **Import file as binary image** if the file format is binary.

Enter the location of the file in the field provided or click on:

- **File System...** to locate the file in an external folder
- **Workspace...** to locate the file in a workspace project.

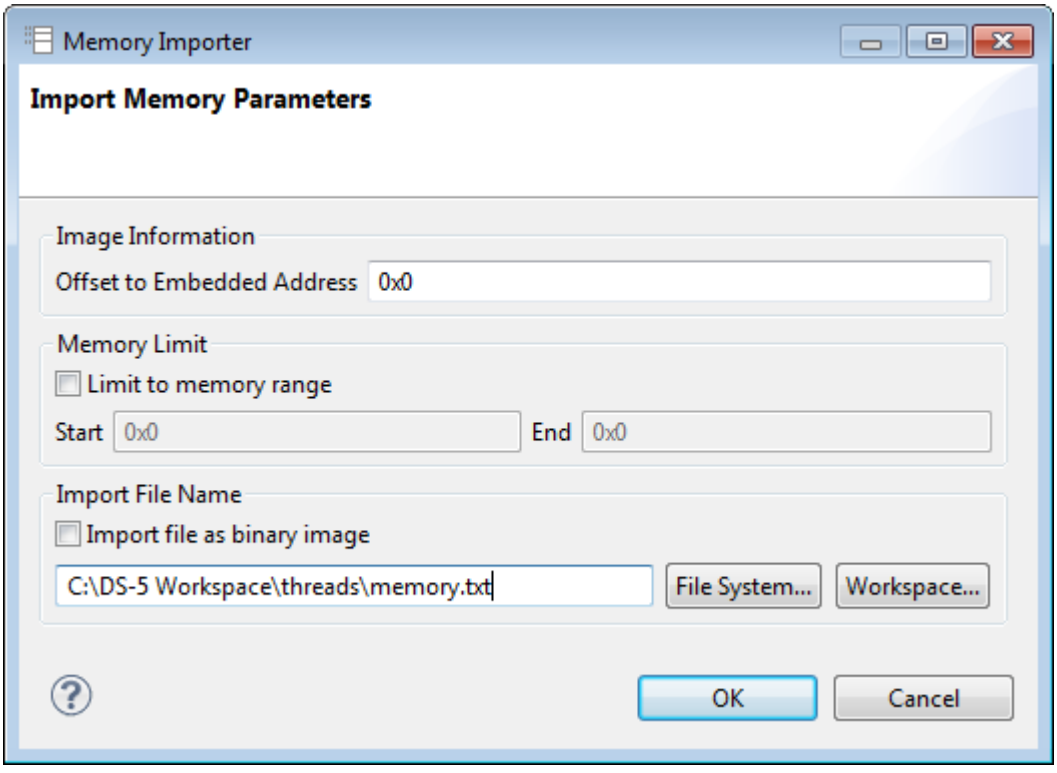


Figure 11-41 Memory Importer dialog box

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.32 Fill Memory dialog box

Use the **Fill Memory** dialog box to fill a memory region with a pattern of bytes.

Memory Bounds

Specifies the memory region:

`Start Address`

Specifies the start address of the memory region.

`End Address`

Specifies the inclusive end address of the memory region.

`Length in Bytes`

Specifies the number of bytes to fill.

Data Pattern

Specifies the fill pattern and its size in bytes.

`Fill size`

Specifies the size of the fill pattern as either 1, 2, 4, or 8 bytes.

`Pattern`

Specifies the pattern with which to fill the memory region.

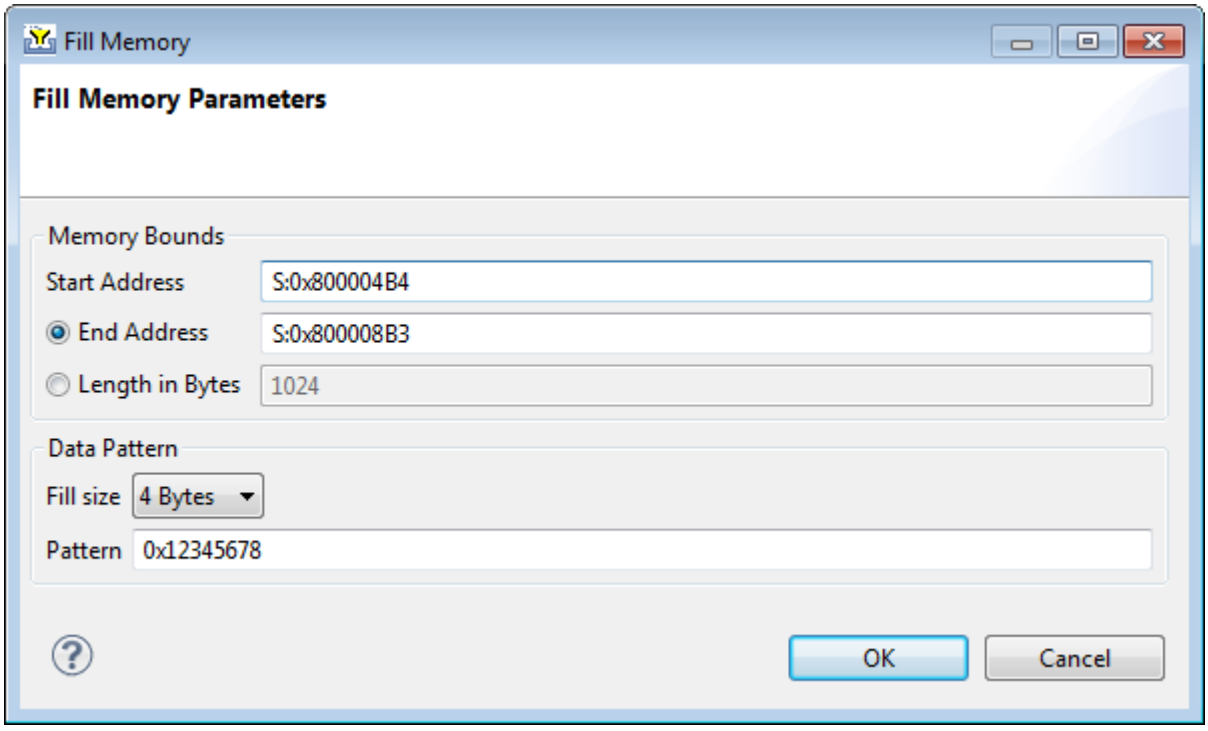


Figure 11-42 Fill Memory dialog box

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.33 Export Trace Report dialog box

Use the **Export Trace Report** dialog box to export a trace report.

Report Name

Enter the report location and name.

Base Filename

Enter the report name.

Output Folder

Enter the report folder location.

Browse

Selects the report location in the file system.

Include core

Enables you to add the core name in the report filename.

Include date time stamp

Enables you to add the date time stamp to the report filename.

Split Output Files

Splits the output file when it reaches the selected size.

Select source for trace report

Selects the required trace data.

Use trace view as report source

Instructions that are decoded in the trace view.

Use trace buffer as report source

Trace data that is currently contained in the trace buffer.

Note

When specifying a range, ensure that the range is large enough otherwise you might not get any trace output. This is due to the trace packing format used in the buffer.

Report Format

Configures the report.

Output Format

Selects the output format.

Include column headers

Enables you to add column headers in the first line of the report.

Select columns to export

Enables you to filter the trace data in the report.

Record Filters

Enables or disables trace filters.

Check All

Enables you to select all the trace filters.

Uncheck All

Enables you to unselect all the trace filters.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

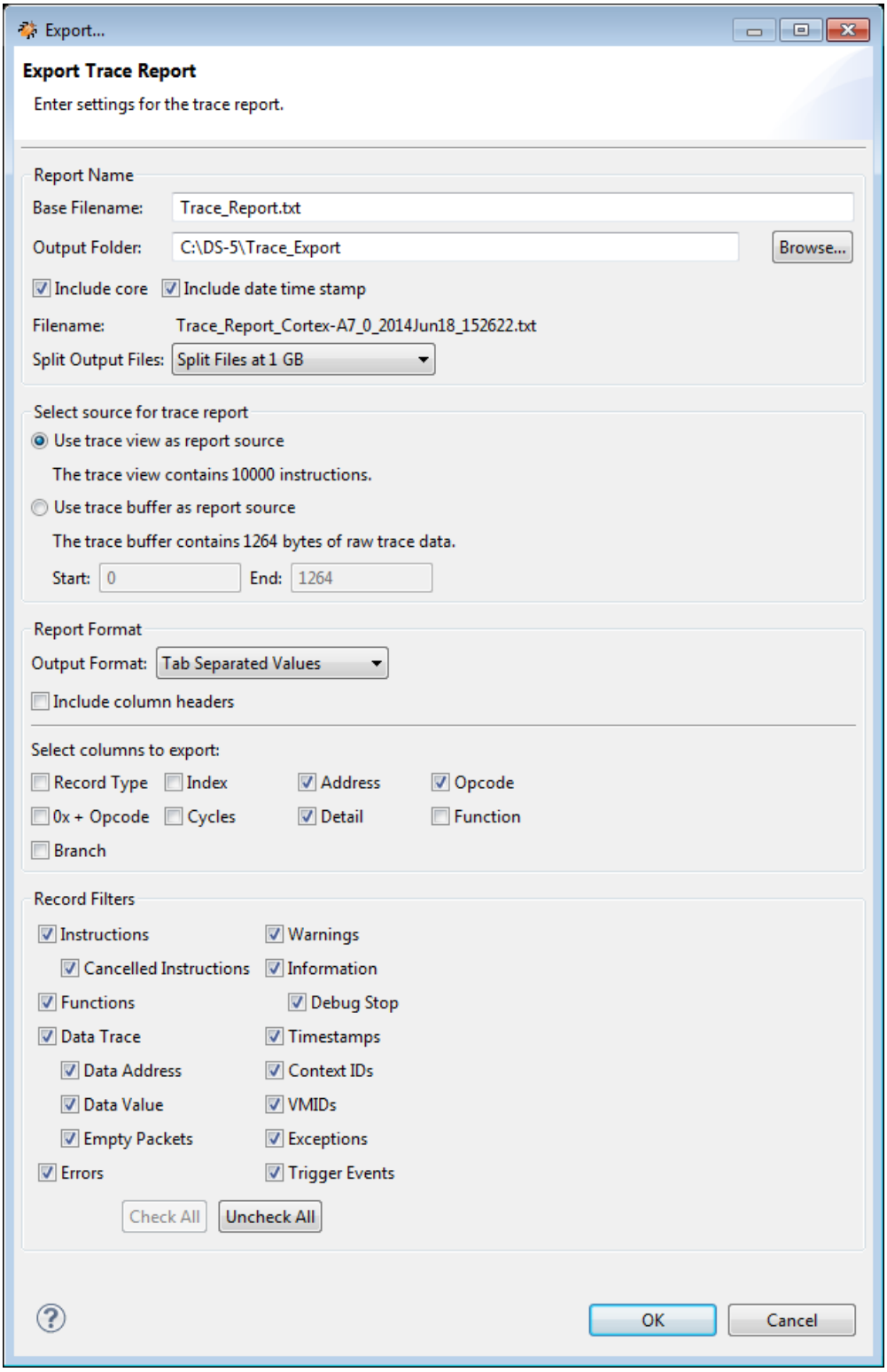


Figure 11-43 Export Trace Report dialog box

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.34 Breakpoint Properties dialog box

Use the **Breakpoint Properties** dialog box to display the properties of a breakpoint.

It also enables you to:

- Set a stop condition and an ignore count for the breakpoint.
- Specify a script file to run when the breakpoint is hit.
- Configure the debugger to automatically continue running on completion of all the breakpoint actions.
- Assign a breakpoint action to a specific thread or processor, if available.

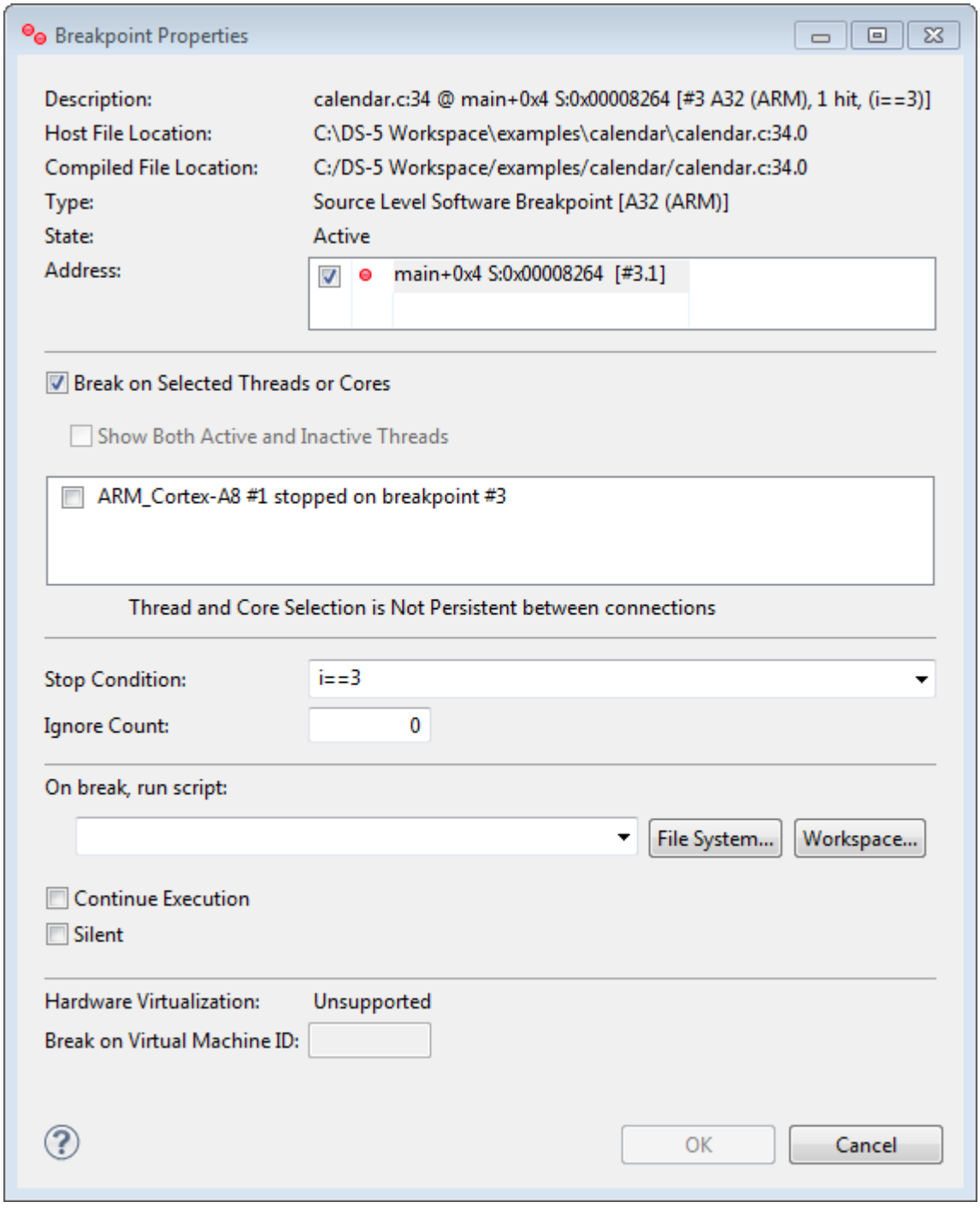


Figure 11-44 Breakpoint properties dialog box

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Breakpoint information

The breakpoint information shows the basic properties of a breakpoint. It comprises:

Description

- If the source file is available, the file name and line number in the file where the breakpoint is set, for example `calendar.c:34`.
- The name of the function in which the breakpoint is set and the number of bytes from the start of the function. For example, `main+0x4` shows that the breakpoint is 4 bytes from the start of the `main()` function.
- The address at which the breakpoint is set.
- A breakpoint ID number, `#N`. In some cases, such as in a **`for`** loop, a breakpoint might comprise a number of sub-breakpoints. These are identified as `N.n`, where `N` is the number of the parent.
- The instruction set at the breakpoint, `A32 (ARM)` or `T32 (Thumb)`.
- An `ignore` count, if set. The display format is:

  `ignore = num/count`

  `num` equals `count` initially, and decrements on each pass until it reaches zero.

  `count` is the value you have specified for the `ignore` count.
- A `hits` count that increments each time the breakpoint is hit. This is not displayed until the first hit. If you set an `ignore` count, `hits` count does not start incrementing until the `ignore` count reaches zero.
- The stop condition you have specified, for example `i==3`.

Host File Location

The location of the image on the host machine.

Compiled File Location

The path that the image was compiled with. This can be relative or absolute. This location might be different from the host file location if you compile and debug the image on different machines.

Type

This shows:

- Whether or not the source file is available for the code at the breakpoint address, `Source Level` if available or `Address Level` if not available.
- If the breakpoint is on code in a shared object, `Auto` indicates that the breakpoint is automatically set when that shared object is loaded.
- If the breakpoint is `Active`, the type of the breakpoint, either `Software Breakpoint` or `Hardware Breakpoint`.
- The instruction set of the instruction at the address of the breakpoint, `A32 (ARM)` or `T32 (Thumb)`.

State

Indicates one of the following:

Active

The image or shared object containing the address of the breakpoint is loaded, and the breakpoint is set.

Disabled

The breakpoint is disabled.

No Connection

The breakpoint is in an application that is not connected to a target.

Pending

The image or shared object containing the address of the breakpoint has not yet been loaded. The breakpoint becomes active when the image or shared object is loaded.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Address
A dialog box that displays one or more breakpoint or sub-breakpoint addresses. You can use the check boxes to enable or disable the breakpoints.

Breakpoint options

The following options are available for you to set:

Break on Selected Threads or Cores
Select this option if you want to set a breakpoint for a specific thread or processor. This option is disabled if none are available.

Stop Condition
Specify a C-style conditional expression for the selected breakpoint. For example, to activate the breakpoint when the value of `x` equals `10`, specify `x==10`.

Ignore Count
Specify the number of times the selected breakpoint is ignored before it is activated.

The debugger decrements the count on each pass. When it reaches zero, the breakpoint activates. Each subsequent pass causes the breakpoint to activate.

On break, run script
Specify a script file to run when the selected breakpoint is activated.

Note

Take care with the commands you use in a script that is attached to a breakpoint. For example, if you use the `quit` command in a script, the debugger disconnects from the target when the breakpoint is hit.

Continue Execution
Select this option if you want to continue running the target after the breakpoint is activated.

Silent
Controls the printing of messages for the selected breakpoint in the **Commands** view.

Hardware Virtualization
Indicates whether Hardware Virtualization is supported.

Break on Virtual Machine ID
If Hardware Virtualization is supported, specify the *Virtual Machine ID* (VMID) of the guest operating system to which the breakpoint applies.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.35 Watchpoint Properties dialog box

Use the **Watchpoint Properties** dialog box to display the properties of a watchpoint.

You can:

- View the **Location** at which the watchpoint is set.
- View the memory **Address** at which the watchpoint is set.
- View the **Access Type** of the watchpoint.
- Enable or disable the watchpoint.
- Set the **Data Width**.
- Specify a **Stop Condition**.

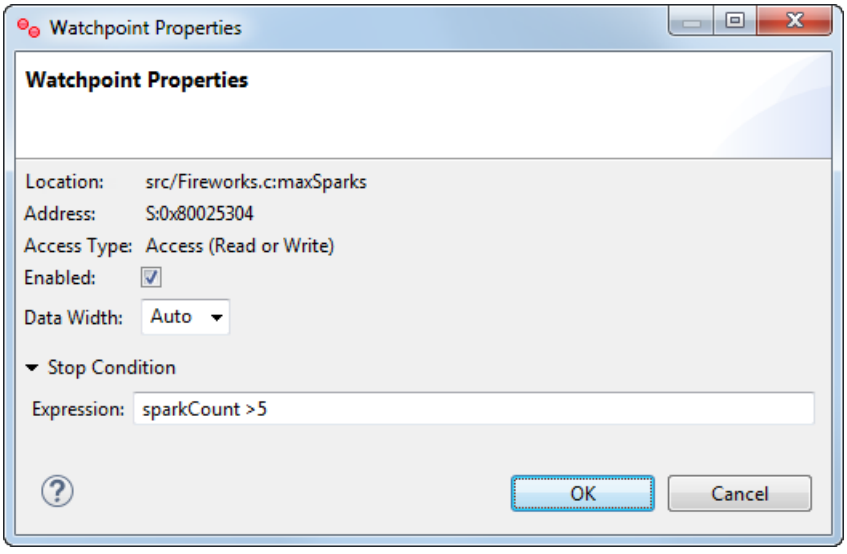


Figure 11-45 Watchpoint Properties dialog box

Location
The data location at which the watchpoint is set.

Address
The memory address at which the watchpoint is set.

Access Type
The type of access specified for the watchpoint.

Enabled
Select to enable watchpoint, deselect to disable watchpoint.

Data Width
Specify the width to watch at the given address, in bits. Accepted values are: 8, 16, 32, and 64 if supported by the target. This parameter is optional.
The width defaults to:

- 32 bits for an address.
- The width corresponding to the type of the symbol or expression, if entered.

Stop Condition
Specify the condition which must evaluate to true at the time the watchpoint is triggered for the target to stop. Enter a C-style expression. For example, if your application code has a variable `x`, then you can specify: `x == 10`.

Note

You can create several conditional watchpoints, but when a conditional watchpoint is enabled, no other watchpoints (regardless of whether they are conditional) can be enabled.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.36 Tracepoint Properties dialog box

Use the **Tracepoint Properties** dialog box to display the properties of a tracepoint.

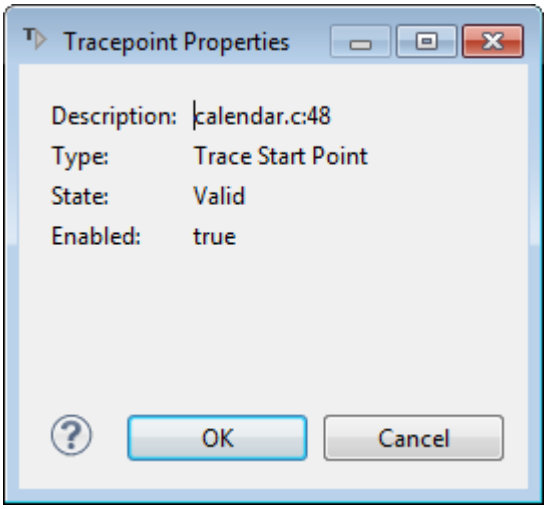


Figure 11-46 Tracepoint Properties dialog box

The following types are available:

Trace Start Point
Enables trace capture when it is hit.

Trace Stop Point
Disables trace capture when it is hit.

Trace Trigger Point
Starts trace capture when it is hit.

Note

Tracepoint behavior might vary depending on the selected target.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.37 Manage Signals dialog box

Use the **Manage Signals** dialog box to control the handler (vector catch) settings for one or more signals or processor exceptions.

To view the **Manage Signals** dialog box:

1. Select **Manage Signals** from the **Breakpoints** toolbar or the view menu.
2. Select the individual **Signal** you want to **Stop** or **Print** information, and click **OK**.

View the results in the **Command** view.

Tip

You can also use the `info signals` command to display the current signal handler settings.

When a signal or processor exception occurs you can choose to stop execution, print a message, or both. **Stop** and **Print** are selected for all signals by default.

Note

When connected to an application running on a remote target using gdbserver, the debugger handles Unix signals, but on bare-metal targets with no operating system it handles processor exceptions.

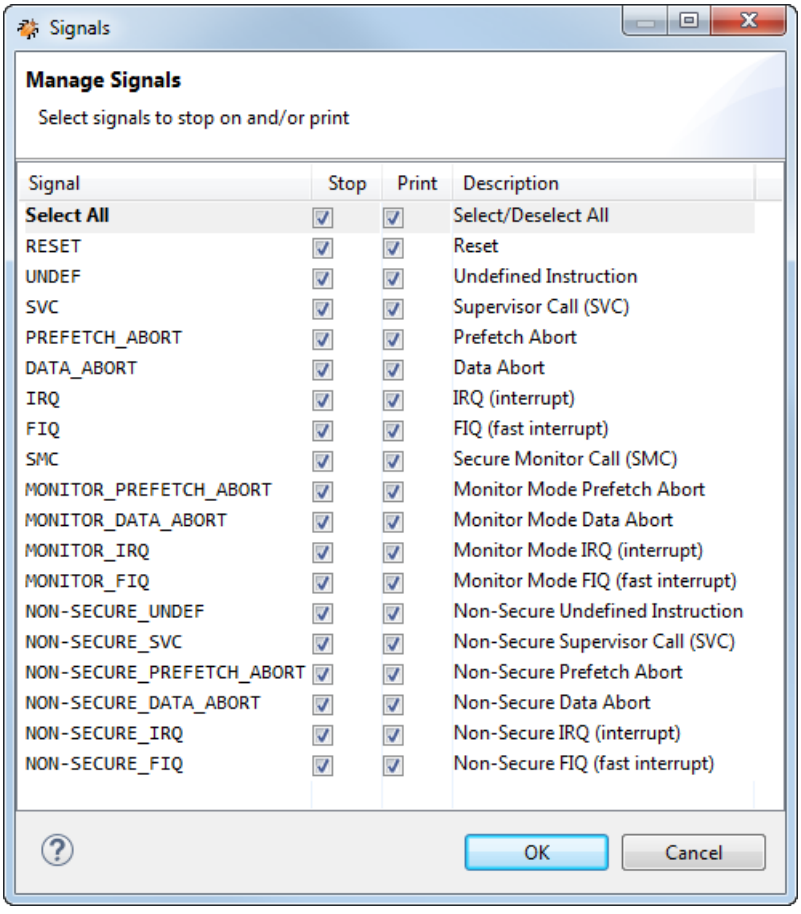


Figure 11-47 Manage Signals dialog box

Related references

3.14 Handling UNIX signals on page 3-90.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

3.15 Handling processor exceptions on page 3-92.
11.4 Breakpoints view on page 11-268.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.38 Functions Filter dialog box

Use the **Functions Filter** dialog box to filter the list of symbols that are displayed in the **Functions** view.

You can filter functions by compilation unit or image and by function name.

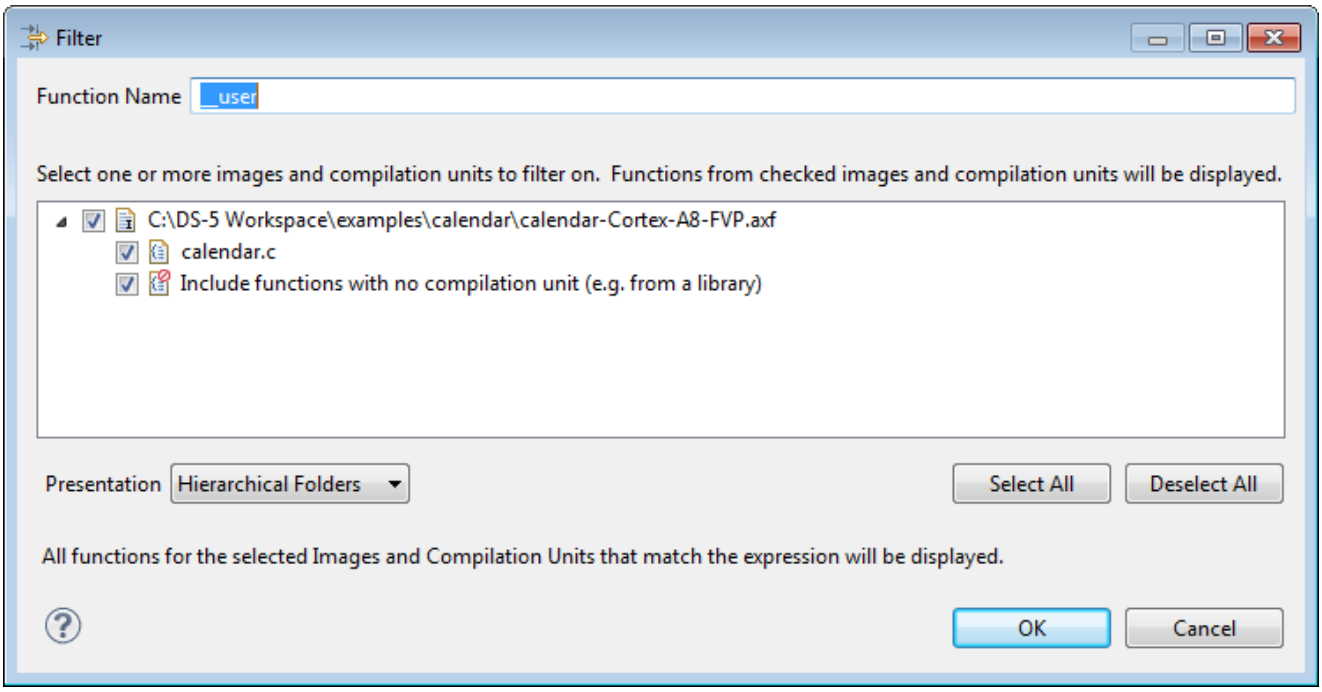


Figure 11-48 Function filter dialog box

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.39 Script Parameters dialog box

Use the **Script Parameters** dialog box to specify script parameters.

Script Parameters
Specifies parameters for the script in the text field. Parameters must be space-delimited.

Variables...
Opens the **Select Variable** dialog box, in which you can select variables that are passed to the application when the debug session starts. For more information on Eclipse variables, use the dynamic help.

Enable Verbose Mode
Checking this option causes the script to run in verbose mode. This means that each command in the script is echoed to the **Commands** view.

OK
Saves the current parameters and closes the Script Parameters dialog box.

Cancel
Closes the Script Parameters dialog box without saving the changes.

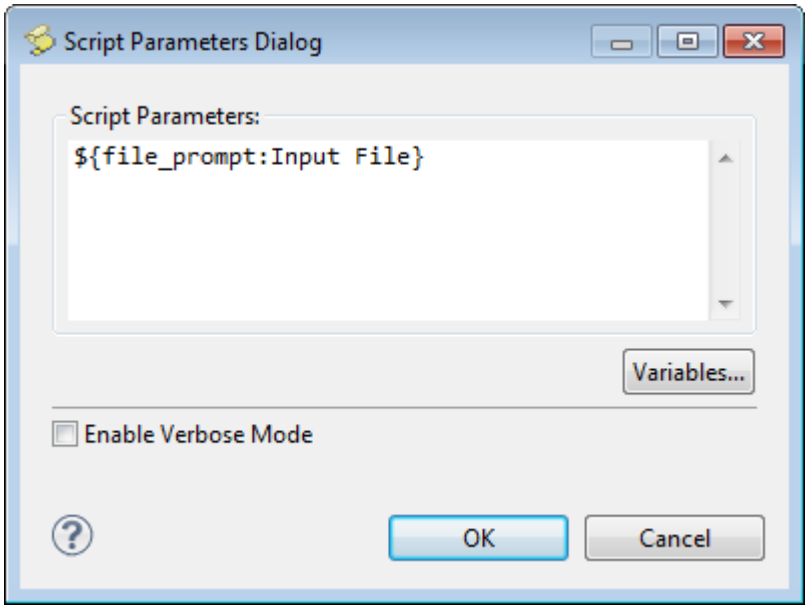


Figure 11-49 Script Parameters dialog box

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.40 Debug Configurations - Connection tab

Use the **Connection** tab in the **Debug Configurations** dialog box to configure DS-5 Debugger target connections. Each configuration you create is associated with a single target processor.

If the development platform has multiple processors, then you must create a separate configuration for each processor. Be aware that when connecting to multiple targets you cannot perform synchronization or cross-triggering operations.

Note

Options in the **Connection** tab are dependent on the type of platform that you select.

Select target
These options enable you to select the target manufacturer, board, project type, and debug operation.

DTSL Options
Select **Edit...** to open a dialog box to configure additional debug and trace settings.

Connections
These options enable you to configure the connection between the debugger and the target:

RSE connection
A list of *Remote Systems Explorer* (RSE) configurations that you have previously set up. Select the required RSE configuration that you want to use for this debug configuration. You must select an RSE connection to the target if your Linux application debug operation is:

- **Download and debug application**
- **Start gdbserver and debug target-resident application**.

gdbserver (TCP)
Specify the target IP address or name and the associated port number for the connection between the debugger and `gdbserver`.
The following options might also be available, depending on the debug operation you selected:

- Select the **Use Extended Mode** checkbox if you want to restart an application under debug. Be aware that this might not be fully implemented by `gdbserver` on all targets.
- Select the **Terminate gdbserver on disconnect** checkbox to terminate `gdbserver` when you disconnect from the target.
- Select the **Use RSE Host** checkbox to connect to `gdbserver` using the RSE configured host.

gdbserver (serial)
Specify the local serial port and connection speed for the serial connection between the debugger and `gdbserver`.

For model connections, details for `gdbserver` are obtained automatically from the target.

Select the **Use Extended Mode** checkbox if you want to restart an application under debug. Be aware that this might not be fully implemented by `gdbserver` on all targets.

Bare Metal Debug
Specify the target IP address or name of the debug hardware adapter. You can also click on **Browse...** to display all the available debug hardware adapters on your local subnet or USB connections.

Model parameters
Specify the parameter for launching the model.

Model parameters (pre-configured to boot ARM Embedded application)

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

These options are only enabled for the pre-configured option that boots an ARM Embedded *Fixed Virtual Platform*.

You can configure a *Virtual File System* (VFS) that enables a model to run an application and related shared library files from a directory on the local host. Alternatively, you can disable VFS and manually transfer the files to a directory on the model.

Enable virtual file system support
Enable or disable the use of *Virtual File System* (VFS).

Host mount point
Specify the location of the file system on the local host. You can:

- Enter the location in the field provided.
- Click **File System...** to locate the directory in an external location from the workspace.
- Click **Workspace...** to locate the directory within your workspace.

Remote target mount point
Displays the default location of the file system on the model. The default is the `/writeable` directory.

Apply
Save the current configuration. This does not connect to the target.

Revert
Undo any changes and revert to the last saved configuration.

Debug
Connect to the target and close the **Debug Configurations** dialog box.

Close
Close the **Debug Configurations** dialog box.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

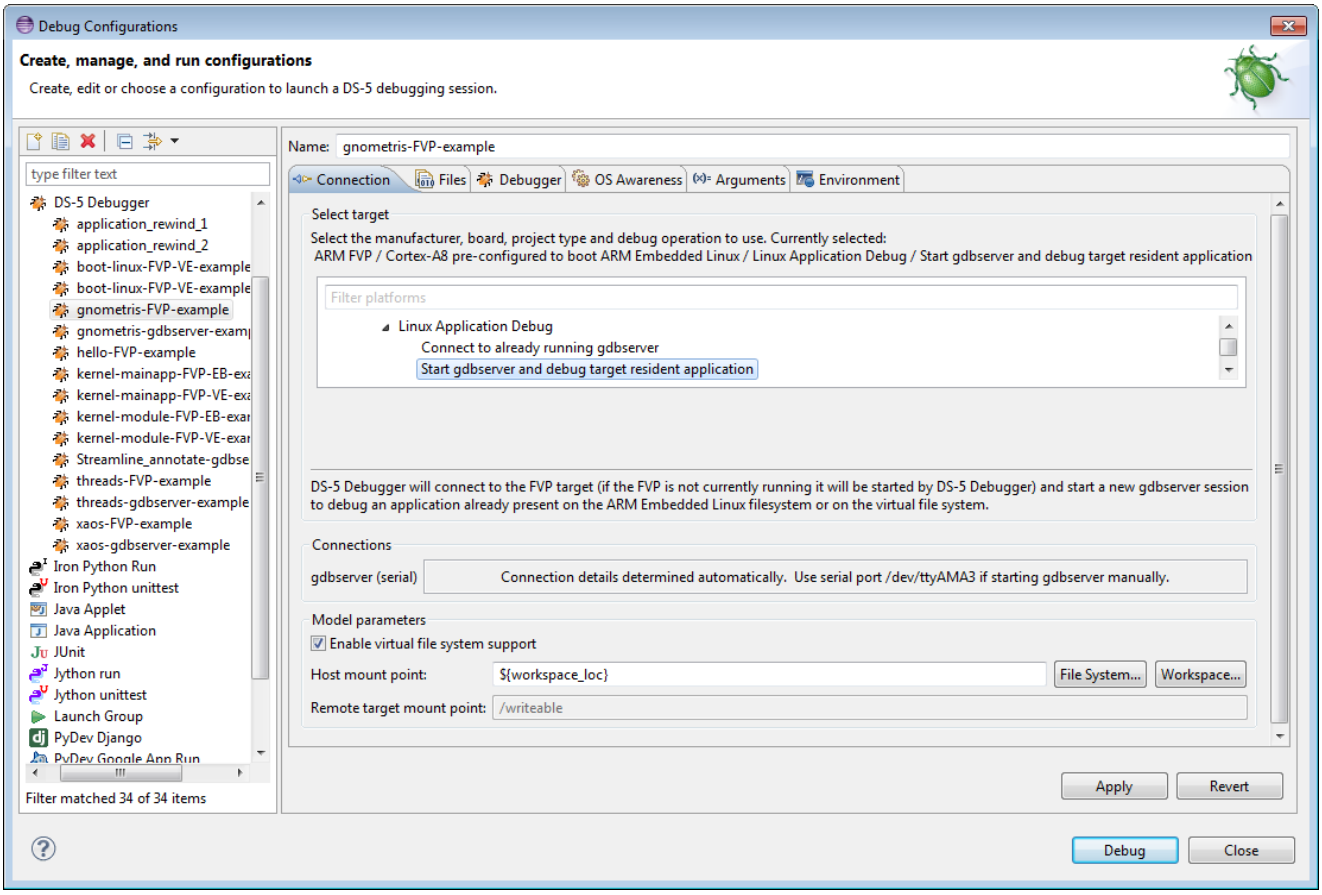


Figure 11-50 Connection tab (Shown with connection configuration for an FVP with virtual file system support enabled)

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.41 Debug Configurations - Files tab

Use the **Files** tab in the **Debug Configurations** dialog box to select debug versions of the application file and libraries on the host that you want the debugger to use.

You can also specify the target file system folder to which files can be transferred if required.

Note

Options in the **Files** tab depend on the type of platform and debug operation that you select.

Files

These options enable you to configure the target file system and select files on the host that you want to download to the target or use by the debugger. The **Files** tab options available for each **Debug operation** are:

Table 11-2 Files tab options available for each Debug operation

	Download and debug application	Debug target resident application	Connect to already running gdbserver	Debug via DSTREAM\RVI	Debug and ETB Trace via DSTREAM\RVI
Application on host to download	Yes	-	-	Yes	Yes
Application on target	-	Yes	-	-	-
Target download directory	Yes	-	-	-	-
Target working directory	Yes	Yes	-	-	-
Load symbols from file	Yes	Yes	Yes	Yes	Yes
Other file on host to download	Yes	-	-	-	-
Path to target system root directory	Yes	Yes	Yes	-	-

Apply

Save the current configuration. This does not connect to the target.

Revert

Undo any changes and revert to the last saved configuration.

Debug

Connect to the target and close the **Debug Configurations** dialog box.

Close

Close the **Debug Configurations** dialog box.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

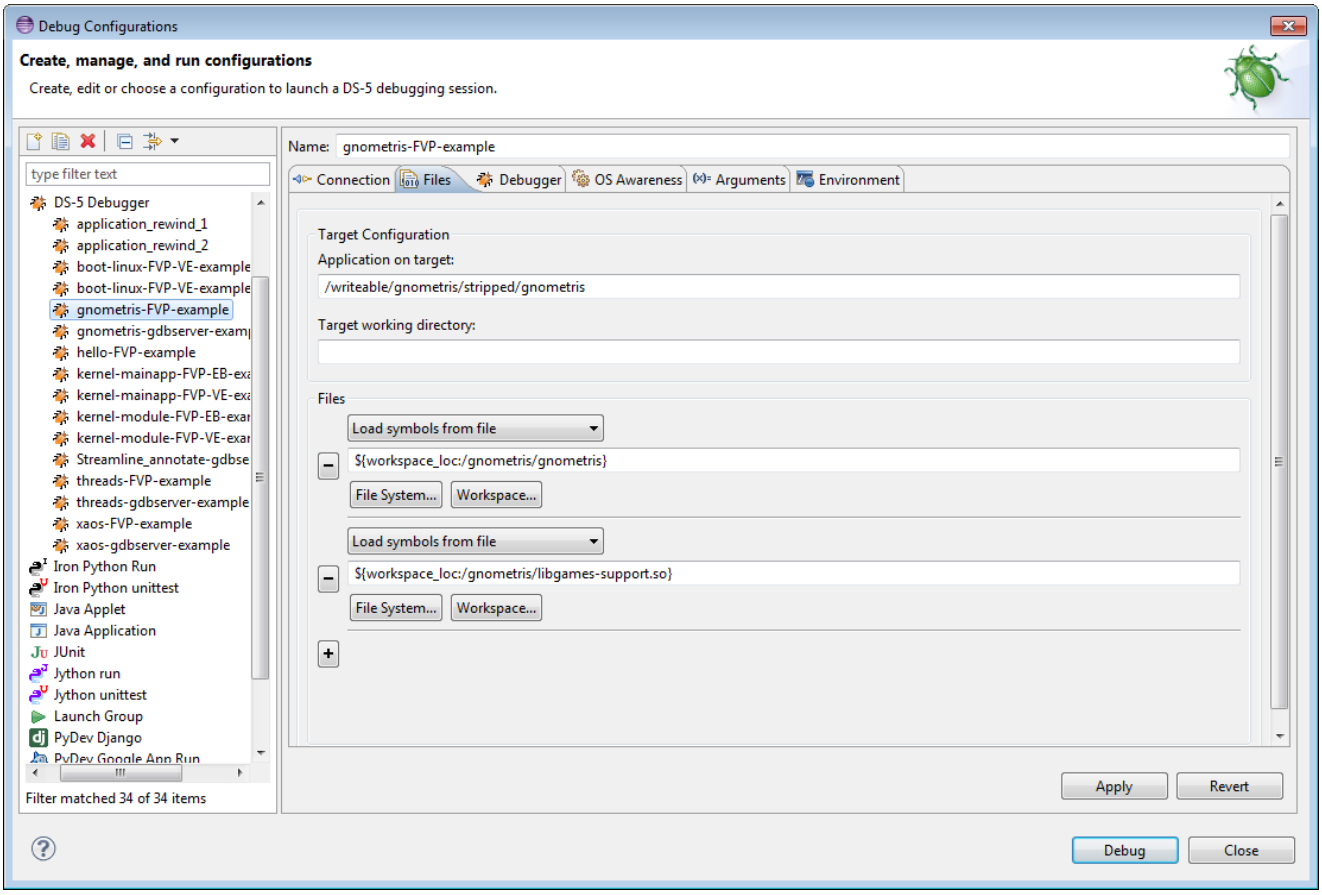


Figure 11-51 Files tab (Shown with file system configuration for an application on an FVP)

Files options summary

The Files options available depend on the debug operation you selected on the **Connection** tab. The possible options are:

Application on host to download

Specify the application image file on the host that you want to download to the target:

- Enter the host location and file name in the field provided.
- Click on **File System...** to locate the file in an external directory from the Eclipse workspace.
- Click on **Workspace...** to locate the file in a project directory or sub-directory within the Eclipse workspace.

  For example, to download the stripped (no debug) Gnometris application image, select the `gnometris/stripped/gnometris` file.

Select **Load symbols** to load the debug symbols from the specified image.

Application on target

Specify the location of the application on the target. `gdbserver` uses this to launch the application.

For example, to use the stripped (no debug) Gnometris application image when using a model and VFS is configured to mount the host workspace as `/writeable` on the target, specify the following in the field provided:

`/writeable/gnometris/stripped/gnometris`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Target download directory

If the target has a preloaded image, then you might have to specify the location of the corresponding image on your host.

The debugger uses the location of the application image on the target as the default current working directory. To change the default setting for the application that you are debugging, enter the location in the field provided. The current working directory is used whenever the application references a file using a relative path.

Load symbols from file

Specify the application image containing the debug information to load:

- Enter the host location and file name in the field provided.
- Click on **File System...** to locate the file in an external directory from the workspace.
- Click on **Workspace...** to locate the file in a project directory or sub-directory within the workspace.

For example, to load the debug version of Gnometris you must select the `gnometris` application image that is available in the `gnometris` project root directory.

Although you can specify shared library files here, the usual method is to specify a path to your shared libraries with the **Shared library search directory** option on the **Debugger** tab.

Note

Load symbols from file is selected by default.

Add peripheral description files from directory

A directory with configuration files defining peripherals that must be added before connecting to the target.

Other file on host to download

Specify other files that you want to download to the target:

- Enter the host location and file name in the field provided.
- Click on **File System...** to locate the file in an external directory from the workspace.
- Click on **Workspace...** to locate the file in a project directory or sub-directory within the workspace.

For example, to download the stripped (no debug) Gnometris shared library to the target you can select the `gnometris/stripped/libgames-support.so` file.

Path to target system root directory

Specifies the system root directory to search for shared library symbols.

The debugger uses this directory to search for a copy of the debug versions of target shared libraries. The system root on the host workstation must contain an exact representation of the libraries on the target root filesystem.

Target working directory

If this field is not specified, the debugger uses the location of the application image on the target as the default current working directory. To change the default setting for the application that you are debugging, enter the location in the field provided. The current working directory is used whenever the application refers to a file using a relative path.

Remove this resource file from the list

To remove a resource from the configuration settings, click this button next to the resource that you want to remove.

Add a new resource to the list

To add a new resource to the file settings, click this button and then configure the options as required.

Related concepts

6.10.2 About debugging a Linux kernel on page 6-156.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.42 Debug Configurations - Debugger tab

Use the **Debugger** tab in the **Debug Configurations** dialog box to specify the actions that you want the debugger to do after connection to the target.

Run Control

These options enable you to define the running state of the target when you connect:

Connect only

Connect to the target, but do not run the application.

Note

The PC register is not set and pending breakpoints or watchpoints are subsequently disabled when a connection is established.

Debug from entry point

Run the application when a connection is established, then stop at the image entry point.

Debug from symbol

Run the application when a connection is established, then stop at the address of the specified symbol. The debugger must be able to resolve the symbol. If you specify a C or C++ function name, then do not use the `()` suffix.

If the symbol can be resolved, execution stops at the address of that symbol.

If the symbol cannot be resolved, a message is displayed in the **Commands** view warning that the symbol cannot be found. The debugger then attempts to stop at the image entry point.

Run target initialization debugger script (.ds / .py)

Select this option to execute target initialization scripts (a file containing debugger commands) immediately after connection. To select a file:

- Enter the location and file name in the field provided.
- Click on **File System...** to locate the file in an external directory from the workspace.
- Click on **Workspace...** to locate the file in a project directory or sub-directory within the workspace.

Run debug initialization debugger script (.ds / .py)

Select this option to execute debug initialization scripts (a file containing debugger commands) after execution of any target initialization scripts and also running to an image entry point or symbol, if selected. To select a file:

- Enter the location and file name in the field provided.
- Click on **File System...** to locate the file in an external directory from the workspace.
- Click on **Workspace...** to locate the file in a project directory or sub-directory within the workspace.

  Note

  You might have to insert a `wait` command before a `run` or `continue` command to enable the debugger to connect and run the application to the specified function.

Execute debugger commands

Enter debugger commands in the field provided if you want to automatically execute specific debugger commands that run on completion of any initialization scripts. Each line must contain only one debugger command.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Host working directory

The debugger uses the Eclipse workspace as the default working directory on the host. To change the default setting for the application that you are debugging, deselect the **Use default** check box and then:

- Enter the location in the field provided.
- Click on **File System...** to locate the external directory.
- Click on **Workspace...** to locate the project directory.

Paths

You can modify the search paths on the host used by the debugger when it displays source code.

Source search directory

Specify a directory to search for source files:

- Enter the location and file name in the field provided.
- Click on **File System...** to locate the directory in an external location from the workspace.
- Click on **Workspace...** to locate the directory within the workspace.

Shared library search directory

Specify a directory to search for shared libraries:

- Enter the location in the field provided.
- Click on **File System...** to locate the directory in an external location from the workspace.
- Click on **Workspace...** to locate the directory within the workspace.

Remove this resource file from the list

To remove a search path from the configuration settings, click this button next to the resource that you want to remove.

Add a new resource to the list

To add a new search path to the configuration settings, click this button and then configure the options as required.

Apply

Save the current configuration. This does not connect to the target.

Revert

Undo any changes and revert to the last saved configuration.

Debug

Connect to the target and close the **Debug Configurations** dialog box.

Close

Close the **Debug Configurations** dialog box.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

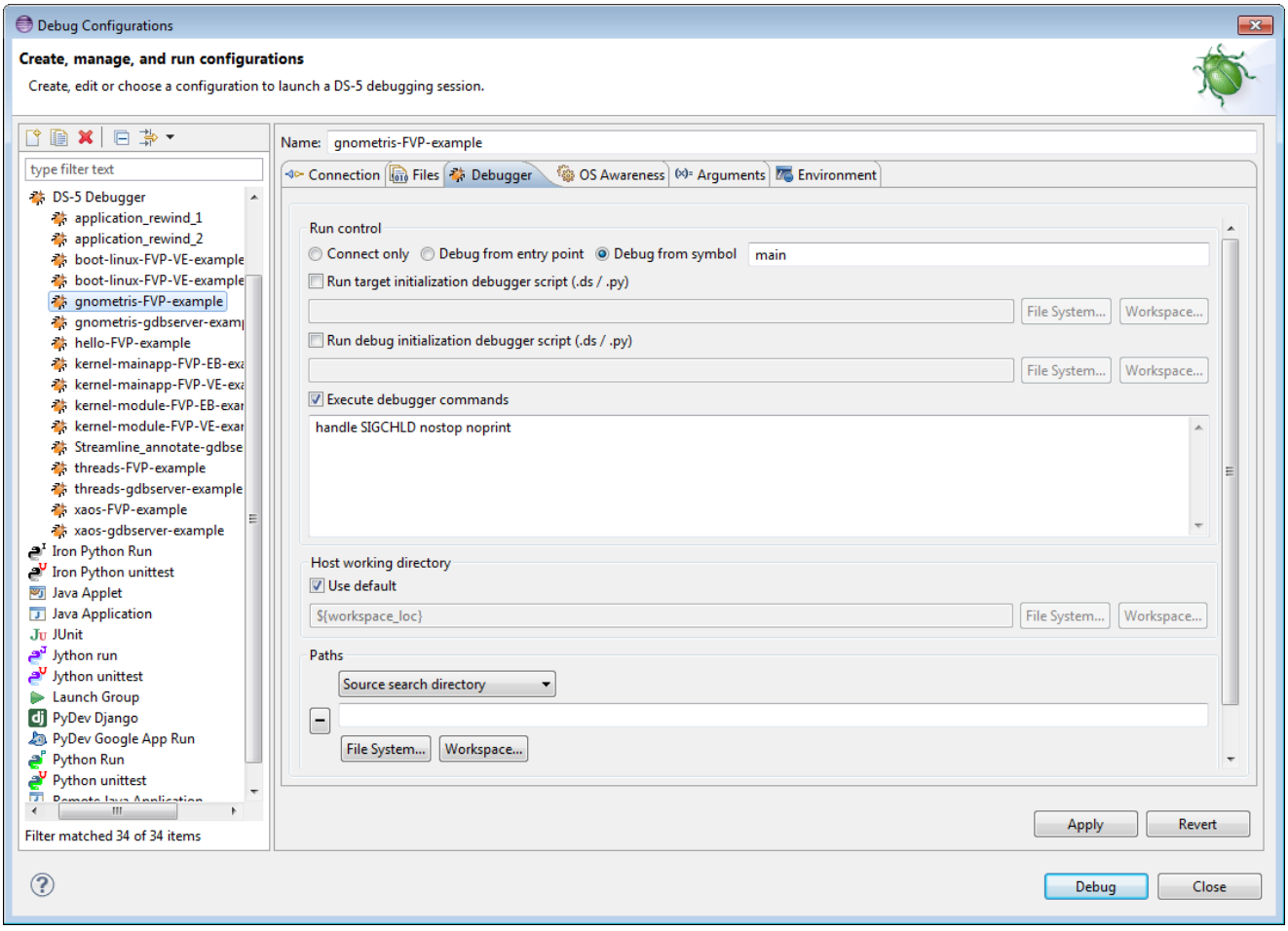


Figure 11-52 Debugger tab (Shown with settings for application starting point and search paths)

Related concepts

6.10.2 About debugging a Linux kernel on page 6-156.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.43 Debug Configurations - OS Awareness tab

Use the **OS Awareness** tab in the **Debug Configurations** dialog box to inform the debugger of the *Operating System* (OS) the target is running. This enables the debugger to provide additional functionality specific to the selected OS.

Multiple options are available in the drop-down box and its content is controlled by the selected platform and connection type in the **Connection** tab. OS awareness depends on having debug symbols for the OS loaded within the debugger.

Note

Linux OS awareness is not currently available in this tab, and remains in the **Connection** tab as a separate debug operation.

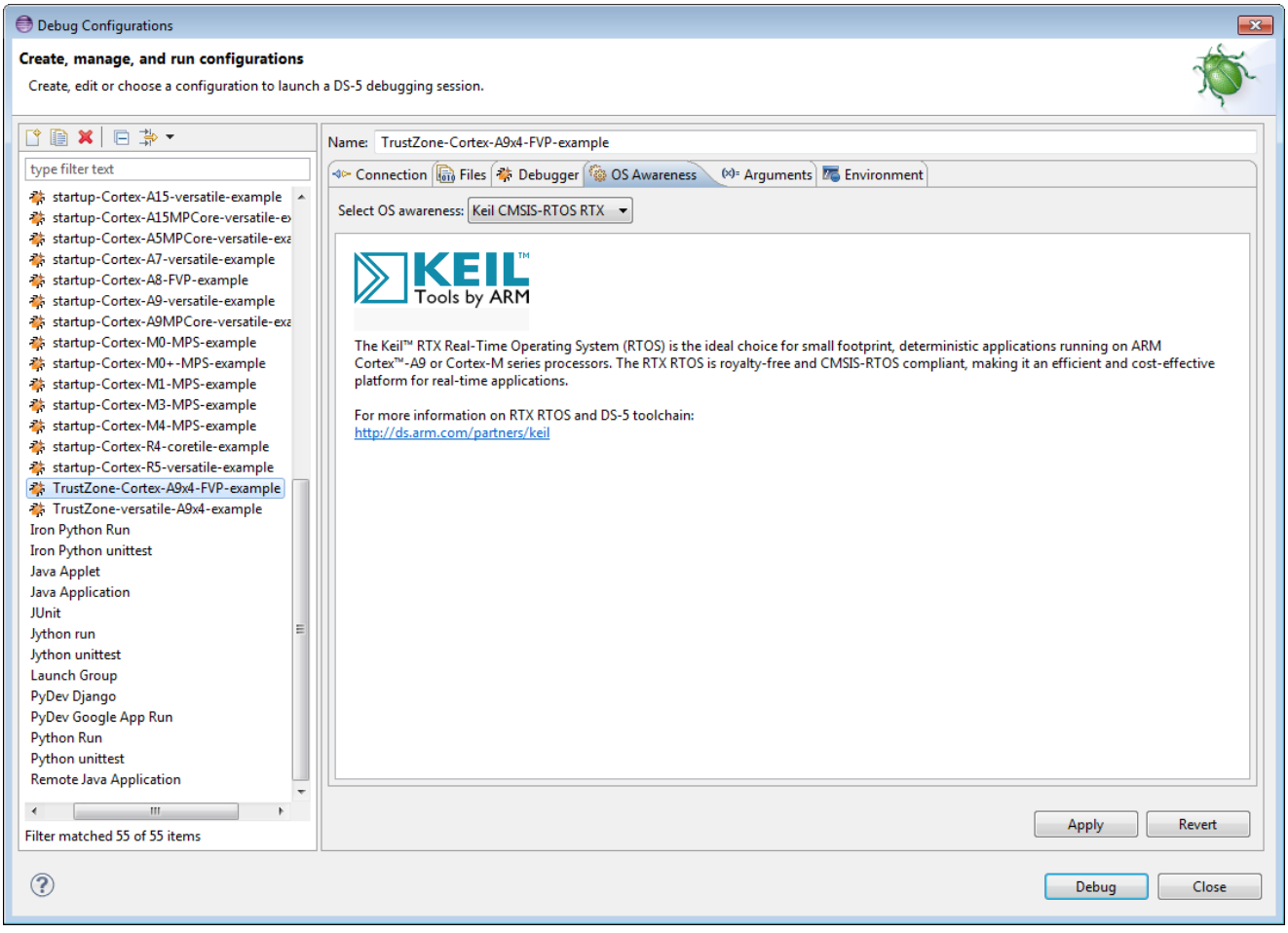


Figure 11-53 OS Awareness tab

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.44 Debug Configurations - Arguments tab

If your application accepts command-line arguments to `main()`, specify them using the **Arguments** tab in the **Debug Configurations** dialog box.

The **Arguments** tab contains the following elements:

Note

These settings only apply if the target supports semihosting and they cannot be changed while the target is running.

Program Arguments

This panel enables you to enter the arguments. Arguments are separated by spaces. They are passed to the target application unmodified except when the text is an Eclipse argument variable of the form `${var_name}` where Eclipse replaces it with the related value.

For a Linux target, you might have to escape some characters using a backslash (`\`) character. For example, the `@`, `(`, `)`, `"`, and `#` characters must be escaped.

Variables...

This button opens the **Select Variable** dialog box where you can select variables that are passed to the application when the debug session starts. For more information on variables, use the dynamic help.

Apply

Save the current configuration. This does not connect to the target.

Revert

Undo any changes and revert to the last saved configuration.

Debug

Connect to the target and close the **Debug Configurations** dialog box.

Close

Close the **Debug Configurations** dialog box.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

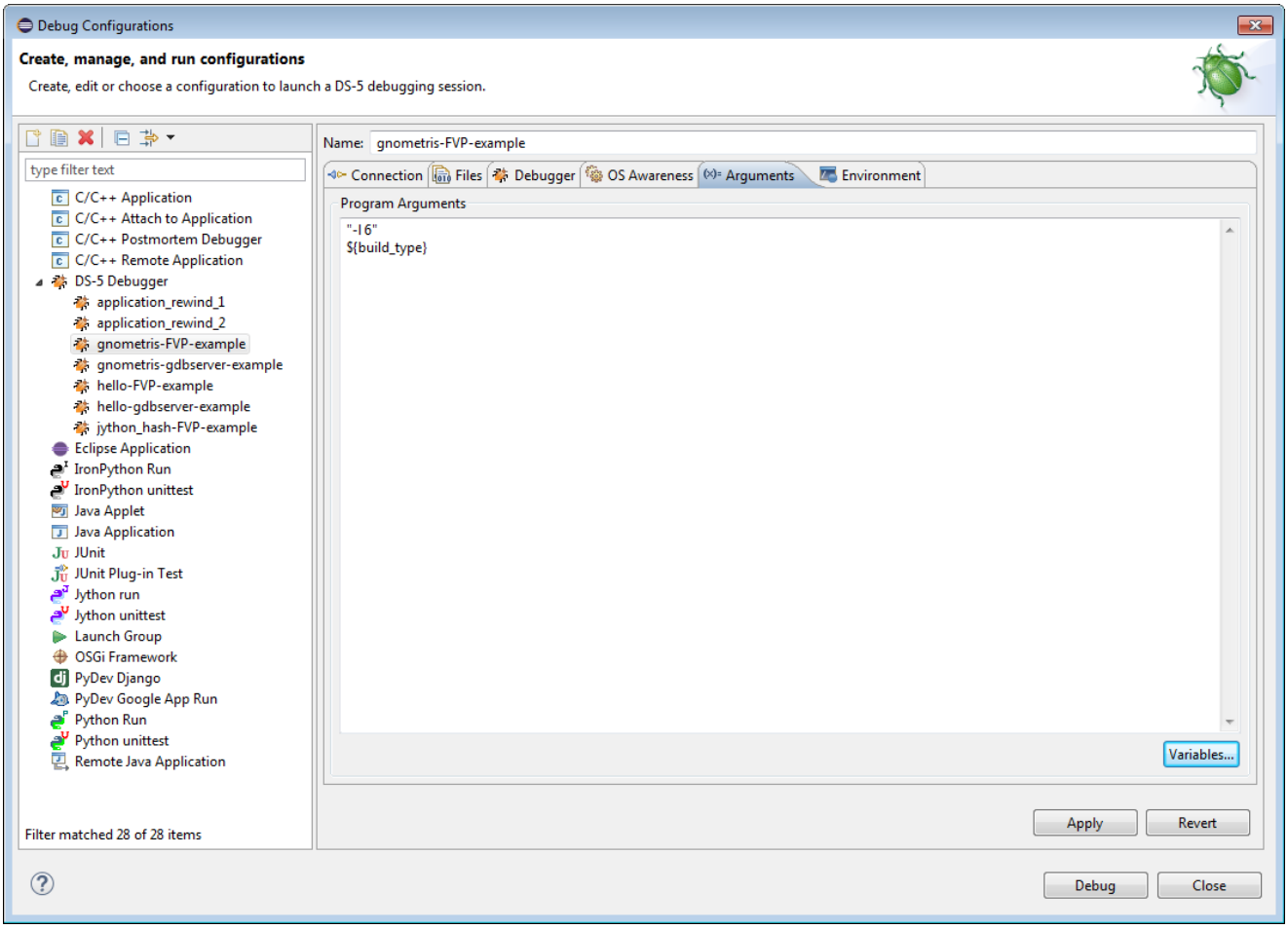


Figure 11-54 Arguments tab

Related references

16.5 About passing arguments to main() on page 16-501.
3.17 Using semihosting to access resources on the host computer on page 3-95.
3.18 Working with semihosting on page 3-97.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.45 Debug Configurations - Environment tab

Use the **Environment** tab in the **Debug Configurations** dialog box to create and configure the target environment variables that are passed to the application when the debug session starts.

The **Environment** tab contains the following elements:

Note

The settings in this tab are not used for connections that use the **Connect to already running gdbserver** debug operation.

Target environment variables to set

This panel displays the target environment variables in use by the debugger.

New...

Opens the **New Environment Variable** dialog box where you can create a new target environment variable.

For example, to debug the Gnometris application on a model you must create a target environment variable for the `DISPLAY` setting.

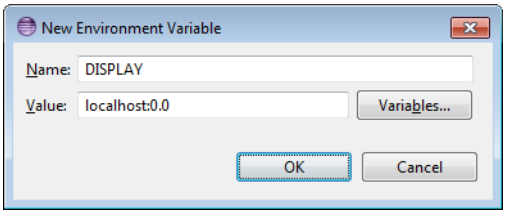


Figure 11-55 New Environment Variable dialog box

Edit...

Opens the **Edit Environment Variable** dialog box where you can edit the properties for the selected target environment variable.

Remove

Removes the selected target environment variables from the list.

Apply

Save the current configuration. This does not connect to the target.

Revert

Undo any changes and revert to the last saved configuration.

Debug

Connect to the target and close the **Debug Configurations** dialog box.

Close

Close the **Debug Configurations** dialog box.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

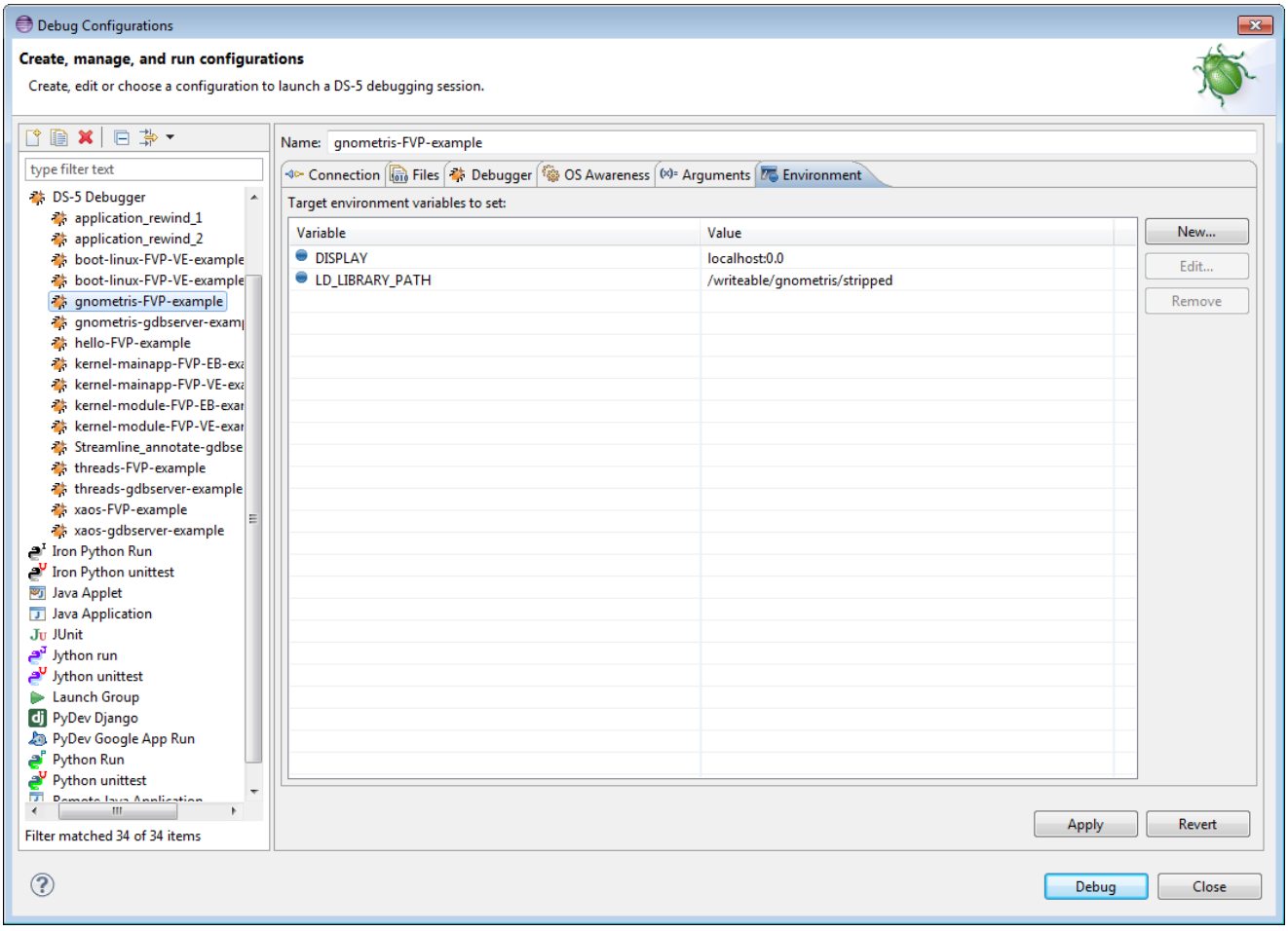


Figure 11-56 Environment tab (Shown with environment variables configured for an FVP)

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.46 DTSL Configuration Editor dialog box

Use the *Debug and Trace Services Layer* (DTSL) **Configuration Editor** to configure additional debug and trace settings. The configuration options available depend on the capabilities of the target. Typically, they enable configuration of the trace collection method and the trace that is generated.

A typical set of configuration options might include:

Trace Capture
Select the collection method that you want to use for this debug configuration. The available trace collection methods depend on the target and trace capture unit but can include *Embedded Trace Buffer* (ETB)/*Micro Trace Buffer* (MTB) (trace collected from an on-chip buffer) or DSTREAM (trace collected from the DSTREAM trace buffer). If no trace collection method is selected then no trace can be collected, even if the trace capture for processors and *Instruction Trace Macrocell* (ITM) are enabled.

Core Trace
Enable or disable trace collection. If enabled then the following options are available:

Enable core *n* trace
Specify trace capture for specific processors.

Cycle accurate trace
Enable or disable cycle accurate trace.

Trace capture range
Specify an address range to limit the trace capture.

ITM
Enable or disable trace collection from the ITM unit.

Named DTSL configuration profiles can be saved for later use.

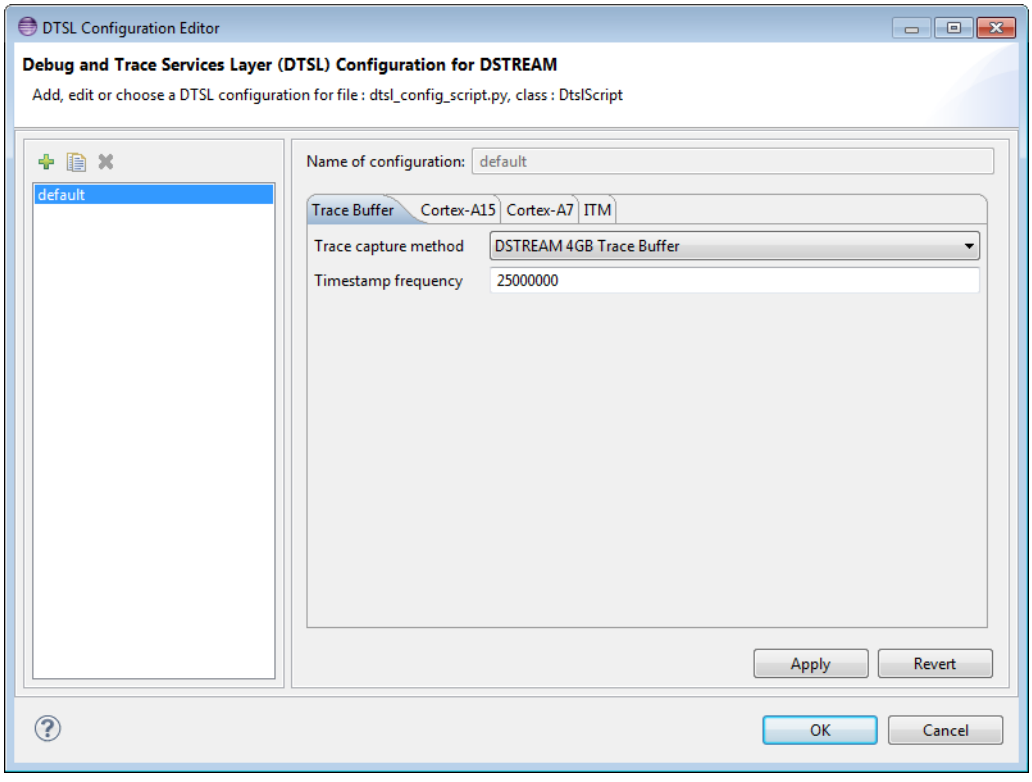


Figure 11-57 DTSL Configuration Editor (Shown with Trace capture method set to DSTREAM)

Related concepts

6.16 About debugging caches on page 6-167.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related references

11.21 Cache Data view on page 11-321.

Related information

DS-5 Debugger cache commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.47 About the Remote System Explorer

Use the *Remote Systems Explorer* (RSE) perspective to connect to and work with a variety of remote systems.

It enables you to:

- Set up Linux SSH connections to remote targets using TCP/IP.
- Create, copy, delete, and rename resources.
- Set the read, write, and execute permissions for resources.
- Edit files by double-clicking to open them in the C/C++ editor view.
- Execute commands on the remote target.
- View and kill running processes.
- Transfer files between the host workstation and remote targets.
- Launch terminal views.

Useful RSE views that can be added to the DS-5 Debug perspective are:

- Remote Systems.
- Remote System Details.
- Remote Scratchpad.
- Terminals.

To add an RSE view to the DS-5 Debug perspective:

1. Ensure that you are in the DS-5 perspective. You can change perspective by using the perspective toolbar or you can select **Window** > **Open Perspective** from the main menu.
2. Select **Window** > **Show View** > **Other...** to open the Show View dialog box.
3. Select the required view from the **Remote Systems** group.
4. Click **OK**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.48 Remote Systems view

The **Remote Systems** view is a hierarchical tree view of local and remote systems.

It enables you to:

- Set up a connection to a remote target.
- Access resources on the host workstation and remote targets.
- Display a selected file in the C/C++ editor view.
- Open the **Remote System Details** view and show the selected connection configuration details in a table.
- Open the **Remote Monitor** view and show the selected connection configuration details.
- Import and export the selected connection configuration details.
- Connect to the selected target.
- Delete all passwords for the selected connection.
- Open the Properties dialog box and display the current connection details for the selected target.

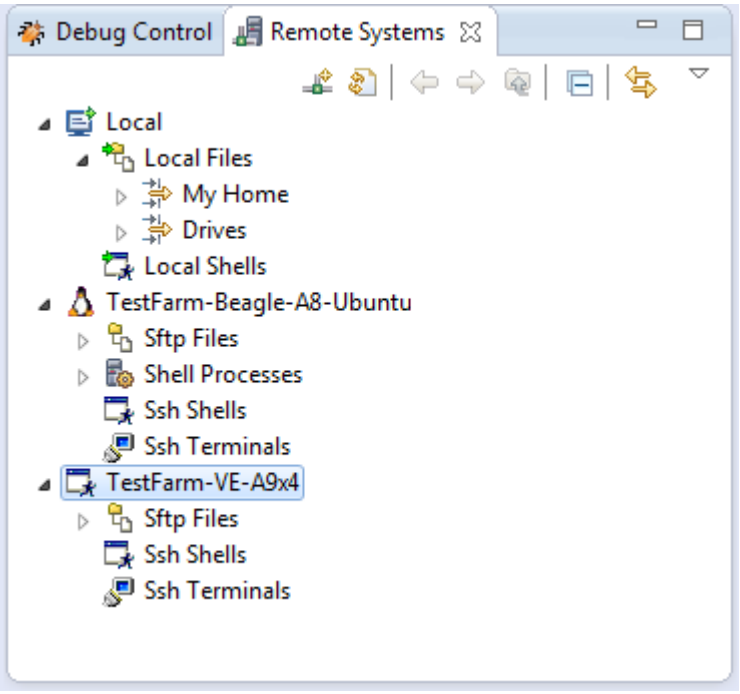


Figure 11-58 Remote Systems view

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.49 Remote System Details view

The **Remote System Details** view is a tabular view giving details about local and remote systems.

It enables you to:

- Set up a Linux connection to a remote target.
- Access resources on the host workstation and remote targets.
- Display a selected file in the C/C++ editor view.
- Open the **Remote Systems** view and show the selected connection configuration details in a hierarchical tree.
- Open the **Remote Monitor** view and show the selected connection configuration details.
- Import and export the selected connection configuration details.
- Connect to the selected target.
- Delete all passwords for the selected connection.
- Open the Properties dialog box and display the current connection details for the selected target.

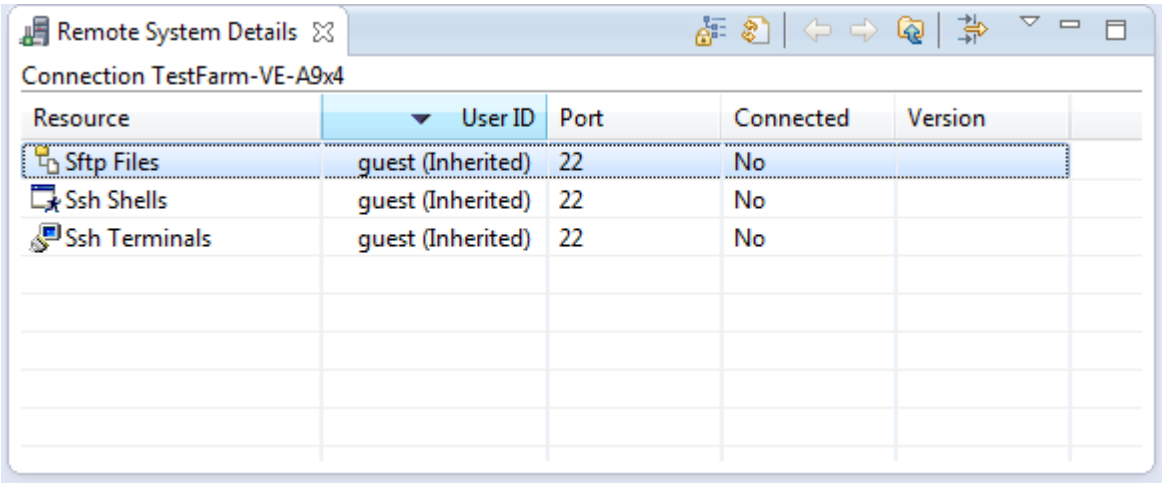


Figure 11-59 Remote System Details view

The **Remote System Details** view is not visible by default. To add this view:

1. Select **Window** > **Show View** > **Other...** to open the Show View dialog box.
2. Expand the **Remote Systems** group and select **Remote System Details**.
3. Click **OK**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.50 Target management terminal for serial and SSH connections

Use the target management terminal to enter shell commands directly on the target without launching any external application.

For example, you can browse remote files and folders by entering the `ls` or `pwd` commands in the same way as you would in a Linux terminal.

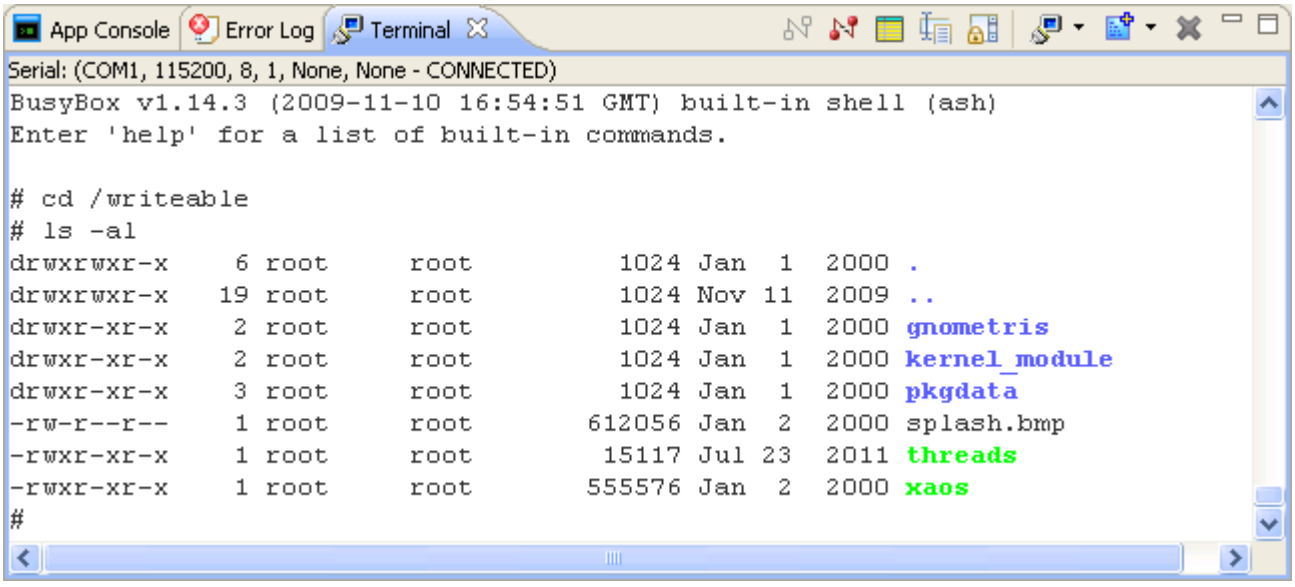


Figure 11-60 Terminal view

The **Terminal** view is not visible by default. To add this view:

1. Select **Window** > **Show View** > **Other...** to open the Show View dialog box.
2. Expand the **Terminal** group and select **Terminal**
3. Click **OK**.
4. In the **Terminal** view, click on the **Settings**
5. Select the required connection type.
6. Enter the appropriate information in the Settings dialog box
7. Click **OK**.

Related tasks

2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.

2.6 Configuring a connection to a Linux kernel on page 2-48.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.51 Remote Scratchpad view

Use the **Remote Scratchpad** view as an electronic clipboard. You can copy and paste or drag and drop useful files and folders into it for later use.

This enables you to keep a list of resources from any connection in one place.

Note

Be aware that although the scratchpad only shows links, any changes made to a linked resource also change it in the original file system.

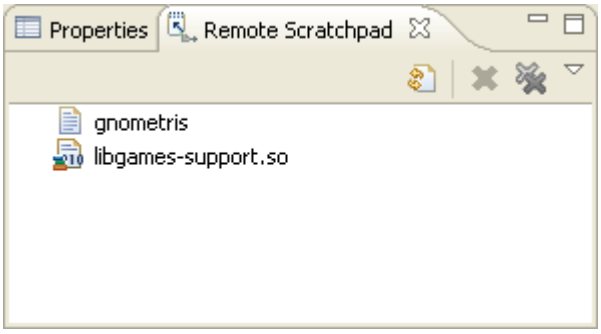


Figure 11-61 Remote Scratchpad

The **Remote Scratchpad** view is not visible by default. To add this view:

1. Select **Window** > **Show View** > **Other...** to open the Show View dialog box.
2. Expand the **Remote Systems** group and select **Remote Scratchpad**.
3. Click **OK**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.52 Remote Systems terminal for SSH connections

Use the **Remote Systems** terminal to enter shell commands directly on the target without launching any external application.

For example, you can browse remote files and folders by entering the `ls` or `pwd` commands in the same way as you would in a Linux terminal.

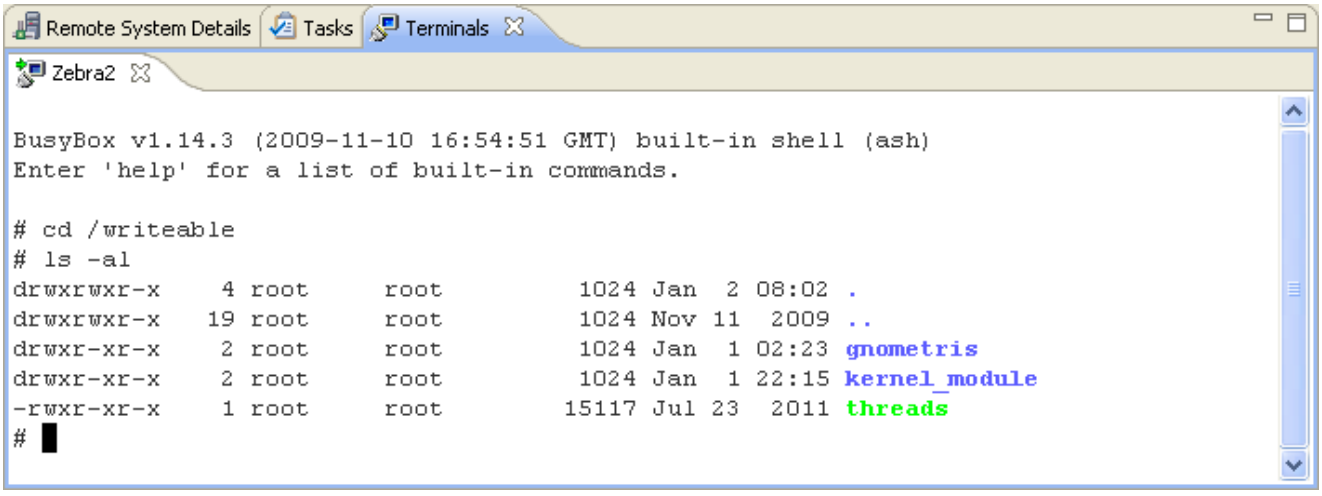


Figure 11-62 Remote Systems terminal

This terminal is not visible by default. To add this view:

1. Select **Window** > **Show View** > **Other...** to open the Show View dialog box.
2. Expand the **Remote Systems** group and select **Remote Systems**.
3. Click **OK**.
4. In the **Remote Systems** view:
   a. Click on the toolbar icon **Define a connection to remote system** and configure a connection to the target.
   b. Right-click on the connection and select **Connect** from the context menu.
   c. Enter the User ID and password in the relevant fields.
   d. Click **OK** to connect to the target.
   e. Right-click on **Ssh Terminals**.
5. Select **Launch Terminal** to open a terminal shell that is connected to the target.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.53 Terminal Settings dialog box

Use the **Terminal Settings** dialog box to change the view title, encoding, connection type, and connection settings for the terminal.

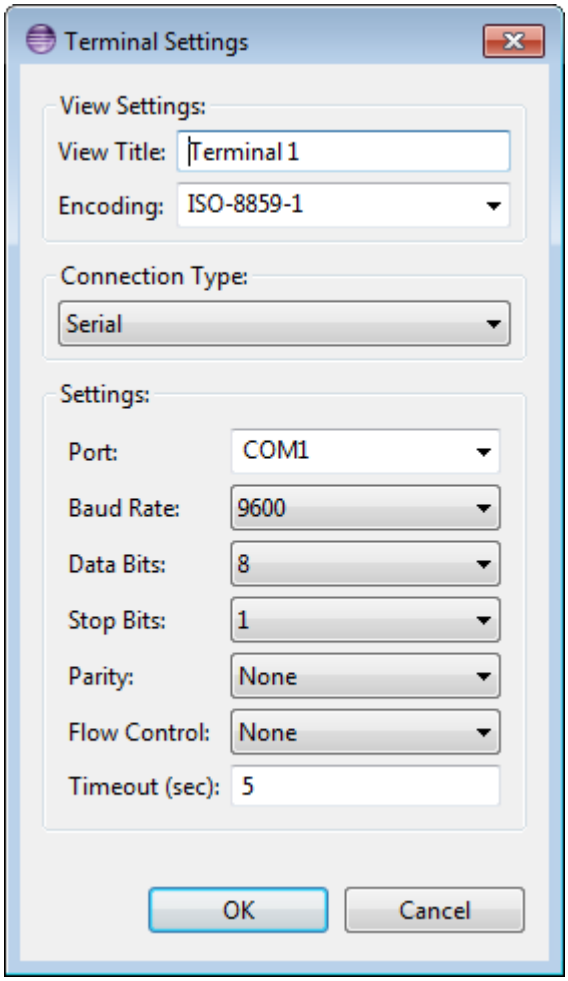


Figure 11-63 Terminal Settings dialog box

View Settings

Enables you to specify the name and encoding for the **Terminal**.

View Title

Enter a name for the **Terminal** view.

Encoding

Select the character set encoding for the terminal.

Connection Type

Specifies a connection type. Either Serial or *Secure SHell* (SSH).

Settings

Enables you to configure the connection settings.

Port

Specifies the port that the target is connected to.

Baud Rate

Specifies the connection baud rate.

Data Bits

Specifies the number of data bits.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Stop Bits

Specifies the number of stop bits for each character.

Parity

Specifies the parity type:

- None. This is the default.
- Even.
- Odd.
- Mark.
- Space.

Flow Control

Specifies the flow control of the connection:

- None. This is the default.
- RTS/CTS.
- Xon/Xoff.

Timeout (sec)

Specifies the connections timeout in seconds.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.54 Debug Hardware Configure IP view

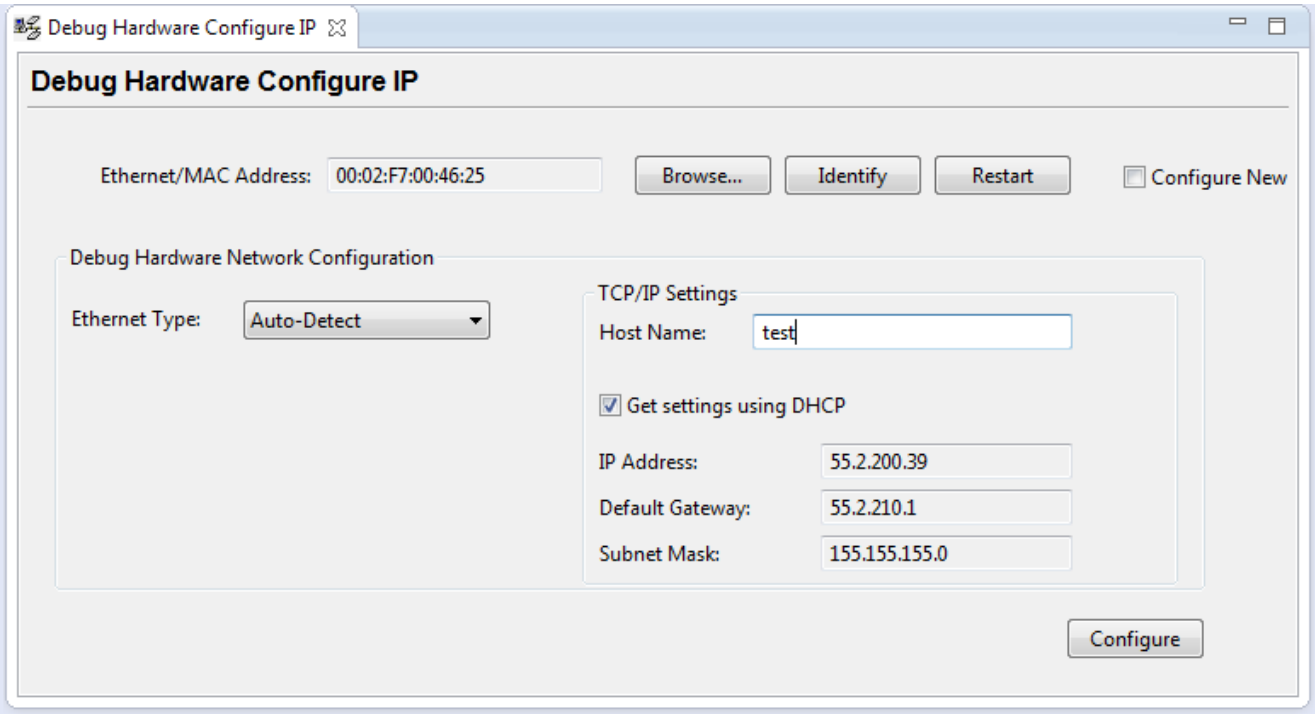
Use the **Debug Hardware Configure IP** view to configure Ethernet and internet protocol settings on the debug hardware units connected to the host workstation.

To access the **Debug Hardware Configure IP** view from the main menu, select **Window** > **Show View** > **Other** > **DS-5 Debugger** > **Debug Hardware Configure IP**.

The configuration process depends on the way in which the debug hardware unit is connected to the host computer, and whether or not your network uses Dynamic Host Configuration Protocol (DHCP). If you have connected your debug hardware unit to an Ethernet network or directly to the host computer using an Ethernet cross-over cable, you must configure the network settings before you can use the unit for debugging. You have to configure the network settings only once for each debug hardware unit.

The following connections are possible:

- Your debug hardware unit is connected to your local network that uses DHCP. In this situation, you do not have to know the Ethernet address of the unit, but you must enable DHCP.
- Your debug hardware unit is connected to your local network that does not use DHCP. In this situation, you must assign a static IP address to the debug hardware unit.



Note

If you want to connect to a debug hardware unit on a separate network, you must manually enter the MAC address of that unit.

Figure 11-64 Debug Hardware Configure IP view

Debug Hardware Configure IP view options

Ethernet/MAC Address

The Ethernet address/media access control (MAC) address of the debug hardware unit.
The address is automatically detected when you click **Browse** and select the hardware. To enter the value manually, select the **Configure New** option.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Browse
Click to display the **Connection Browser** dialog. Use it to browse and select the debug hardware unit in your local network or one that is connected to a USB port on the host workstation.

Identify
Click to visually identify your debug hardware unit using the indicators available on the debug hardware. On DSTREAM , the DSTREAM logo flashes during identification. On RVI™, all LEDs on the front panel flash during identification.

Restart
Click to restart the selected debug hardware unit.

Configure New
Select this option to manually configure a debug hardware unit that was not previously configured or is on a different subnet.

Ethernet Type
Select the type of Ethernet you are connecting to. **Auto-Detect** is the default option. For DSTREAM devices, ensure that this is set to **Auto-Detect**. For RVI, other available options are: **10-MBit Half Duplex**, **10-MBit Full Duplex**, **100-MBit Half Duplex**, and **100-MBit Full Duplex**.

TCP/IP Settings
Host Name - The name of the debug hardware unit. This must contain only the alphanumeric characters (A to Z, a to z, and 0 to 9) and the - character, and must be no more than 39 characters long.
Get settings using DHCP - Enables or disables the Dynamic Host Configuration Protocol (DHCP) on the debug hardware unit. If using DHCP, you must specify the hostname for your debug hardware unit.
IP Address - The static IP address to use.
Default Gateway - The default gateway to use.
Subnet Mask - The subnet mask to use.

Configure
Click to apply changes to the debug hardware unit.

Related references

11.55 Debug Hardware Firmware Installer view on page 11-384.
11.56 Connection Browser dialog box on page 11-387.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.55 Debug Hardware Firmware Installer view

Use the **Debug Hardware Firmware Installer** view to update the firmware for your debug hardware.

Firmware files for ARM debug hardware units typically contain:

Templates for devices supported by the debug hardware unit
Each template defines how to communicate with the device and the settings that you can configure for that device. A firmware update might contain support for newer devices that the debug hardware unit can now support.

Firmware updates and patches
ARM periodically releases updates and patches to the firmware that is installed on a debug hardware unit. These updates or patches might extend the capabilities of your debug hardware, or might fix an issue that has become apparent.

To access the **Debug Hardware Firmware Installer** view, from the main menu, select **Window** > **Show View** > **Other** > **DS-5 Debugger** > **Debug Hardware Firmware Installer**.

Updating your debug hardware unit firmware using the Debug Hardware Firmware Installer view

1. Connect your debug hardware to the client PC.
2. From the main menu, select **Window** > **Show View** > **Other** > **DS-5 Debugger** > **Debug Hardware Firmware Installer** to display the view.
3. Click **Browse** and select your debug hardware unit.
4. Click **Connect** to your debug hardware unit.
   The current firmware status of your debug hardware is displayed. For example:

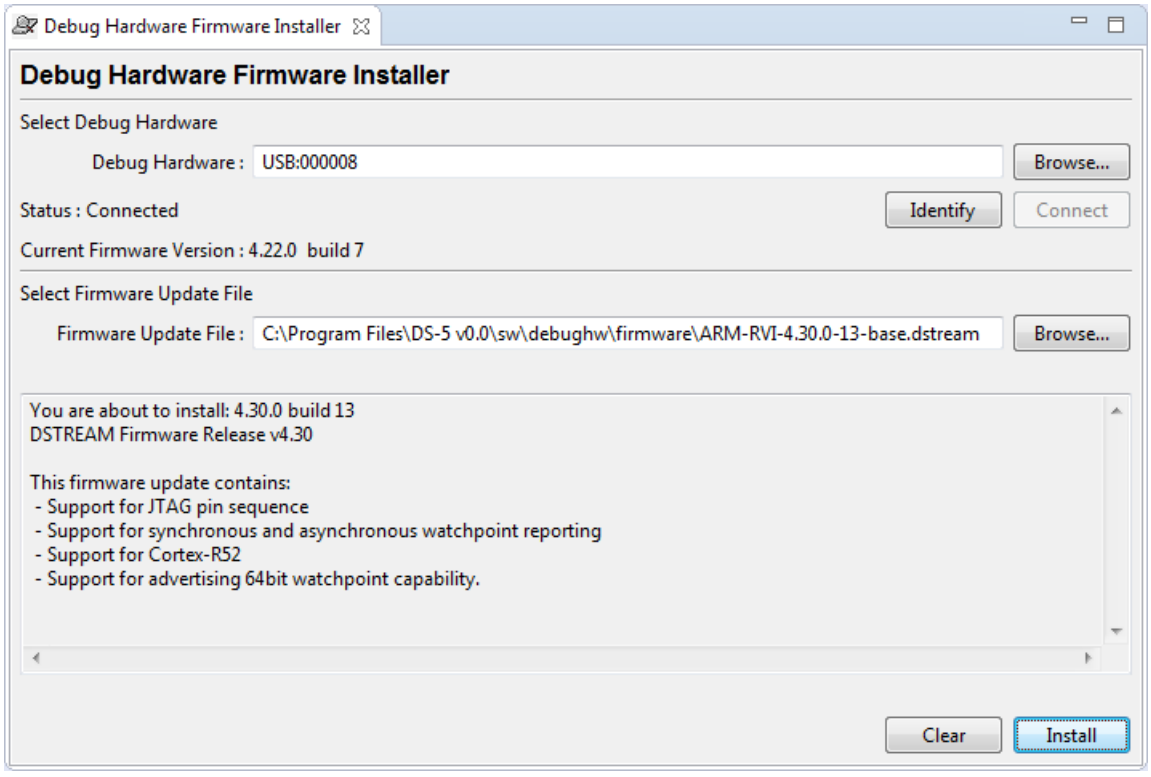


Figure 11-65 Debug Hardware Firmware Installer view

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Note

In DS-5, the latest firmware files are available at: `DS-5_install_directory\sw\debughw\firmware\`. If you want to choose a different firmware file, click **Browse** and select the new location and file.

5. Click **Install**. The firmware update process starts. When complete, a message is displayed indicating the status of the update.

Debug Hardware Firmware Installer view options

Select Debug Hardware
The currently selected debug hardware. You can either enter the IP address or host name of the debug hardware unit, or use the **Browse** button and select the debug hardware unit.

Browse
Click to display the **Connection Browser** dialog. Use it to browse and select the debug hardware unit in your local network or one that is connected to a USB port on the host workstation.

Identify
Click to visually identify your debug hardware unit using the indicators available on the debug hardware. On RVI, all LEDs on the front panel flash during identification. On DSTREAM, the DSTREAM logo flashes during identification.

Connect
Click to connect to your debug hardware. When connected, the dialog shows the current firmware status.

Select Firmware Update File
DS-5 automatically loads the firmware file supplied with your installation. If you want to use a different firmware file, use the **Browse** button and select the firmware file. When the file is selected, the dialog shows the selected firmware update file details.

Browse
Click to browse and select the firmware file.

Clear
Click to clear the currently selected debug hardware and firmware file.

Install
Click to install the firmware file on the selected debug hardware.

Firmware file format

Firmware files have the following syntax: `ARM-RVI-N.n.p-bld-type.unit`

`N.n.p`
Is the version of the firmware. For example, `4.5.0` is the first release of firmware version `4.5`.

`build`
Is a build number.

`Type`
Is either:

`base`
The first release of the firmware for version `N.n`.

`patch`
Updates to the corresponding `N.n` release of the firmware.

`unit`
Identifies the debug hardware unit, and is one of:

`dstream`
For a DSTREAM debug and trace unit.

`rvi`
For an RVI debug unit.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related references

11.54 Debug Hardware Configure IP view on page 11-382.
11.56 Connection Browser dialog box on page 11-387.
16.7 Updating multiple debug hardware units on page 16-503.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.56 Connection Browser dialog box

Use the **Connection Browser** dialog box to browse for and select a debug hardware unit in your local network or one that is connected to a USB port on the host workstation. When the **Connection Browser** dialog box finds a unit, it is added to the list of available units.

To view the **Connection Browser** dialog, click **Browse** from the **Debug Hardware Configure IP** or **Debug Hardware Firmware Installer** views.

To connect to the debug hardware, select the hardware from the list, and click **Select**.

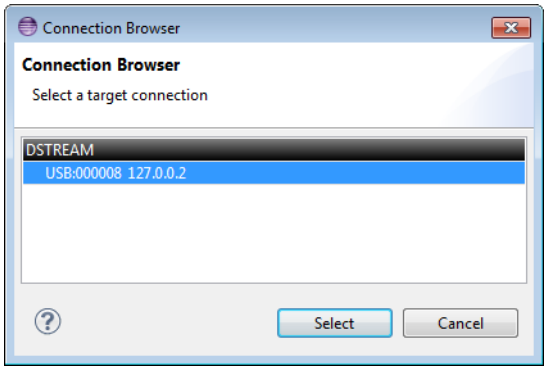


Figure 11-66 Connection Browser (Showing a USB connected DSTREAM)

Note

- If debug hardware units do not appear in the list, check your network and setup of your debug unit.
- Debug hardware units connected to different networks do not appear in the **Connection Browser** dialog box. If you want to connect to a debug hardware unit on a separate network, you must know the IP address of that unit.
- Any unit shown in light gray has responded to browse requests but does not have a valid IP address. You cannot connect to that unit by TCP/IP until you have configured it for use on your network.
- Only appropriate debug hardware units are shown. VSTREAM connections are not shown.

Related references

11.54 Debug Hardware Configure IP view on page 11-382.
11.55 Debug Hardware Firmware Installer view on page 11-384.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

11.57 DS-5 Debugger menu and toolbar icons

Describes the menus and toolbar icons used in the DS-5 Debug perspective.

These tables list the most common menu and toolbar icons available for use with DS-5 Debugger. For information on icons, markers, and buttons not listed in the following tables, see the standard *Workbench User Guide* or the *C/C++ Development User Guide* in the **Help** > **Help Contents** window.

If you leave the mouse pointer positioned on a toolbar icon for a few seconds without clicking, a tooltip appears informing you of the purpose of the icon.

Table 11-3 DS-5 Debugger icons

Icon	Description	Icon	Description
	Connect to target		Connected to target
	Disconnect from target		Delete connection
	Start application and run to main		Start application and run to entry point
	Run application from entry point		Restart the application
	Continue running application		Stop application
	Step into		Step over
	Step out		Toggle stepping mode
	Continue running application backwards		Reverse step
	Reverse step over		Reverse step out
	Collapse all configurations in stack trace		Call stack
	Thread		Process
	Kernel module		Define a new RSE connection
	Refresh the RSE resource tree		Save view contents to a file
	Clear view contents		Switch to History view
	Synchronize view contents		Toggle scroll lock
	Run commands from a script file		Export commands to a script file
	Remove selected breakpoint, watchpoints, or expression (view dependent)		Remove all breakpoints, watchpoints, or expressions (view dependent)
	Display breakpoint location in source file		Deactivate all breakpoints and watchpoints
	Import from a file		Export to a file
	Create new script file or add new expression (view dependent)		Run select script file
	Open selected file for editing		Delete the selected files
	Set display width		Set display format

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Table 11-3 DS-5 Debugger icons (continued)

Icon	Description	Icon	Description
	Toggle the display of ASCII characters		Toggle freeze mode
	Edit Screen view parameters		Add new Screen view
	Add new Disassembly view		Add new Variables view
	Add new Registers view		Add new Memory view
	Add new Expression view		Add new Trace view
	Add Functions view		View update in progress
	Toggle trace marker		Show next match
	Show previous match		Show instruction trace
	Show function trace		Toggle navigation resolution
	Toggle the views		Application rewind information displayed in view

Perspective icons

Table 11-4 Perspective icons

Icon	Description	Icon	Description
	Open new perspective		C/C++ perspective
	DS-5 Debug perspective		Fast view bar

View icons

Table 11-5 View icons

Button	Description	Button	Description
	Display drop-down menu		Synchronize view contents
	Minimize		Maximize
	Restore		Close

View markers

Table 11-6 View markers

Icon	Description	Icon	Description
	Software breakpoint enabled		Hardware breakpoint enabled
	Access watchpoint enabled		Read watchpoint enabled
	Write watchpoint enabled		Software breakpoint disabled

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Table 11-6 View markers (continued)

Icon	Description	Icon	Description
	Hardware breakpoint disabled		Access watchpoint disabled
	Read watchpoint disabled		Write watchpoint disabled
	Software breakpoint pending		Hardware breakpoint pending
	Access watchpoint pending		Read watchpoint pending
	Write watchpoint pending		Software breakpoint disconnected
	Hardware breakpoint disconnected		Access watchpoint disconnected
	Read watchpoint disconnected		Write watchpoint disconnected
	Multiple-statement software breakpoint enabled		Multiple-statement software breakpoint disabled
	Error		Current location
	Warning		Bookmark
	Information		Task
	Search result		

Miscellaneous icons

Table 11-7 Miscellaneous icons

Icon	Description	Icon	Description
	Open a new resource wizard		Open new project wizard
	Open new folder wizard		Open new file wizard
	Open search dialog box		Display context-sensitive help
	Open import wizard		Open export wizard

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 12
Troubleshooting

Describes how to diagnose problems when debugging applications using DS-5 Debugger.

It contains the following sections:

- *12.1 ARM Linux problems and solutions* on page 12-392.
- *12.2 Enabling internal logging from the debugger* on page 12-393.
- *12.3 Target connection problems and solutions* on page 12-394.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

12.1 ARM Linux problems and solutions

Lists possible problems when debugging a Linux application.

You might encounter the following problems when debugging a Linux application.

ARM Linux permission problem

If you receive a permission denied error message when starting an application on the target then you might have to change the execute permissions on the application. :

```
chmod +x myImage
```

A breakpoint is not being hit

You must ensure that the application and shared libraries on your target are the same as those on your host. The code layout must be identical, but the application and shared libraries on your target do not require debug information.

Operating system support is not active

When Operating System (OS) support is required, the debugger activates it automatically where possible. If OS support is required but cannot be activated, the debugger produces an error. :

```
ERROR(CMD16-LKN36):
! Failed to load image "gator.ko"
! Unable to parse module because the operating system support is not active
```

OS support cannot be activated if:

- debug information in the `vmlinux` file does not correctly match the data structures in the kernel running on the target
- it is manually disabled by using the `set os enabled off` command.

To determine whether the kernel versions match:

- stop the target after loading the `vmlinux` image
- enter the `print init_nsproxy.uts_ns->name` command
- verify that the `$1` output is correct. :

```
$1 = {sysname = "Linux", nodename = "(none)", release = "3.4.0-rc3",
version = "#1 SMP Thu Jan 24 00:46:06 GMT 2013", machine = "arm",
domainname = "(none)"}
```

Related tasks

2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.

2.6 Configuring a connection to a Linux kernel on page 2-48.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

12.2 Enabling internal logging from the debugger

Describes how to enable internal logging to help diagnose error messages.

On rare occasions an internal error might occur causing the debugger to generate an error message suggesting that you report it to your local support representatives. You can help to improve the debugger by giving feedback with an internal log that captures the stacktrace and shows where in the debugger the error occurs. To obtain the current version of DS-5, you can select **About ARM DS-5** from the **Help** menu in Eclipse or open the product release notes.

To enable internal logging within Eclipse, enter the following in the Commands view of the **DS-5 Debug** perspective:

1. To enable the output of logging messages from the debugger using the predefined DEBUG level configuration:

   ```
   log config debug
   ```

2. To redirect all logging messages from the debugger to a file:

   ```
   log file debug.log
   ```

Note

Enabling internal logging can produce very large files and slow down the debugger significantly. Only enable internal logging when there is a problem.

Related references

11.6 Commands view on page 11-275.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

12.3 Target connection problems and solutions

Lists possible problems when connecting to a target.

Failing to make a connection

The debugger might fail to connect to the selected debug target because of the following reasons:

- you do not have a valid license to use the debug target
- the debug target is not installed or the connection is disabled
- the target hardware is in use by another user
- the connection has been left open by software that exited incorrectly
- the target has not been configured, or a configuration file cannot be located
- the target hardware is not powered up ready for use
- the target is on a scan chain that has been claimed for use by something else
- the target hardware is not connected
- you want to connect through gdbserver but the target is not running `gdbserver`
- there is no ethernet connection from the host to the target
- the port number in use by the host and the target are incorrect

Check the target connections and power up state, then try and reconnect to the target.

Debugger connection settings

When debugging a bare-metal target the debugger might fail to connect because of the following reasons:

- **Heap Base** address is incorrect
- **Stack Base** (top of memory) address is incorrect
- **Heap Limit** address is incorrect
- Incorrect vector catch settings.

Check that the memory map settings are correct for the selected target. If set incorrectly, the application might crash because of stack corruption or because the application overwrites its own code.

Related tasks

2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.
2.6 Configuring a connection to a Linux kernel on page 2-48.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 13
File-based Flash Programming in ARM DS-5

Describes the file-based flash programming options available in DS-5.

It contains the following sections:

- *13.1 About file-based flash programming in ARM® DS-5* on page 13-396.
- *13.2 Flash programming configuration* on page 13-398.
- *13.3 Creating an extension database for flash programming* on page 13-400.
- *13.4 About using or extending the supplied ARM® Keil® flash method* on page 13-401.
- *13.5 About creating a new flash method* on page 13-403.
- *13.6 About testing the flash configuration* on page 13-407.
- *13.7 About flash method parameters* on page 13-408.
- *13.8 About getting data to the flash algorithm* on page 13-409.
- *13.9 About interacting with the target* on page 13-410.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.1 About file-based flash programming in ARM® DS-5

The DS-5 configdb platform entry for a board can contain a flash definition section. This section can define one or more areas of flash, each with its own flash method and configuration parameters.

Flash methods are implemented in Jython and are typically located within the configdb. Each flash method is implemented with a specific technique of programming flash.

These techniques might involve:

- Running an external program supplied by a third party to program a file into flash.
- Copying a file to a file system mount point. For example, as implemented in the ARM Versatile Express designs.
- Download a code algorithm into the target system and to keep running that algorithm on a data set (typically a flash sector) until the entire flash device has been programmed.

Note

You can use the DS-5 Debugger `info flash` command to view the flash configuration for your board.

Examples of downloading a code algorithm into the target system are the Keil flash programming algorithms which are fully supported by DS-5 Debugger. For the Keil flash method, one of the method configuration items is the algorithm to use to perform the flash programming. These algorithms all follow the same top level software interface and so the same DS-5 Keil flash method can be used to program different types of flash. This means that DS-5 Debugger should be able to make direct use of any existing Keil flash algorithm.

Note

All flash methods which directly interact with the target should do so using the DS-5 Debugger's DTSL connection.

Flash programming supported features

The following features are available in file flash programming operations:

- Supports ELF files (`.axf`) programming into flash.
- Supports ELF files containing multiple flash areas which can each be programmed into a flash device or possible several different flash devices.
- Supports many and varied flash programming methods.
- Supports all Keil flash programming algorithms.
- Supports target board setup and teardown to prepare it for flash programming.
- Supports DS-5 configuration database to learn about target flash devices and the options required for flash programming on a specific board or system on chip.
- Supports default flash options modification.
- Supports graphical progress reporting within Eclipse and on a text only type console when used with the debugger outside Eclipse, along with the ability to cancel the programming operation.
- Supports a simple flash programming user interface where you can specify minimal configurations or options.
- Supports displaying warning and error messages to the user.

Note

An example, `flash_example-FVP-A9x4`, is provided with DS-5. This example shows two ways of programming flash devices using DS-5, one using a Keil Flash Method and the other using a Custom Flash Method written in Jython. For convenience, the `Cortex-A9x4 FVP` model supplied with DS-5 is used as the target device. This example can be used as a template for creating new flash algorithms. The `readme.html` provided with the example contains basic information on how to use the example.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

DS-5 File Flash Architecture

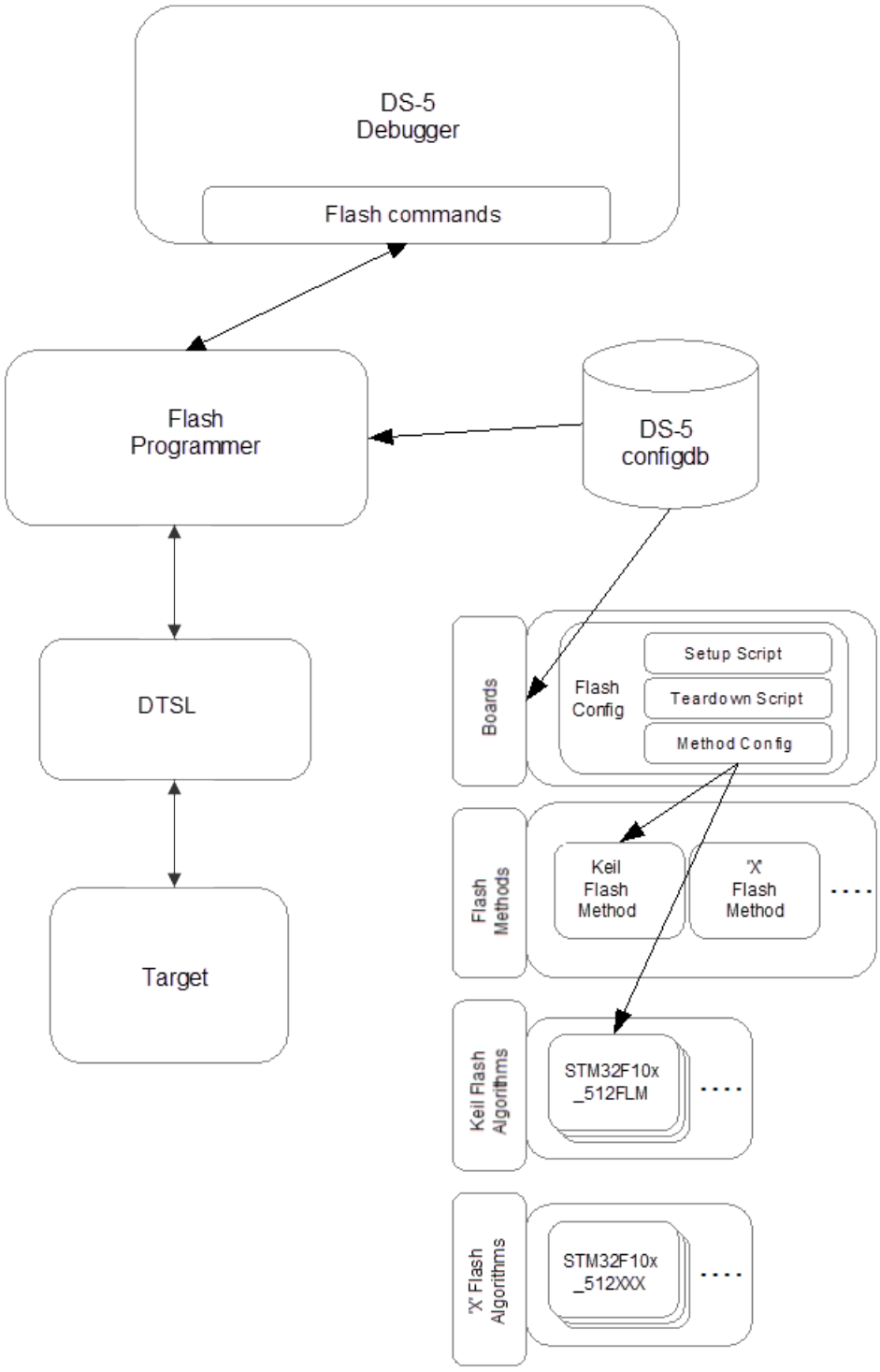


Figure 13-1 DS-5 File Flash Architecture

Related information

Flash commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.2 Flash programming configuration

Each target platform supported by DS-5 has an entry in the DS-5 configuration database. To add support for flash programming, a target's platform entry in the database must define both the flash programming method and any required parameters.

Configuration files

The target's platform entry information is stored across two files in the configuration database:

- `project_types.xml` - This file describes the debug operations supported for the platform and may contain a reference to a flash configuration file. This is indicated by a tag such as `<flash_config>CDB://flash.xml</flash_config>`.

  The `CDB://` tag indicates a path relative to the target's platform directory which is usually the one that contains the `project_types.xml` file. You can define a relative path above the target platform directory using `../`. For example, a typical entry would be similar to `<flash_config>CDB://../../../Flash/STM32/flash.xml</flash_config>`.

  Using relative paths allows the flash configuration file to be shared between a number of targets with the same chip and same flash configuration.
- The `FDB://` tag indicates a path relative to where the Jython flash files (such as the `stm32_setup.py` and `keil_flash.py` used in the examples) are located. For DS-5 installations, this is usually <DS-5 Install folder>\sw\debugger\configdb\Flash.
- A flash configuration `.xml` file. For example, `flash.xml`. This `.xml` file describes flash devices on a target, including which memory regions they are mapped to and what parameters need to be passed to the flash programming method.

A flash configuration must always specify the flash programming method to use, but can also optionally specify a setup script and a teardown script. Setup and teardown scripts are used to prepare the target platform for flash programming and to re-initialize it when flash programming is complete. These scripts might be very specific to the target platform, whereas the flash programming method might be generic.

Configuration file example

This example `flash.xml` is taken from the Keil MCBSTM32E platform. It defines two flash devices even though there is only one built-in flash device in the MCBSTM32E. This is because the two flash sections, the main flash for program code and the option flash for device configuration, are viewed as separate devices when programming.

Note how the flash method is set to the `keil_flash.py` script and how the parameters for that method are subsequently defined.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<!--Copyright (C) 2012 ARM Limited. All rights reserved.-->
<flash_config
     xmlns:xi="http://www.w3.org/2001/XInclude"
     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
     xmlns="http://www.arm.com/flash_config"
     xsi:schemaLocation="http://www.arm.com/flash_config flash_config.xsd">
    <devices>
        <!-- STM32F1xx has 2 flash sections: main flash for program code and option
        flash for device configuration.  These are viewed as separate devices
        when programming -->
        <!-- The main flash device -->
        <device name="MainFlash">
            <programming_type type="FILE">
                <!-- Use the standard method for running Keil algorithms -->
                <method language="JYTHON" script="FDB://keil_flash.py" class="KeilFlash"
method_config="Main"/>
                <!-- Target specific script to get target in a suitable state for
programming -->
                <setup script="FDB://stm32_setup.py" method="setup"/>
            </programming_type>
        </device>
        <!-- The option flash device -->
        <device name="OptionFlash">
            <programming_type type="FILE">
                <method language="JYTHON" script="FDB://keil_flash.py" class="KeilFlash"
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
method_config="Option"/>
                <setup script="FDB://stm32_setup.py" method="setup"/>
            </programming_type>
        </device>
    </devices>
    <method_configs>
        <!-- Parameters for programming the main flash -->
        <method_config id="Main">
            <params>
                <!-- Programming algorithm binary to load to target -->
                <param name="algorithm" type="string" value="FDB://algorithms/
STM32F10x_512.FLM"/>
                <!-- The core in the target to run the algorithm -->
                <param name="coreName" type="string" value="Cortex-M3"/>
                <!-- RAM location & size for algorithm code and write buffers -->
                <param name="ramAddress" type="integer" value="0x20000000"/>
                <param name="ramSize" type="integer" value="0x10000"/>
                <!-- Allow timeouts to be disabled -->
                <param name="disableTimeouts" type="string" value="false"/>
                <!-- Set to false to skip the verification stage -->
                <param name="verify" type="string" value="true"/>
            </params>
        </method_config>
        <!-- Parameters for programming the option flash -->
        <method_config id="Option">
            <params>
                <!-- Programming algorithm binary to load to target -->
                <param name="algorithm" type="string" value="FDB://algorithms/
STM32F10x_OPT.FLM"/>
                <!-- The core in the target to run the algorithm -->
                <param name="coreName" type="string" value="Cortex-M3"/>
                <!-- RAM location & size for algorithm code and write buffers -->
                <param name="ramAddress" type="integer" value="0x20000000"/>
                <param name="ramSize" type="integer" value="0x10000"/>
                <!-- Allow timeouts to be disabled -->
                <param name="disableTimeouts" type="string" value="false"/>
                <!-- Set to false to skip the verification stage -->
                <param name="verify" type="string" value="true"/>
            </params>
        </method_config>
    </method_configs>
</flash_config>
```

Related tasks

13.3 Creating an extension database for flash programming on page 13-400.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.3 Creating an extension database for flash programming

In certain scenarios, it might not be desirable or possible to modify the default DS-5 configuration database. In this case, you can create your own configuration databases and use them to extend the default installed database.

To create an extension configuration database:

Procedure

1. At your preferred location, create a new directory with the name of your choice for the extension database.
2. In your new directory, create two subdirectories and name them `Boards` and `Flash` respectively.
   a. In the `Boards` directory, create a subdirectory for the board manufacturer.
   b. In the board manufacturer subdirectory, create another directory for the board.
   c. In the `Flash` directory, create a subdirectory and name it `Algorithms`.

   For example, for a manufacturer `MegaSoc-Co` who makes `Acme-Board-2000`, the directory structure would look similar to this:

```
Boards
   \---> MegaSoc-Co
            \---> Acme-Board-2000
                      project_types.xml

Flash
   \---> Algorithms
            Acme-Board-2000.flm
   Acme-Board-2000-Flash.py
```

3. From the main menu in DS-5, select **Window** > **Preferences** > **DS-5** > **Configuration Database**.
   a. In the **User Configuration Databases** area, click **Add**.
   b. In the **Add configuration database location** dialog, enter the **Name** and **Location** of the your configuration database and click **OK**.
4. In the **Preferences** dialog, click **OK** to confirm your changes.

   Within the `project_types.xml` file for your platform, any reference to a `CDB://` location will now resolve to the `Boards/<manufacturer>/<board>` directory and any reference to a `FDB://` location will resolve to the `Flash` directory.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.4 About using or extending the supplied ARM® Keil® flash method

DS-5 Debugger contains a full implementation of the Keil® flash programming method. This might be used to program any flash device supported by the Keil MDK product. It might also be used to support any future device for which a Keil flash programming algorithm can be created.

For details on creating new Keil Flash Programming algorithms (these links apply to the Keil µVision® product), see:

Algorithm Functions

Creating New Algorithms

To aid in the creation of new Keil flash programming algorithms within DS-5, DS-5 Debugger contains a full platform flash example for the Keil MCBSTM32E board. This can be used as a template for new flash support.

Note

An example, `flash_example-FVP-A9x4`, is provided with DS-5. This example shows two ways of programming flash devices using DS-5, one using a Keil Flash Method and the other using a Custom Flash Method written in Jython. For convenience, the `Cortex-A9x4 FVP` model supplied with DS-5 is used as the target device. This example can be used as a template for creating new flash algorithms. The `readme.html` provided with the example contains basic information on how to use the example.

This section describes how to add flash support to an existing platform using an existing Keil flash program, and how to add flash support to an existing platform using a new Keil flash algorithm.

This section contains the following subsections:

- *13.4.1 Adding flash support to an existing platform using an existing Keil flash algorithm* on page 13-401.
- *13.4.2 Adding flash support to an existing target platform using a new Keil flash algorithm* on page 13-402.

13.4.1 Adding flash support to an existing platform using an existing Keil flash algorithm

To use the Keil MDK flash algorithms within DS-5, the algorithm binary needs to be imported into the target configuration database and the flash configuration files created to reference the `keil_flash.py` script.

This example uses the flash configuration for the Keil MCBSTM32E board example in Flash programming configuration as a template to add support to a board called the Acme-Board-2000 made by MegaSoc-Co.

Procedure

1. Copy the algorithm binary `.FLM` into your configuration database `Flash/Algorithms` directory.
2. Copy the flash configuration file from `Boards/Keil/MCBSTM32E/keil-mcbstm32e_flash.xml` to `Boards/MegaSoc-Co/Acme-Board-2000/flash.xml`.
3. Edit the platform's `project_types.xml` to reference the `flash.xml` file by inserting `<flash_config>CDB://flash.xml</flash_config>` below `platform_data` entry, for example:

```
<?xml  version="1.0" encoding="UTF-8" standalone="no"?>
<!--Copyright (C) 2009-2012 ARM Limited. All rights reserved.-->
<platform_data xmlns="http://www.arm.com/project_type"
               xmlns:peripheral="http://com.arm.targetconfigurationeditor"
               xmlns:xi="http://www.w3.org/2001/XInclude"
               xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"type="HARDWARE"
               xsi:schemaLocation="http://www.arm.com/project_type../../../Schemas/
platform_data-1.xsd">
               <flash_config>CDB://flash.xml</flash_config>
```

4. Edit the devices section, and create a `<device>` block for each flash device on the target.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Note

The `method_config` attribute should refer to a unique `<method_config>` block for that device in the `<method_configs>` section.

5. Optionally, create and then reference any setup or teardown script required for your board. If your board does not need these, then do not add these lines to your configuration.

```
<setup script="FDB://Acme-Board-2000-Flash.py" method="setup"/>
<teardown script="FDB://Acme-Board-2000-Flash.py" method="teardown"/>
```

6. Edit the `method_configs` section, creating a `<method_config>` block for each device.

Note

- The value for the algorithm parameter should be changed to the path to the algorithm copied in *Step 1*. The `FDB:// ` prefix is used to indicate the file can be found in the configuration database `Flash` directory.
- The `coreName` parameter must be the name of the core on the target that runs the algorithm. This must be the same name as used in the `<core>` definition within `project_types.xml`. For example, `<core connection_id ="Cortex-M3" core_definition ="Cortex-M3"/>`.
- The `ramAddress` and `ramSize` parameters should be set to an area of RAM that the algorithm can be downloaded in to and used as working RAM. It should be big enough to hold the algorithm, stack plus scratch areas required to run the algorithm, and a sufficiently big area to download image data.
- The other parameters do not normally need to be changed.

13.4.2 Adding flash support to an existing target platform using a new Keil flash algorithm

DS-5 ships with a complete Keil flash algorithm example for the STM32 device family. You can use this as a template for creating and building your new flash algorithm.

Locate the `Bare-metal_examples_ARMv7.zip` file within the `DS-5/examples` directory. Extract it to your file system and then import the `DS-5Examples\flash_algo-STM32F10x` project into your DS-5 Eclipse Workspace.

Using this as your template, create a new project, copy the content from the example into your new project and modify as needed.

Once you have successfully built your `.FLM` file(s), proceed as explained in the *Adding flash support to an existing platform using an existing Keil flash algorithm* topic.

Related tasks

13.4.1 Adding flash support to an existing platform using an existing Keil flash algorithm on page 13-401.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.5 About creating a new flash method

If the Keil flash method is inappropriate for your requirements, it is necessary to create a new custom flash method for your use.

Programming methods are implemented in Jython (Python, utilizing the Jython runtime). The use of Jython allows access to the DTSL APIs used by DS-5 Debugger. DS-5 includes the PyDev tools to assist in writing Python scripts.

In a DS-5 install, the `configdb\Flash\flashprogrammer` directory holds a number of Python files which contain utility methods used in the examples.

This section describes a default implementation of `com.arm.debug.flashprogrammer.FlashMethodv1` and creating a flash method using a Python script.

This section contains the following subsections:

- *13.5.1 About using the default implementation FlashMethodv1* on page 13-403.
- *13.5.2 About creating the flash method Python script* on page 13-404.

13.5.1 About using the default implementation FlashMethodv1

Flash programming methods are written as Python classes that are required to implement the `com.arm.debug.flashprogrammer.IFlashMethod` interface. This interface defines the methods the flash programming layer of DS-5 Debugger might invoke.

See the `flash_method_v1.py` file in the `<Install folder>\sw\debugger\configdb\Flash\flashprogrammer` for a default implementation of `com.arm.debug.flashprogrammer.FlashMethodv1`. This has empty implementations of all functions - this allows a Python class derived from this object to only implement the required functions.

Running a flash programming method is split into three phases:

1. Setup - the `setup()` function prepares the target for performing flash programming. This might involve:
   - Reading and validating parameters passed from the configuration file.
   - Opening a connection to the target.
   - Preparing the target state, for example, to initialize the flash controller.
   - Loading any flash programming algorithms to the target.
2. Programming - the `program()` function is called for each section of data to be written. Images might have multiple load regions, so the `program()` function might be called several times. The data to write is passed to this function and the method writes the data into flash at this stage.
3. Teardown - the `teardown()` function is called after all sections have been programmed. At this stage, the target state can be restored (for example, take the flash controller out of write mode or reset the target) and any debug connection closed.

   Note

   The `setup()` and `teardown()` functions are not to be confused with the target platform optional `setup()` and `teardown()` scripts. The `setup()` and `teardown()` functions defined in the flash method class are for the method itself and not the board.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.5.2 About creating the flash method Python script

For the purposes of this example the Python script is called `example_flash.py`.

- Start by importing the objects required in the script:

```
from flashprogrammer.flash_method_v1 import FlashMethodv1
from com.arm.debug.flashprogrammer import TargetStatus
```

- Then, define the class implementing the method:

```
class ExampleFlashWriter(FlashMethodv1):
    def __init__(self, methodServices):
        FlashMethodv1.__init__(self, methodServices)

    def setup(self):
        # perform any setup for the method here
        pass

    def teardown(self):
        # perform any clean up for the method here
        # return the target status
        return TargetStatus.STATE_RETAINED

    def program(self, regionID, offset, data):
        # program a block of data to the flash
        # regionID indicates the region within the device (as defined in the flash
configuration file)
        # offset is the byte offset within the region

        # perform programming here

        # return the target status
        return TargetStatus.STATE_RETAINED
```

Note

- The `__init__` function is the constructor and is called when the class instance is created.
- `methodServices` allows the method to make calls into the flash programmer - it should not be accessed directly.
- `FlashMethodv1` provides functions that the method can call while programming.
- The `program()` and `teardown()` methods should return a value that describes the state the target has been left in.
  This can be one of:
  - `STATE_RETAINED` - The target state has not been altered from the state when programming started. In this state, the register and memory contents have been preserved or restored.
  - `STATE_LOST` - Register and memory contents have been altered, but a system reset is not required.
  - `RESET_REQUIRED` - It is recommended or required that the target be reset.
  - `POWER_CYCLE_REQUIRED` - It is required that the target be manually power cycled. For example, when a debugger-driven reset is not possible or not sufficient to reinitialize the target.

Creating the target platform setup and teardown scripts

If the hardware platform requires some setup (operations to be performed before flash programming) and/or teardown (operations to be performed after flash programming) functionality, you must create one or more scripts which contain `setup()` and `teardown()` functions. These can be in separate script files or you can combine them into a single file. This file should be placed into the configdb `Flash` directory so that it can be referenced using a `FDB://` prefix in the flash configuration file.

For example, the contents of a single file which contains both the `setup()` and `teardown()` functions would be similar to:

```
from com.arm.debug.flashprogrammer.IFlashClient import MessageLevel
from flashprogrammer.device import ensureDeviceOpen
from flashprogrammer.execution import ensureDeviceStopped
from flashprogrammer.device_memory import writeToTarget

def setup(client, services):
     # get a connection to the core
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
     conn = services.getConnection()
     dev = conn.getDeviceInterfaces().get("Cortex-M3")
     ensureDeviceOpen(dev)
     ensureDeviceStopped(dev)
     # Perform some target writes to enable flash programming
     writeToTarget(dev, FLASH_EN, intToBytes(0x81))

def teardown(client, services):
     # get a connection to the core
     conn = services.getConnection()
     dev = conn.getDeviceInterfaces().get("Cortex-M3")
     ensureDeviceOpen(dev)
     ensureDeviceStopped(dev)
     # Perform some target writes to disable flash programming
     writeToTarget(dev, FLASH_EN, intToBytes(0))
```

Creating the flash configuration file

To use the method to program flash, a configuration file must be created that describes the flash device, the method to use and any parameters or other information required. This is an `.xml` file and is typically stored in the same directory as the target's other configuration files (`Boards/<Manufacturer>/<Board name>`) as it contains target-specific information.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<flash_config
    xmlns:xi="http://www.w3.org/2001/XInclude"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns="http://www.arm.com/flash_config"
    xsi:schemaLocation="http://www.arm.com/flash_config flash_config.xsd">
    <devices>
        <device name="Example">
            <regions>
                <region address="0x8000" size="0x10000"/>
            </regions>
            <programming_type type="FILE">
                <method language="JYTHON" script="FDB://example_flash.py"
class="ExampleFlashWriter" method_config="Default"/>
                <setup script="FDB://file_target.py" method="setup"/>
                <teardown script="FDB://file_target.py" method="teardown"/>
            </programming_type>
        </device>
    </devices>
    <method_configs>
        <method_config id="Default">
            <params>
                <!-- Use last 2K of RAM -->
                <param name="ramAddress" type="integer" value="0x00100000"/>
                <param name="ramSize" type="integer" value="0x800"/>
            </params>
        </method_config>
    </method_configs>
</flash_config>
```

- The `flash_config` tag defines used XML spaces and schema. This does not usually need to be changed. Under the `flash_config` tag, a devices tag is required. This contains a number of device tags, each representing one flash device on the target. The device tag defines the name of the device - this is the name reported by the `info flash` command and is used only when programming to a specific device. It also defines a number of regions where the flash device appears in the target's memory - the addresses of each region are matched against the address of each load region of the image being programmed.
- The `programming_type` tag defines the programming method and setup/teardown scripts to be used for a flash programming operation. Currently, only `FILE` is supported.
- The `method` tag defines the script which implements the programming method. Currently, only `JYTHON` is supported for the language attribute. The script and class attributes define which script file to load and the name of the class that implements the programming method within the script. The `method_config` attributes define which set of parameters are used by the device. This allows multiple devices to share a set of parameters.
- The `programming_type` may also have optional setup and teardown tags. These define a script and a method within that script to call before or after flash programming.
- Within the `method_configs` tag, the parameters for each device are contained within `method_config` tags.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

- Parameters must have a unique name and a default value. You can override the value passed to the method. See the help for the `flash load` command within the DS-5 Debugger.
- Where the configuration file references another file, for example, the script files, the `FDB:// ` prefix indicates that the file is located in the `Flash` subdirectory of the configuration database. If there are multiple databases, then the `Flash` subdirectory of each database is searched until the file is found.
- The last file that needs to be changed is the `project_types.xml` file in the target's directory to tell DS-5 that the flash configuration can be found in the file created above. The following line should be added under the top-level `platform_data` tag:

  ```
  <flash_config>CDB://flash.xml</flash_config>
  ```

  The `CDB:// ` prefix tells DS-5 that the `flash.xml` file is located in the same directory as the `project_types.xml` file.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.6 About testing the flash configuration

With the files described in the previous sections in place, it should be possible to make a connection to the target in DS-5 and inspect the flash devices available and program an image. Although, with the files in their current form, no data will actually be written to flash.

Note

If DS-5 is already open and `project_types.xml` is changed, it will be necessary to rebuild the configuration database.

Within DS-5 Debugger, connect to your target system and enter `info flash` into the **Commands** view. You should get an output similar to:

```
info flash
MainFlash
regions:    0x8000000-0x807FFFF
parameters: programPageTimeout: 100
             driverVersion: 257
             programPageSize: 0x400
             eraseSectorTimeout: 500
             sectorSizes: ((0x800, 0x00000000))
             valEmpty: 0xff
             type: 1
             size: 0x00080000
             name: STM32F10x High-density Flash
             address: 0x08000000
             algorithm: FDB://algorithms/STM32F10x_512.FLM
             coreName: Cortex-M3
             ramAddress: 0x20000000
             ramSize: 0x10000
             disableTimeouts: false
             verify: true
```

You can test the flash programming operation by attempting to program with a test ELF file.

```
flash load flashyprogram.axf
Writing segment 0x00008000 ~ 0x0000810C (size 0x10C)
Flash programming completed OK (target state has been preserved)
```

Note

You can use any ELF (`.axf`) file which contains data within the configured address range.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.7 About flash method parameters

Programming methods can take parameters that serve to change the behavior of the flash programming operation.

Example parameters could be:

- The programming algorithm image to load, for example, the Keil Flash Algorithm file.
- The location & size of RAM the method can use for running code, buffers, and similar items.
- Clock speeds.
- Timeouts.
- Programming and erase page sizes.

The default values of the parameters are taken from the flash configuration file.

Note

You can override the parameters from the DS-5 command line.

The programming method can obtain the value of the parameters with:

- `getParameter(name)` returns the value of a parameter as a string. The method can convert this to another type, such as integers, as required. `None` is returned if no value is set for this parameter.
- `getParameters()` returns a map of all parameters to values. Values can then be obtained with the `[]` operator.

For example:

```
def setup(self):
    # get the name of the core to connect to
    coreName = self.getParameter("coreName")

    # get parameters for working RAM
    self.ramAddr = int(self.getParameter("ramAddress"), 0)
    self.ramSize = int(self.getParameter("ramSize"), 0)
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.8 About getting data to the flash algorithm

Data is passed to the `program()` function by the data parameter.

A data parameter is an object that provides the following functions:

- `getSize()` returns the amount of data available in bytes.
- `getData(sz)` returns a buffer of up to `sz` data bytes. This may be less, for example, at the end of the data. The read position is advanced.
- `seek(pos)` move the read position.
- `getUnderlyingFile()` gets the file containing the data. (None, if not backed by a file). This allows the method to pass the file to an external tool.

The method can process the data with:

```
def program(self, regionID, offset, data):
    data.seek(0)
    bytesWritten = 0
    while bytesWritten < data.getSize():
        # get next block of data
        buf = data.getData(self.pageSize)

                  # write buf to flash
                  bytesWritten += len(buf)
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

13.9 About interacting with the target

To perform flash programming, the programming method might need to access the target.

The flash programmer provides access to the DTSL APIs for this and the programming method can then get a connection with the `getConnection()` function of class `FlashMethodv1`.

This is called from the `setup()` function of the programming method. If there is already an open connection, for example, from the DS-5 Debugger, this will be re-used.

```
def setup(self):
    # connect to core
    self.conn = self.getConnection()
```

Note

An example, `flash_example-FVP-A9x4`, is provided with DS-5. This example shows two ways of programming flash devices using DS-5, one using a Keil Flash Method and the other using a Custom Flash Method written in Jython. For convenience, the `Cortex-A9x4 FVP` model supplied with DS-5 is used as the target device. This example can be used as a template for creating new flash algorithms. The `readme.html` provided with the example contains basic information on how to use the example.

Accessing the core

When interacting with the target, it might be necessary to open a connection to the core. If the debugger already has an open connection, a new connection might not be always possible. A utility function, `ensureDeviceOpen()`, is provided that will open the connection only if required. It will return `true` if the connection is open and so should be closed after programming in the `teardown()` function.

To access the core's registers and memory, the core has to be stopped. Use the `ensureDeviceStopped()` function to assist with this.

```
def setup(self):
    # connect to core & stop
    self.conn = self.getConnection()
    coreName = self.getParameter("coreName")
    self.dev = self.conn.getDeviceInterfaces().get(coreName)
    self.deviceOpened = ensureDeviceOpen(self.dev)
    ensureDeviceStopped(self.dev)

def teardown(self):
    if self.deviceOpened:
        # close device connection if opened by this script
        self.dev.closeConn()
```

Reading/writing memory

The core's memory can be accessed using the `memWrite()`, `memFill()`, and `memRead()` functions of the dev object (`IDevice`).

```
from com.arm.rddi import RDDI
from com.arm.rddi import RDDI_ACC_SIZE
from jarray import zeros

...

    def program(self):
        ...
        self.dev.memFill(0, addr, RDDI_ACC_SIZE.RDDI_ACC_WORD,
                         RDDI.RDDI_MRUL_NORMAL, False, words, 0)
        self.dev.memWrite(0, addr, RDDI_ACC_SIZE.RDDI_ACC_WORD,
                          RDDI.RDDI_MRUL_NORMAL, False, len(buf), buf)
        ...

    def verify(self):
        ...
        readBuf = zeros(len(buf), 'b')
        self.dev.memRead(0, addr, RDDI_ACC_SIZE.RDDI_ACC_WORD,
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
                        RDDI.RDDI_MRUL_NORMAL, len(readBuf), readBuf)
        ...
```

Utility routines to make the method code clearer are provided in `device_memory`:

```
from flashprogrammer.device_memory import writeToTarget, readFromTarget

...
    def program(self):
        ...
        writeToTarget(self.dev, address, buf)
        ...

    def verify(self):
        ...
        readBuf = readFromTarget(self.dev, addr, count)
        ...
```

Reading and writing registers

The core's registers can be read using the `regReadList()` and written using the `regWriteList()` functions of `Idevice`.

Note

You must be careful to only pass integer values and not long values.

These registers are accessed by using numeric IDs. These IDs are target specific. For example, `R0` is register 1 on a Cortex-A device, but register 0 on a Cortex-M device.

`execution.py` provides functions that map register names to numbers and allow reading or writing by name.

- `writeRegs(device, regs)` writes a number of registers to a device. `regs` is a list of (name, value) pairs. For example:

  ```
  writeRegs (self.dev, [ ("R0", 0), ("R1", 1234), ("PC", 0x8000) ]
  ```

  will set `R0`, `R1`, and `PC` (R15).
- `readReg(device, reg)` reads a named register. For example:

  ```
  value = readReg ("R0")
  ```

  will read R0 and return its value.

Running code on the core

The core can be started and stopped via the `go()` and `stop()` functions. Breakpoints can be set with the `setSWBreak()` or `setHWBreak()` functions and cleared with the `clearSWBreak()` or `clearHWBreak()` functions. As it may take some time to reach the breakpoint, before accessing the target further, the script should wait for the breakpoint to be hit and the core stopped.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

`execution.py` provides utility methods to assist with running code on the target.

- To request the core to stop and wait for the stop status event to be received, and raise an error if no event is received before timeout elapses.

```
stopDevice(device, timeout=1.0):
```

- To check the device's status and calls `stopDevice()` if it is not stopped.

```
ensureDeviceStopped(device, timeout=1.0):
```

- To start the core and wait for it to stop, forces the core to stop and raise an error if it doesn't stop before timeout elapses. The caller must set the registers appropriately and have set a breakpoint or vector catch to cause the core to stop at the desired address.

```
runAndWaitForStop(device, timeout=1.0):
```

- To set a software breakpoint at `addr`, start the core and wait for it to stop by calling `runAndWaitForStop()`. The caller must set the registers appropriately.

```
runToBreakpoint(device, addr, bpFlags = RDDI.RDDI_BRUL_STD, timeout=1.0):
```

Flash programming algorithms are often implemented as functions that are run on the target itself. These functions may take parameters where the parameters are passed through registers.

`funcCall()` allows methods to call functions that follow AAPCS (with some restrictions):

- Up to the first four parameters are passed in registers `R0-R3`.
- Any parameters above this are passed via the stack.
- Only integers up to 32-bit or pointer parameters are supported. Floating point or 64-bit integers are not supported.
- The result is returned in `R0`.

We can use the above to simulate flash programming by writing the data to RAM. See `example_method_1.py`. This:

- Connects to the target on `setup()`.
- Fills the destination RAM with 0s to simulate erase.
- Writes data to a write buffer in working RAM.
- Runs a routine that copies the data from the write buffer to the destination RAM.
- Verifies the write by reading from the destination RAM.

Loading programming algorithm images onto the target

Programming algorithms are often compiled into `.elf` images.

`FlashMethodv1.locateFile()` locates a file for example, from a parameter, resolving any `FDB://` prefix to absolute paths.

`symfile.py` provides a class, `SymbolFileReader`, that allows the programming method to load an image file and get the locations of symbols. For example, to get the location of a function:

```
        # load the algorithm image
        algorithmFile = self.locateFile(self.getParameter('algorithm'))
        algoReader = SymbolFileReader(algorithmFile)

        # Find the address of the Program() function
        funcInfo = algoReader.getFunctionInfo()['Program']
        programAddr = funcInfo['address']
        if funcInfo['thumb']:
            # set bit 0 if symbol is thumb
            programAddr |= 1
```

`image_loader.py` provides routines to load the image to the target:

```
        # load algorithm into working RAM
        algoAddr = self.ramAddr + 0x1000 # allow space for stack, buffers etc
        loadAllCodeSegmentsToTarget(self.dev, algoReader, algoAddr)
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

If the algorithm binary was linked as position independent, the addresses of the symbols are relative to the load address and this offset should be applied when running the code on the target:

```
        programAddr += algoAddr
        args = [ writeBuffer, destAddr, pageSize ]
        funcCall(self.dev, programAddr, args, self.stackTop)
```

Progress reporting

Flash programming can be a slow process, so it is desirable to have progress reporting features. The method can do this by calling `operationStarted()`. This returns an object with functions:

- `progress()` - update the reported progress.
- `complete()` - report the operation as completed, with a success or failure.

Progress reporting can be added to the `program()` function in the previous example:

```
    def program(self, regionID, offset, data):
        # calculate the address to write to
        region = self.getRegion(regionID)
        addr = region.getAddress() + offset

        # Report progress, assuming erase takes 20% of the time, program 50%
        # and verify 30%
        progress = self.operationStarted(
            'Programming 0x%x bytes to 0x%08x' % (data.getSize(), addr),
            100)

        self.doErase(addr, data.getSize())
        progress.progress('Erasing completed', 20)

        self.doWrite(addr, data)
        progress.progress('Writing completed', 20+50)

        self.doVerify(addr, data)
        progress.progress('Verifying completed', 20+50+30)

        progress.completed(OperationResult.SUCCESS, 'All done')

        # register values have been changed
        return TargetStatus.STATE_LOST
```

The above example only has coarse progress reporting, only reporting at the end of each phase. Better resolution can be achieved by allowing each sub-task to have a progress monitor. `subOperation()` creates a child progress monitor.

Care should be taken to ensure `completed()` is called on the progress monitor when an error occurs. It is recommended that a `try: except:` block is placed around the code after a progress monitor is created.

```
    import java.lang.Exception
    def program(self, regionID, offset, data):
        progress = self.operationStarted(
            'Programming 0x%x bytes to 0x%08x' % (data.getSize(), addr),
            100)
        try:
            # Do programming
        except (Exception, java.lang.Exception), e:
            # exceptions may be derived from Java Exception or Python Exception
            # report failure to progress monitor & rethrow
            progress.completed(OperationResult.FAILURE, 'Failed')
            raise
```

Note

`import java.lang.Exception` - If you omit import and a Java exception is thrown, you may get a confusing error report from Jython indicating that it cannot find the Java namespace. Further, the python line location indicated as the source of the error will not be accurate.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Cancellation

If you wish to abort a long-running flash operation, programming methods can call `isCancelled()` to check if the operation is canceled. If this returns true, the method stops programming.

Note

The `teardown()` functions are still called.

Messages

The programming method can report messages by calling the following:

- `warning()` - reports a warning message.
- `info()` - reports an informational message.
- `debug()` - reports a debug message - not normally displayed.

Locating and resolving files

`FlashMethodv1.locateFile()` locates a file for example, from a parameter, resolving any `FDB://` prefix to absolute paths.

This searches paths of all flash subdirectories of every configuration database configured in DS-5.

For example:

`<DS5_INSTALL_DIR>/sw/debugger/configdb/Flash/`

`c:\MyDB\Flash`

Error handling

Exceptions are thrown when errors occur. Errors from the API calls made by the programming method will be `com.arm.debug.flashprogrammer.FlashProgrammerException` (or derived from this). Methods may also report errors using Python's `raise` keyword. For example, if verification fails:

```
# compare contents
res = compareBuffers(buf, readBuf)
if res != len(buf):
    raise FlashProgrammerRuntimeException, "Verify failed at address: %08x" %
(addr + res)
```

If a programming method needs to ensure that a cleanup occurs when an exception is thrown, the following code forms a template:

```
    import java.lang.Exception
         ...
        try:
            # Do programming
        except (Exception, java.lang.Exception), e:
            # exceptions may be derived from Java Exception or Python Exception
            # report failure to progress monitor & rethrow

            # Handle errors here

            # Rethrow original exception
            raise
        finally:
            # This is always executed on success or failure
            # Close resources here
```

See the Progress handler section for example usage.

Note

`import java.lang.Exception` - If you omit import and a Java exception is thrown, you may get a confusing error report from Jython indicating that it cannot find the Java namespace. Further, the python line location indicated as the source of the error will not be accurate.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Running an external tool

Some targets may already have a standalone flash programming tool. It is possible to create a DS-5 Debugger programming method to call this tool, passing it to the path of the image to load. The following example shows how to do this, using the `fromelf` tool in place of a real flash programming tool.

```
from flashprogrammer.flash_method_v1 import FlashMethodv1
from com.arm.debug.flashprogrammer.IProgress import OperationResult
from com.arm.debug.flashprogrammer import TargetStatus
import java.lang.Exception
import subprocess

class RunProgrammer(FlashMethodv1):
    def __init__(self, methodServices):
        FlashMethodv1.__init__(self, methodServices)


    def program(self, regionID, offset, data):

        progress = self.operationStarted(
            'Programming 0x%x bytes with command %s' % (data.getSize(), ' '.join(cmd)),
            100)
        try:
            # Get the path of the image file
            file = data.getUnderlyingFile().getCanonicalPath()

            cmd = [ 'fromelf', file ]
            self.info("Running %s" % ' '.join(cmd))

     # run command
     proc = subprocess.Popen(cmd, stdout=subprocess.PIPE)
     out, err = proc.communicate()

     # pass command output to user as info message
     self.info(out)

            progress.progress('Completed', 100)
            progress.completed(OperationResult.SUCCESS, 'All done')

        except (Exception, java.lang.Exception), e:
            # exceptions may be derived from Java Exception or Python Exception
            # report failure to progress monitor & rethrow
            progress.completed(OperationResult.FAILURE, 'Failed')
            raise

        return TargetStatus.STATE_RETAINED
```

`os.environ` can be used to lookup environment variables, for example, the location of a target's toolchain:

```
programmerTool = os.path.join(os.environ['TOOLCHAIN_INSTALL'], 'flashprogrammer')
```

Setup and teardown

The flash configuration file can specify scripts to be run before and after flash programming. These are termed setup and teardown scripts and are defined using setup and teardown tags. The setup script should put the target into a state ready for flash programming.

This might involve one or more of:

- Reset the target.
- Disable interrupts.
- Disable peripherals that might interfere with flash programming.
- Setup DRAM.
- Enable flash control.
- Setup clocks appropriately.

The teardown script should return the target to a usable state following flash programming.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

In both cases, it may be necessary to reset the target. The following code can be used to stop the core on the reset vector.

Note

This example code assumes that the core supports the RSET vector catch feature.

```
def setup(client, services):
    # get a connection to the core
    conn = services.getConnection()
    dev = conn.getDeviceInterfaces().get("Cortex-M3")
    ensureDeviceOpen(dev)
    ensureDeviceStopped(dev)

    dev.setProcBreak("RSET")
    dev.systemReset(0)
    # TODO: wait for stop!
    dev.clearProcBreak("RSET")
```

Other ways of providing flash method parameters

The flash configuration file can provide flash region information and flash parameter information encoded into the XML. However, for some methods, this information may need to be extracted from the flash algorithm itself.

Programming methods can extend any information in the flash configuration file (if any) with address regions and parameters for the method by overriding a pair of class methods - `getDefaultRegions()` and `getDefaultParameters()`.

```
getDefaultParameters().
from com.arm.debug.flashprogrammer import FlashRegion

...
class ProgrammingMethod(FlashMethodv1):
...

    def getDefaultRegions(self):
        return [ FlashRegion(0x00100000, 0x10000), FlashRegion(0x00200000, 0x10000) ]

    def getDefaultParameters(self):
        params = {}
        params['param1'] = "DefaultValue1"
        params['param2'] = "DefaultValue2"
        return params
```

The above code defines two 64kB regions at `0x00100000` and `0x00200000`. Regions supplied by this method are only used if no regions are specified for the device in the configuration file. The above code defines 2 extra parameters. These parameters are added to the parameters in the flash configuration. If a parameter is defined in both, the default value in the flash configuration file is used. This region and parameter information can be extracted from the algorithm binary itself (rather than being hard-coded as in the above example). The Keil algorithm images contain a data structure defining regions covered by the device and the programming parameters for the device. The Keil programming method loads the algorithm binary (specified by a parameter in the configuration file) and extracts this information to return in these calls.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 14
Writing OS Awareness for DS-5 Debugger

Describes the OS awareness feature available in DS-5.

It contains the following sections:

- *14.1 About Writing operating system awareness for DS-5 Debugger* on page 14-418.
- *14.2 Creating an OS awareness extension* on page 14-419.
- *14.3 Implementing the OS awareness API* on page 14-423.
- *14.4 Enabling the OS awareness* on page 14-425.
- *14.5 Implementing thread awareness* on page 14-430.
- *14.6 Implementing data views* on page 14-433.
- *14.7 Advanced OS awareness extension* on page 14-436.
- *14.8 Programming advice and noteworthy information* on page 14-438.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

14.1 About Writing operating system awareness for DS-5 Debugger

DS-5 Debugger offers an Application Programming Interface (API) for third parties to contribute awareness for their operating systems (OS).

The OS awareness extends the debugger to provide a representation of the OS threads - or tasks - and other relevant data structures, typically semaphores, mutexes, or queues.

Thread-awareness, in particular, enables the following features in the debugger:

- Setting breakpoints for a particular thread, or a group of threads.
- Displaying the call stack for a specific thread.
- For any given thread, inspecting local variables and register values at a selected stack frame.

To illustrate different stages of the implementation, this chapter explains how to add support for a fictional OS named `myos`.

The steps can be summarized as follows:

1. Create a new configuration database folder to host the OS awareness extension and add it to the DS-5 Debugger preferences in Eclipse.
2. Create the files `extension.xml` and `messages.properties` so that the extension appears on the **OS Awareness** tab in the **Debug configuration** dialog.
3. Add `provider.py` and implement the awareness enablement logic.
4. Add `contexts.py` and implement the thread awareness.
5. Add `tasks.py` to contribute a table to the **RTOS Data** view, showing detailed information about tasks.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

14.2 Creating an OS awareness extension

The debugger searches for OS awareness extensions in its configuration database. All files pertaining to a particular extension must be located in a folder or at the root of a Java Archive (JAR) file in the configuration database `OS/` folder.

The actual name of the folder or JAR file is not relevant and is not shown anywhere. Within this folder or JAR file, the debugger looks for a file named `extension.xml` to discover the OS awareness extension.

This file contains the following information:

- The OS name, description, and, optionally, a logo to display in the **OS Awareness** selection pane.
- The root Python script or Java class providing the actual implementation.
- The details of cores, architectures, or platforms this implementation applies to.

You can create a new OS awareness extension by directly modifying the configuration database in the DS-5 installation folder with appropriate access privileges, but this is not recommended.

Instead, create a new configuration database folder, containing an empty folder named `OS` (upper case):

```
<some folder>
    /mydb
      /OS
```

Then, add `mydb` to the known configuration databases in the Eclipse preferences panel for DS-5.

1. In Eclipse, go to menu **Windows** > **Preferences**, then expand the DS-5 node and select **Configuration Database**.
2. Then click **Add** and enter the path to `mydb`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

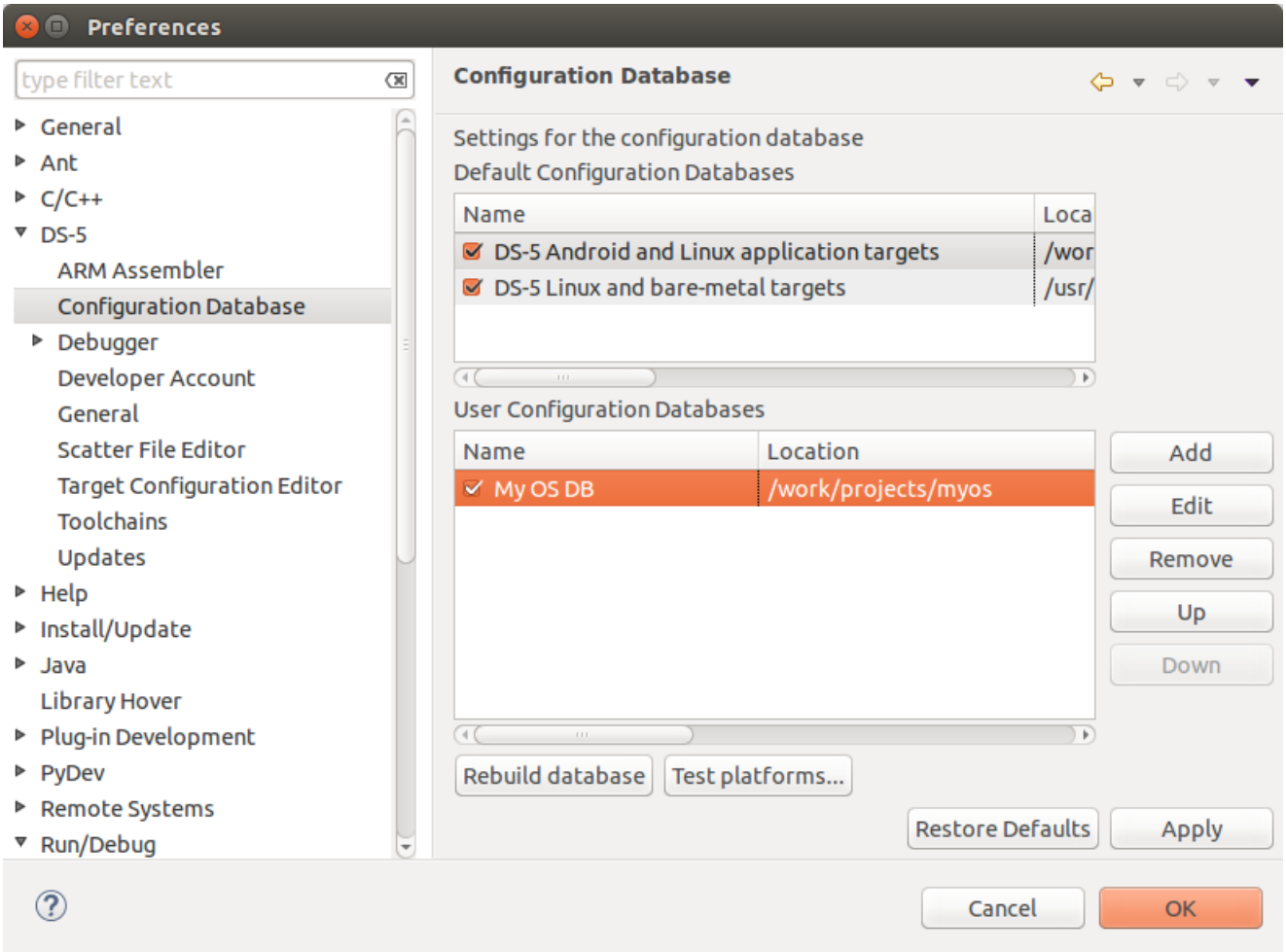


Figure 14-1 Eclipse preferences for `mydb`

Note

The `some folder` entry is represented by `/work/projects` in the figure.

3. Now, add the OS awareness extension in `mydb/OS`. To do so, create a new folder named `myos` containing the following files:

```
<some folder>
    /mydb
        /OS
          /myos
              /extension.xml
              /messages.properties
```

As explained earlier, `extension.xml` declares the OS awareness extension. The schema describing the structure of file `extension.xml` can be found in the DS-5 installation folder at `sw/debugger/configdb/Schemas/os_extension.xsd`.

The file `messages.properties` contains all user-visible strings. The file format is documented here:

http://docs.oracle.com/javase/7/docs/api/java/util/Properties.html#load(java.io.Reader)

Having user-visible strings in a separate file allows them to be translated. The debugger searches for translations in the following order in the named files:

- First `messages_<language code>_<country code>.properties`,
- Then `messages_<language code>.properties`,
- And finally in `messages.properties`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Language and country codes are defined here respectively:

- *http://www.loc.gov/standards/iso639-2/englangn.html*
- *http://www.iso.ch/iso/en/prods-services/iso3166ma/02iso-3166-code-lists/list-en1.html*

4. Consider the following content to start adding support for `myos`:
   - `extension.xml`

```
<?xml version="1.0" encoding="UTF-8"?>
<os id="myos" version="5.15" xmlns="http://www.arm.com/os_extension">
    <name>myos.title</name>
    <description>myos.desc</description>
    <provider><!-- todo --></provider>
</os>
```

Note

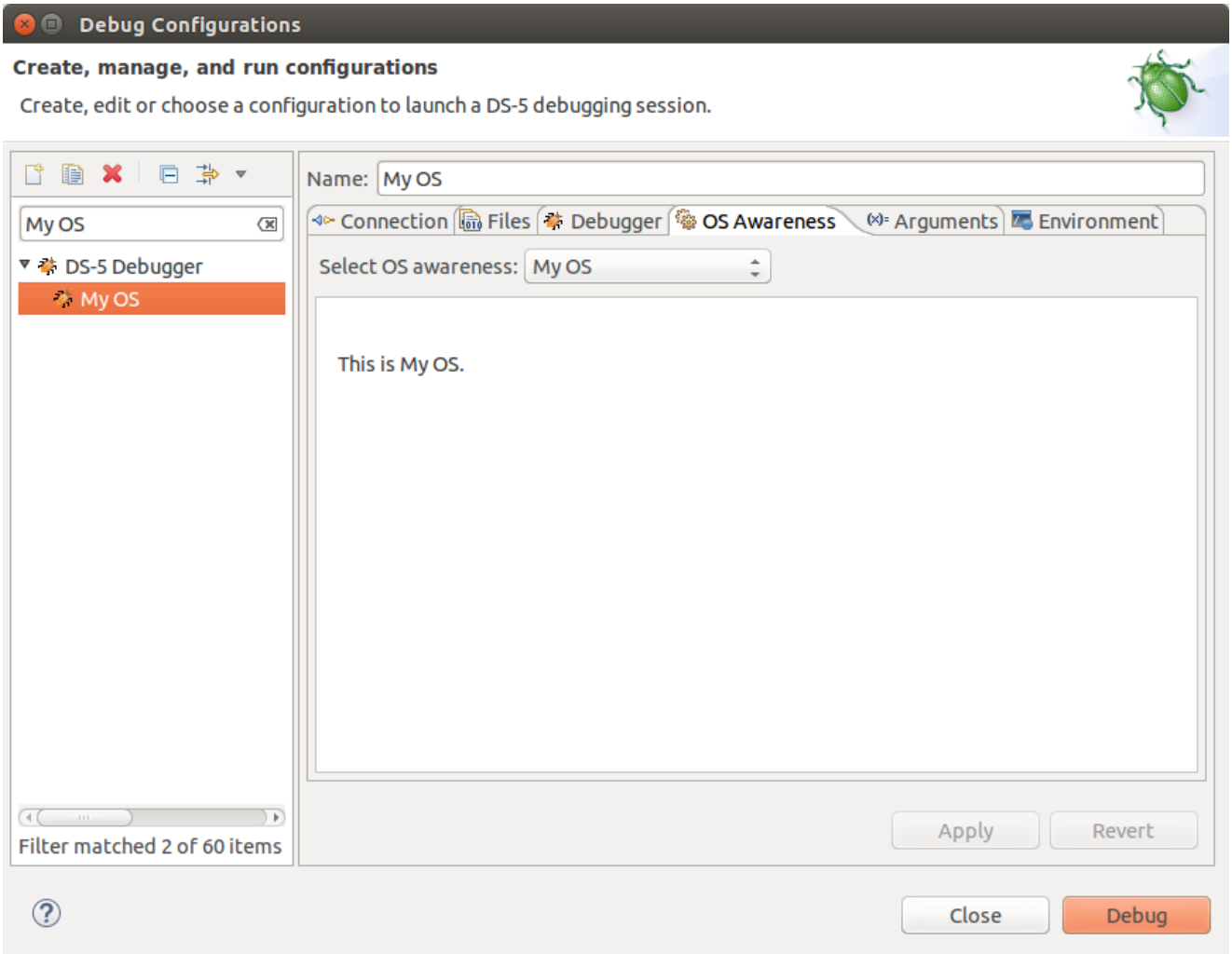
The `version` attribute in the `os` element refers to the API version, which is aligned with the version of DS-5 that the API was made public with. You must set the `version` attribute to the DS-5 version that the OS awareness extension was developed in, or the lowest version that it was tested with. The debugger does not display any extensions that require a higher version number. However, as the API is backwards compatible, the debugger displays extensions with earlier API versions. The earliest API version was 5.15.

   - `messages.properties`

```
myos.title=My OS
myos.desc=This is My OS.
myos.help=Displays information about My OS.
```

This is sufficient for the OS awareness extension to appear in the Eclipse debug configuration, even though the implementation is obviously not complete and would cause errors if it is used for an actual debugger connection at this stage:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential



The `myos.help` string is only visible from the debugger's command line interface, for instance, when typing `help myos` once connected.

Using the `extension.xml`, you can include a reference to an image file to be shown above the description in the **OS Awareness** tab. Supported image formats are `.BMP`, `.GIF`, `.JPEG`, `.PNG`, and `.TIFF`.

Also, it is possible to control the targets for which the OS awareness extension is available.

The complete XML schema for `extension.xml` file is available in `[DS-5 install folder]/sw/debugger/configdb/Schemas/os_extension.xsd`.

Figure 14-2 Custom OS awareness displayed in Eclipse Debug Configurations dialog

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

14.3 Implementing the OS awareness API

The OS awareness API consists of callbacks that the debugger makes at specific times. For each callback, the debugger provides a means for the implementation to retrieve information about the target and resolve variables and pointers, through an expression evaluator.

The API exists primarily as a set of Java interfaces since the debugger itself is written in Java. However, the debugger provides a Python interpreter and bindings to translate calls between Python and Java, allowing the Java interfaces to be implemented by Python scripts. This section and the next ones refer to the Java interfaces but explain how to implement the extension in Python.

Note

A Python implementation does not require any particular build or compilation environment, as opposed to a Java implementation. On the other hand, investigating problems within Python code is more difficult, and you are advised to read the *Programming advice and noteworthy information* section before starting to write your own Python implementation.

The detailed Java interfaces to implement are available in the DS-5 installation folder under `sw/eclipse/dropins/plugins`, within the `com.arm.debug.extension.source_<version>.jar` file.

Note

You are encouraged to read the Javadoc documentation on Java interfaces as it contains essential information that is not presented here.

The Java interface of immediate interest at this point is `IOSProvider`, in the package `com.arm.debug.extension.os`. This interface must be implemented by the provider instance that was left out with a `todo` comment in `extension.xml`.

First, add the simplest implementation to the configuration database entry:

```
<some folder>
    /mydb
        /OS
            /myos
                /extension.xml
                /messages.properties
                /provider.py
```

- `extension.xml`

```
<?xml version="1.0" encoding="UTF-8"?>
<os id="myos" version="5.15" xmlns="http://www.arm.com/os_extension">
    <name>myos.title</name>
    <description>myos.desc</description>
    <provider>provider.py</provider>
</os>
```

- `provider.py`

```
# this script implements the Java interface IOSProvider
def areOSSymbolsLoaded(debugger):
    return False

def isOSInitialised(debugger):
    return False

def getOSContextProvider():
    return None

def getDataModel():
    return None
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

This is enough to make the OS awareness implementation valid. A debug configuration with this OS awareness selected works, although this does not add anything on top of a plain bare-metal connection. However, this illustrates the logical lifecycle of the OS awareness:

1. Ensure debug information for the OS is available. On loading symbols, the debugger calls `areOSSymbolsLoaded();` the implementation returns true if it recognizes symbols as belonging to the OS, enabling the next callback.
2. Ensure the OS is initialized. Once the symbols for the OS are available, the debugger calls `isOSInitialised(),` immediately if the target is stopped or whenever the target stops next. This is an opportunity for the awareness implementation to check that the OS has reached a state where threads and other data structures are ready to be read, enabling the next two callbacks.
3. Retrieve information about threads and other data structures. Once the OS is initialized, the debugger calls out to `getOSContextProvider()` and `getDataModel()` to read information from the target. In reality, the debugger may call out to `getOSContextProvider()` and `getDataModel()` earlier on, but does not use the returned objects to read from the target until `areOSSymbolsLoaded()` and `isOSInitialised()` both returned `true`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

14.4 Enabling the OS awareness

The below implementation in `provider.py`, assumes `myos` has a global variable called `tasks` listing the OS tasks in an array and another global variable `scheduler_running` indicating that the OS has started scheduling tasks.

```
# this script implements the Java interface IOSProvider
from osapi import DebugSessionException

def areOSSymbolsLoaded(debugger):
    return debugger.symbolExists("tasks") \
        and debugger.symbolExists("scheduler_running")

def isOSInitialised(debugger):
    try:
        result = debugger.evaluateExpression("scheduler_running")
        return result.readAsNumber() == 1
    except DebugSessionException:
        return False

def getOSContextProvider():
    return None

def getDataModel():
    return None
```

The `osapi` module in the import statement at the top of `provider.py` is a collection of wrappers around Java objects and utility functions. The file `osapi.py` itself can be found in JAR file `com.arm.debug.extension_<version>.jar`.

Connecting to a running target and loading symbols manually for the OS shows both `areOSSymbolsLoaded()` and `isOSInitialised()` stages distinctly.

- On connecting to the target running the OS, without loading symbols, the **Debug Control** view displays **Waiting for symbols to be loaded**.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

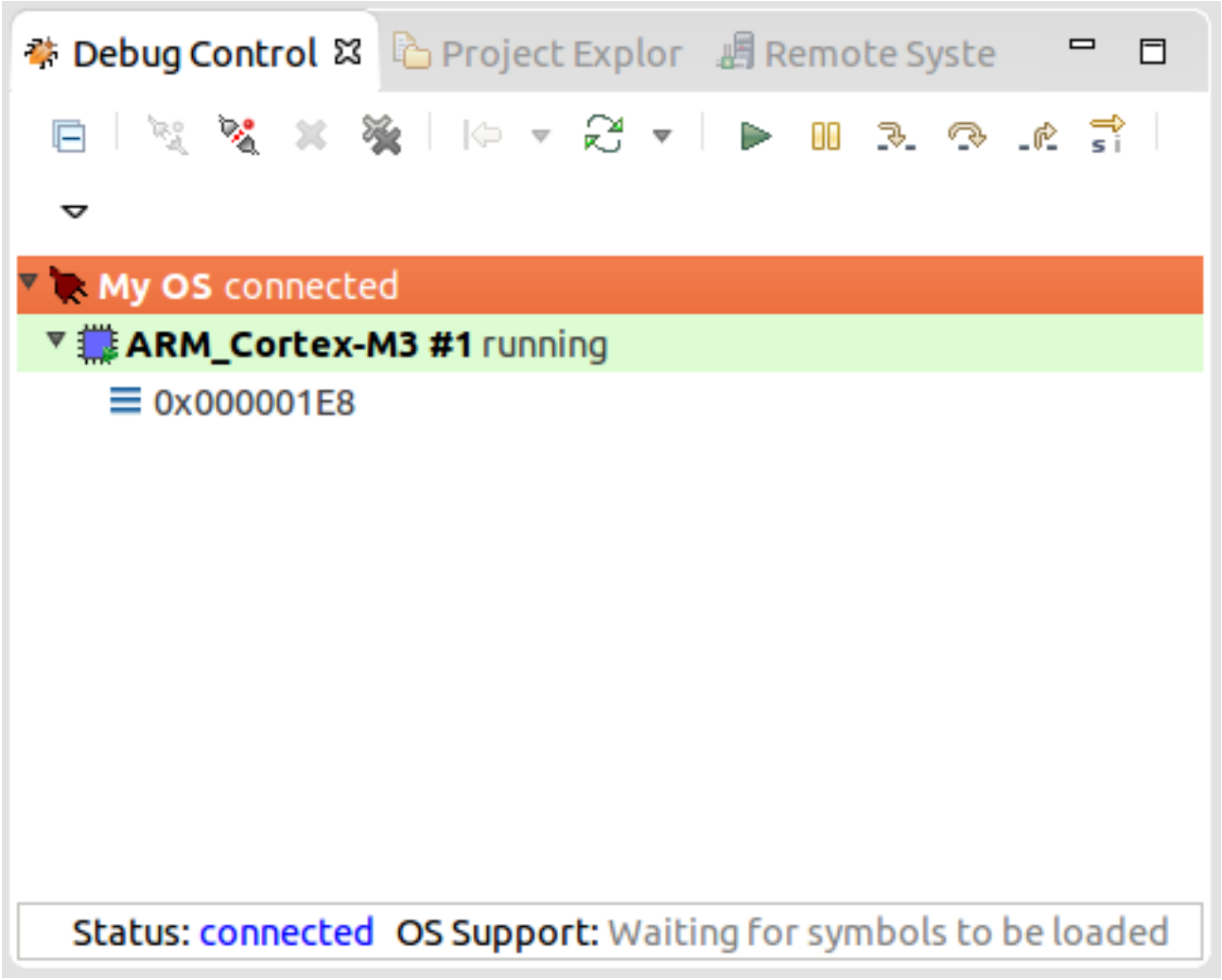


Figure 14-3 myos waiting for symbols to be loaded

- After loading symbols for the OS, with the target still running, the **Debug Control** view now displays **Waiting for the target to stop**. At this point, `areOSSymbolsLoaded()` has been called and returned true, and the debugger is now waiting for the target to stop to call `isOSInitialised()`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

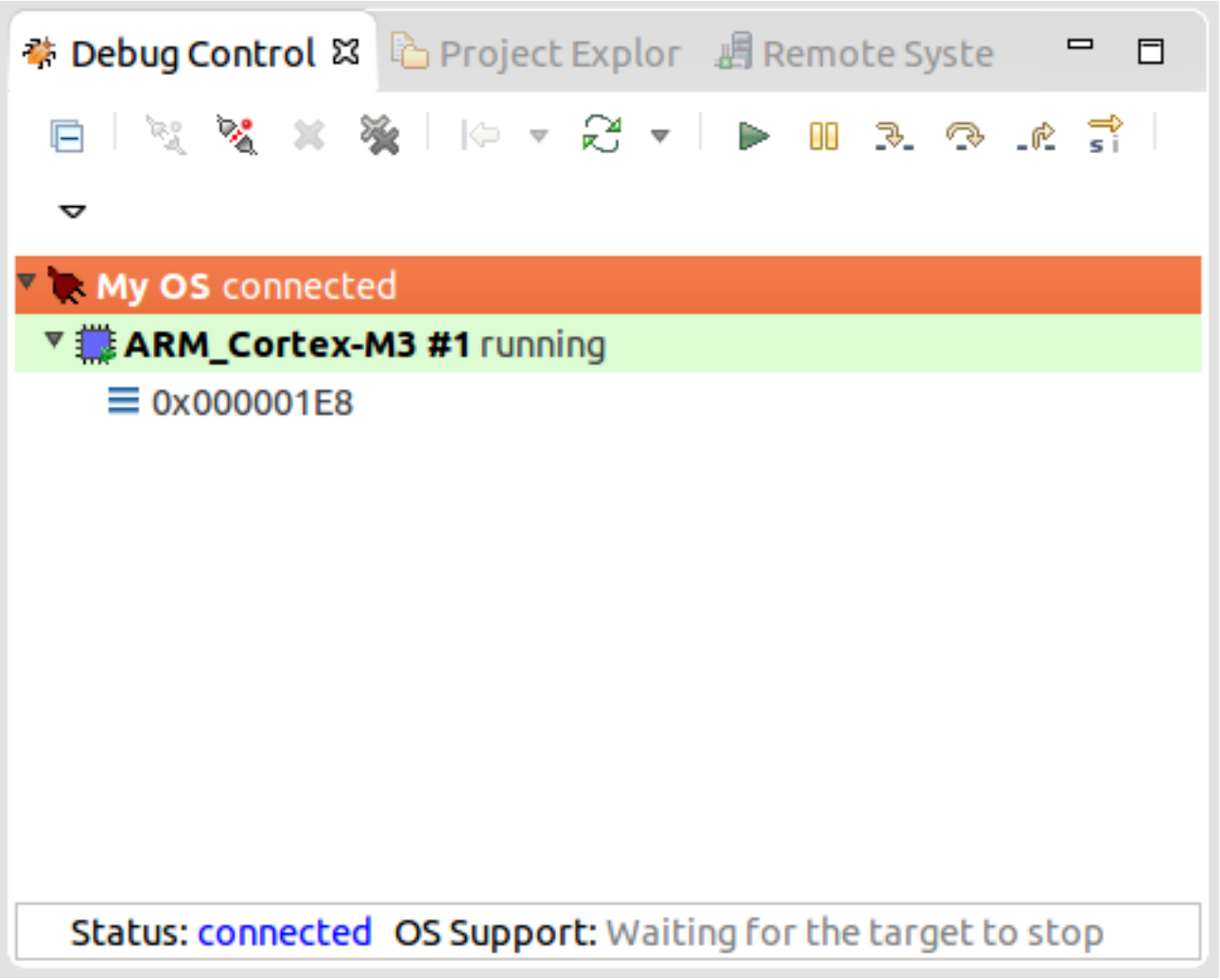


Figure 14-4 myos waiting for the target to stop

- As soon as the target is stopped, the **Debug Control** view updates to show the OS awareness is enabled. At this point, `isOSInitialised()` has been called and returned `true`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

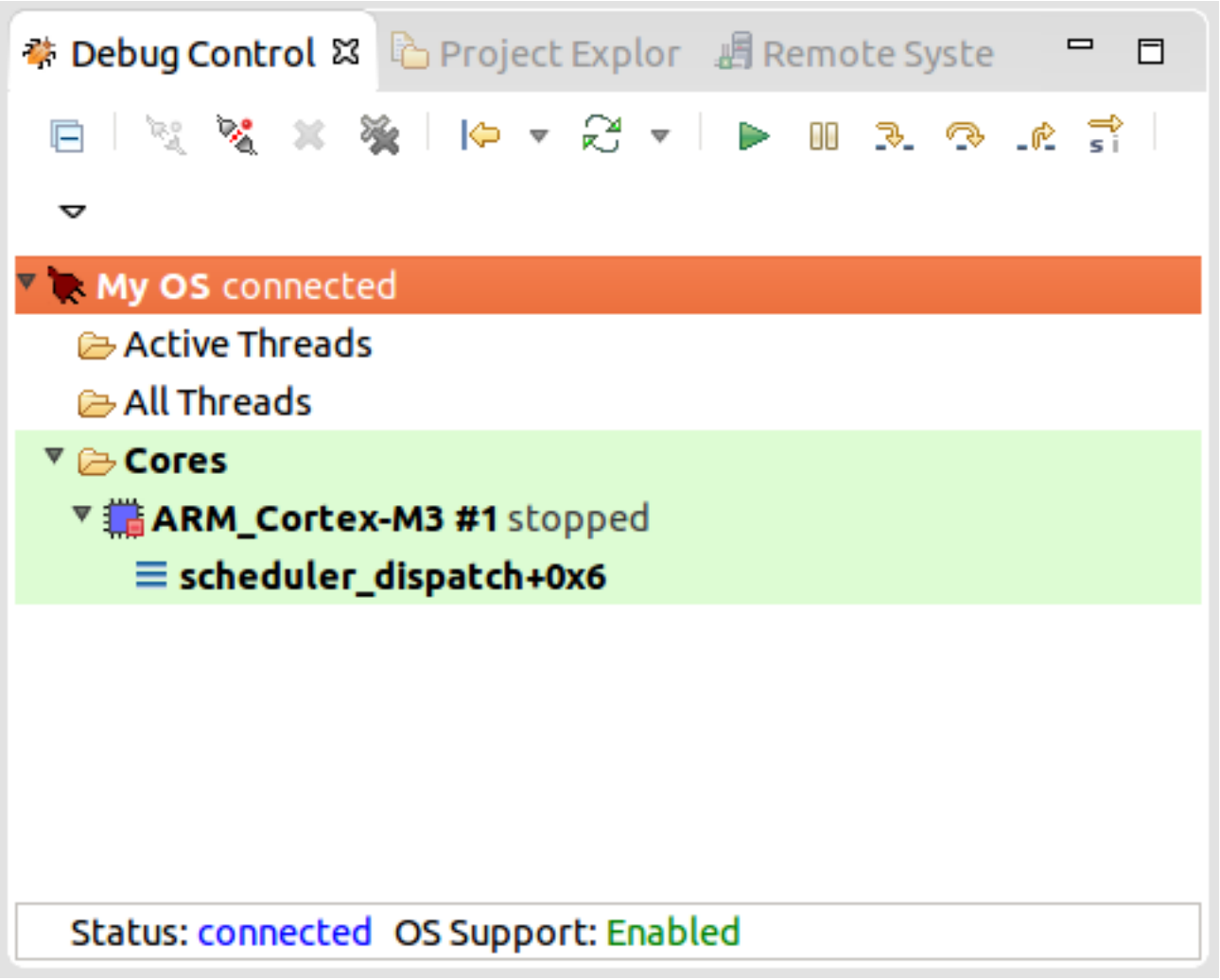


Figure 14-5 myos Enabled

Both the `Active Threads` and `All Threads` folders are always empty until you implement thread awareness using `getOSContextProvider()`.

Note

You can show the `Cores` folder by enabling the **Always Show Cores** option in the View Menu of the **Debug Control** view.

- Another case worth mentioning is where `areOSSymbolsLoaded()` returns `true` but `isOSInitialised()` returns `false`. This can happen for instance when connecting to a stopped target, loading both the kernel image to the target and associated symbols in the debugger and starting debugging from a point in time earlier than the OS initialization, for example, debugging from the image entry point. In this case, the **Debug Control** view shows **Waiting for the OS to be initialised** as `scheduler_running` is not set to `1` yet, but symbols are loaded:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

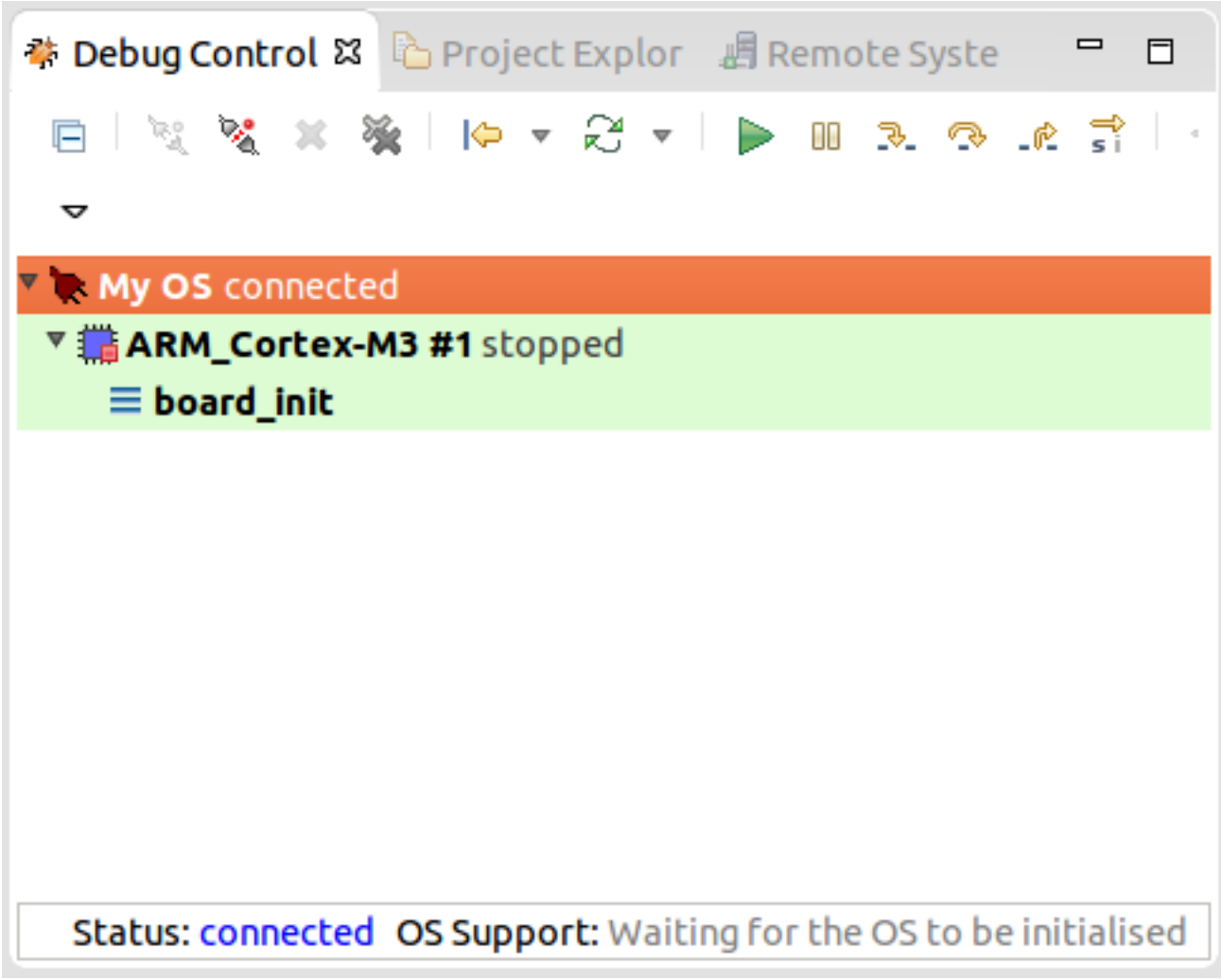


Figure 14-6 myos waiting for the OS to be initialised

Without the call to `isOSInitialised()` the debugger lets the awareness implementation start reading potentially uninitialized memory, which is why this callback exists. The debugger keeps calling back to `isOSInitialised()` on subsequent stops until it returns true, and the OS awareness can finally be enabled.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

14.5 Implementing thread awareness

Thread awareness is probably the most significant part of the implementation.

The corresponding call on the API is `getOSContextProvider()`, where `context` here means `execution context`, as in a thread or a task. The API expects an instance of the Java interface `IOSContextProvider` to be returned by `getOSContextProvider()`. This interface can be found in package `com.arm.debug.extension.os.context` within the same JAR file as `IOSProvider` mentioned earlier.

Given the following C types for myos tasks:

```
typedef enum {
    UNINITIALIZED = 0,
    READY
} tstatus_t ;

typedef struct {
    uint32_t           id;
    char               *name;
    volatile tstatus_t status;
    uint32_t           stack[STACK_SIZE];
    uint32_t           *sp;
} task_t;
```

And assuming the OS always stores the currently running task at the first element of the tasks array, further callbacks can be implemented to return the currently running (or scheduled) task and all the tasks (both scheduled and unscheduled) in a new `contexts.py` file:

```
<some folder>
    /mydb
        /OS
            /myos
                /extension.xml
                /messages.properties
                /provider.py
                /contexts.py
```

- `provider.py`

```
# this script implements the Java interface IOSProvider
from osapi import DebugSessionException
from contexts import ContextsProvider

def areOSSymbolsLoaded(debugger):
    […]

def isOSInitialised(debugger):
    […]

def getOSContextProvider():
    # returns an instance of the Java interface IOSContextProvider
    return ContextsProvider()

def getDataModel():
    […]
```

- `contexts.py`

```
from osapi import ExecutionContext
from osapi import ExecutionContextsProvider

# this class implements the Java interface IOSContextProvider
class ContextsProvider(ExecutionContextsProvider):
    def getCurrentOSContext(self, debugger):
        task = debugger.evaluateExpression("tasks[0]")
        return self.createContext(debugger, task)

    def getAllOSContexts(self, debugger):
        tasks = debugger.evaluateExpression("tasks").getArrayElements()
        contexts = []
        for task in tasks:
            if task.getStructureMembers()["status"].readAsNumber() > 0:
                contexts.append(self.createContext(debugger, task))
        return contexts

    def getOSContextSavedRegister(self, debugger, context, name):
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
        return None

    def createContext(self, debugger, task):
        members = task.getStructureMembers()
        id = members["id"].readAsNumber()
        name = members["name"].readAsNullTerminatedString()
        context = ExecutionContext(id, name, None)
        return context
```

Although `getOSContextSavedRegister()` is not yet implemented, this is enough for the debugger to now populate the **Debug Control** view with the OS tasks as soon as the OS awareness is enabled:

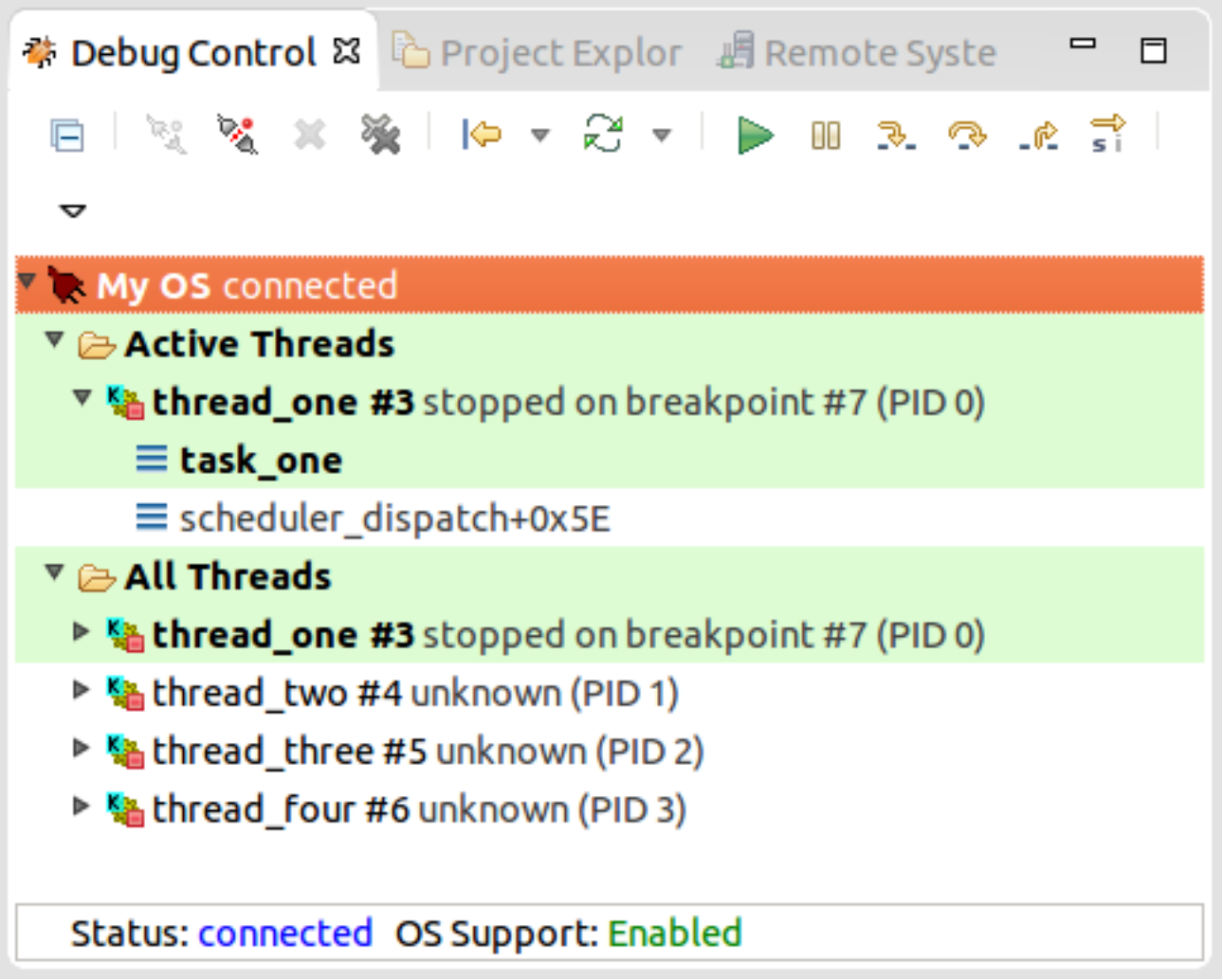


Figure 14-7 myos Debug Control view data

Decoding the call stack of the currently running task and inspecting local variables at specific stack frames for that task works without further changes since the task's registers values are read straight from the core's registers. For unscheduled tasks, however, `getOSContextSavedRegister()` must be implemented to read the registers values saved by the OS on switching contexts. How to read those values depends entirely on the OS context switching logic.

Here is the implementation for `myos`, based on a typical context switching routine for M-class ARM processors where registers are pushed onto the stack when a task is switched out by the OS scheduler:

```
from osapi import ExecutionContext
from osapi import ExecutionContextsProvider

STACK_POINTER = "stack pointer"
REGISTER_OFFSET_MAP = {"R4":0L,    "R5":4L,  "R6":8L,   "R7":12L,
                       "R8":16L,   "R9":20L, "R10":24L, "R11":28L,
                       "R0":32L,   "R1":36L, "R2":40L,  "R3":44L,
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
                        "R12":48L,  "LR":52L, "PC":56L,  "XPSR":60L,
                        "SP":64L}

# this class implements the Java interface IOSContextProvider
class ContextsProvider(ExecutionContextsProvider):

    def getCurrentOSContext(self, debugger):
        […]

    def getAllOSContexts(self, debugger):
        […]

    def getOSContextSavedRegister(self, debugger, context, name):
        offset = REGISTER_OFFSET_MAP.get(name)
        base = context.getAdditionalData()[STACK_POINTER]
        addr = base.addOffset(offset)

        if name == "SP":
            # SP itself isn’t pushed onto the stack: return its computed value
            return debugger.evaluateExpression("(long)" + str(addr))
        else:
            # for any other register, return the value at the computed address
            return debugger.evaluateExpression("(long*)" + str(addr))

    def createContext(self, debugger, task):
        members = task.getStructureMembers()
        id = members["id"].readAsNumber()
        name = members["name"].readAsNullTerminatedString()
        context = ExecutionContext(id, name, None)
        # record the stack address for this task in the context’s
        # additional data; this saves having to look it up later in
        # getOSContextSavedRegister()
        stackPointer = members["sp"].readAsAddress()
        context.getAdditionalData()[STACK_POINTER] = stackPointer

        return context
```

The debugger can now get the values of saved registers, allowing unwinding the stack of unscheduled tasks.

Note

Enter `info threads` in the **Commands** view to display similar information as displayed in the **Debug Control** view.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

14.6 Implementing data views

Along with threads, OS awareness can provide arbitrary tabular data, which the debugger shows in the **RTOS Data** view.

The corresponding callback on the API is `getDataModel()`. It must return an instance of the Java interface `com.arm.debug.extension.datamodel.IDataModel`, which sources can be found in `com.arm.debug.extension.source_<version>.jar`.

This section demonstrates how to implement a view, listing the tasks, including all available information. The following additions to the implementation creates an empty **Tasks** table in the **RTOS Data** view:

```
<some folder>
    /mydb
        /OS
            /myos
                /extension.xml
                /messages.properties
                /provider.py
                /contexts.py
                /tasks.py
```

- `provider.py`

```
# this script implements the Java interface IOSProvider
from osapi import DebugSessionException
from osapi import Model
from contexts import ContextsProvider
from tasks import Tasks

def areOSSymbolsLoaded(debugger):
        […]

def isOSInitialised(debugger):
        […]

def getOSContextProvider():
        […]

def getDataModel():
    # returns an instance of the Java interface IDataModel
    return Model("myos", [Tasks()])
```

- `messages.properties`

```
myos.title=My OS
myos.desc=This is My OS.
myos.help=Displays information about My OS.

tasks.title=Tasks
tasks.desc=This table shows all tasks, including uninitialized ones
tasks.help=Displays tasks defined within the OS and their current status.

tasks.id.title=Task
tasks.id.desc=The task identifier
tasks.name.title=Name
tasks.name.desc=The task name
tasks.status.title=Status
tasks.status.desc=The task status
tasks.priority.title=Priority
tasks.priority.desc=The task priority
tasks.sp.title=Stack pointer
tasks.sp.desc=This task's stack address
```

- `tasks.py`

```
from osapi import Table
from osapi import createField
from osapi import DECIMAL, TEXT, ADDRESS

# this class implements the Java interface IDataModelTable
class Tasks(Table):
    def __init__(self):
        id = "tasks"
        fields = [createField(id, "id", DECIMAL),
                  createField(id, "name", TEXT),
                  createField(id, "status", TEXT),
                  createField(id, "priority", DECIMAL),
                  createField(id, "sp", ADDRESS)]
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
        Table.__init__(self, id, fields)

    def getRecords(self, debugger):
        records = [] # todo
```

Functions `createField` and `Table.__init__()` automatically build up the keys to look for at run-time in the `messages.properties` file. Any key that is not found in `messages.properties` is printed as is.

The above modifications create a new empty `Tasks` table:

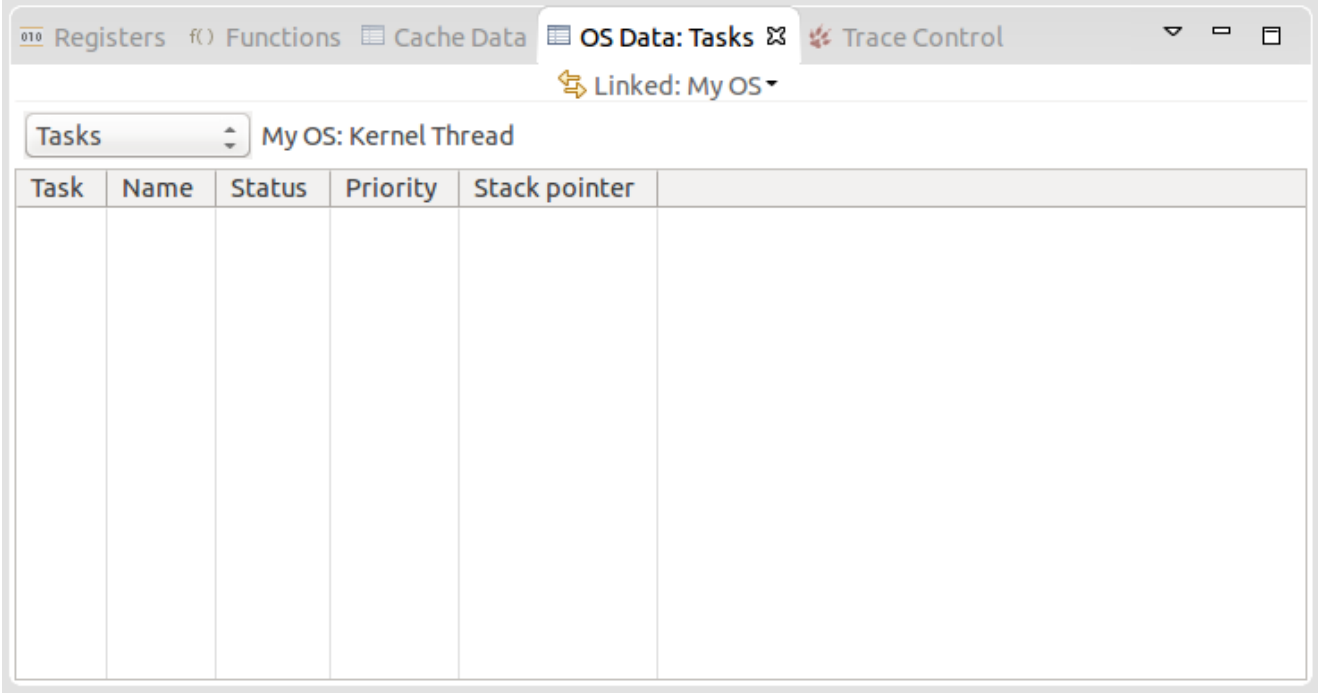


Figure 14-8 myos Empty Tasks table

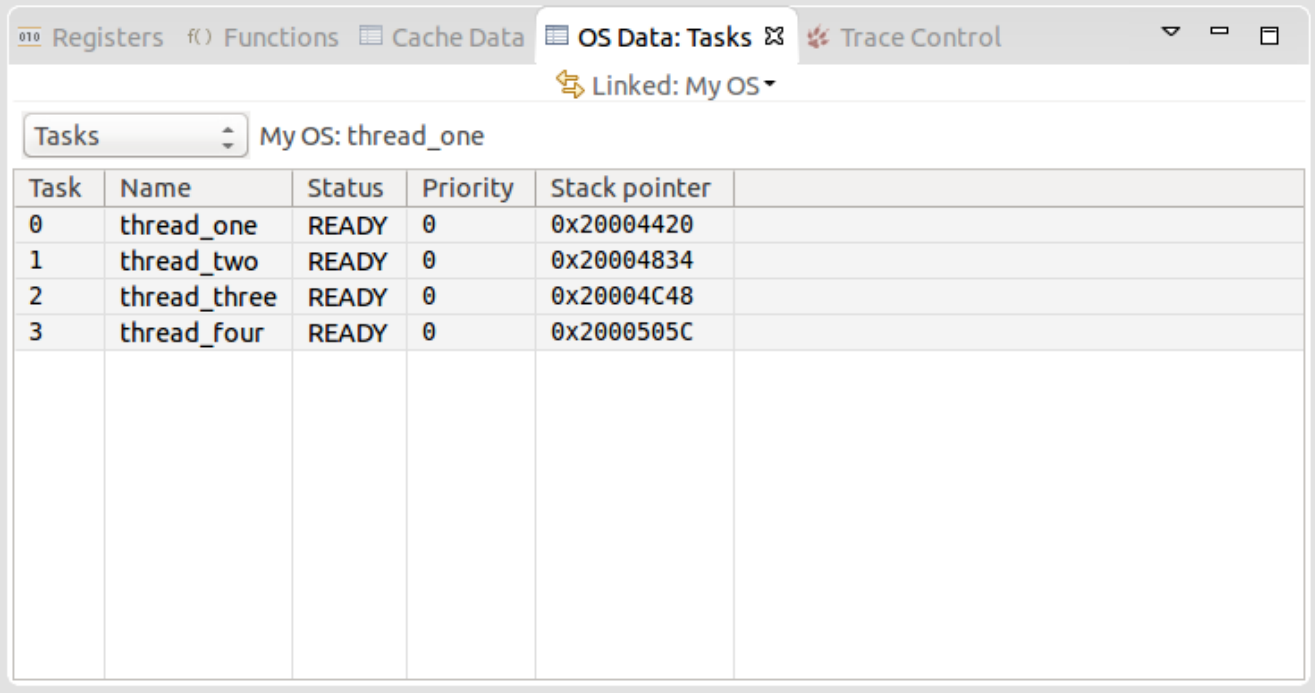
To populate the table, `getRecords()` in `tasks.py` must be implemented:

```
from osapi import Table
from osapi import createField
from osapi import createNumberCell, createTextCell, createAddressCell
from osapi import DECIMAL, TEXT, ADDRESS

# this class implements the Java interface IDataModelTable
class Tasks(Table):
    def __init__(self):
        […]

    def readTask(self, task, first):
        members = task.getStructureMembers()
        id = members["id"].readAsNumber()

        if (members["status"].readAsNumber() == 0):
            status = "Uninitialized"
            name = None
            sp = None
            priority = None
        else:
            if (first):
                status = "Running"
            else:
                status = "Ready"

            name = members["name"].readAsNullTerminatedString()
            sp = members["sp"].readAsAddress()
            priority = members["priority"].readAsNumber()

        cells = [createNumberCell(id),
                 createTextCell(name),
                 createTextCell(status),
                 createNumberCell(priority),
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
                 createAddressCell(sp)]

        return self.createRecord(cells)

    def getRecords(self, debugger):
        records = []
        tasks = debugger.evaluateExpression("tasks").getArrayElements()
        first = True

        for task in tasks:
            records.append(self.readTask(task, first))
            first = False

        return records
```

With this implementation, the **Tasks** table now shows the following values:



Task	Name	Status	Priority	Stack pointer
0	thread_one	READY	0	0x20004420
1	thread_two	READY	0	0x20004834
2	thread_three	READY	0	0x20004C48
3	thread_four	READY	0	0x2000505C

Figure 14-9 myos populated Tasks table

Note

The debugger command `info myos tasks` prints the same information in the **Commands** view.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

14.7 Advanced OS awareness extension

You can extend the OS awareness features by defining more parameters.

The OS awareness extension might sometimes be unable to determine all the necessary information about the OS at runtime. There might be a compile option that controls the presence of a feature which fundamentally changes how a section of the OS works, and this might be undetectable at runtime. An example is whether the OS is compiled with hard or soft floating point support.

In the majority of cases, these features can be detected at runtime. However in rare instances this might not be possible. To deal with these cases you can define parameters for the OS awareness extension, which you can then specify at runtime. For example, you can inform the OS awareness extension of the state of a compile flag. These parameters are then revealed to the debugger as Operating System settings which can be queried from within the OS awareness Python scripts.

Note

This API feature is only available in API version `5.23` and later. You must change the `version` attribute of the `os` element to prevent running in incompatible versions.

The `extension.xml` file declares the OS awareness extension, as described in *14.2 Creating an OS awareness extension* on page 14-419. You can define the additional parameters by adding to the `os` element in `extension.xml` using the syntax that this example shows:

```
<parameter name="my-setting" description="myos.param.my_setting.desc" type="enum"
default="enabled" help="myos.param.my_setting.help">
    <value name="enabled"  description="myos.param.my_setting.enabled"/>
    <value name="disabled" description="myos.param.my_setting.disabled"/>
</parameter>
```

For this example, you must also add the following to `message.properties`:

```
myos.param.my_setting.desc=My setting
myos.param.my_setting.help=This is my setting
myos.param.my_setting.enabled=Enabled
myos.param.my_setting.disabled=Disabled
```

Each parameter has:

type
The only supported type is `enum`.

name
The string used to identify the parameter within the debugger. The string can contain alphanumeric characters `a-z`, `A-Z` and `0-9`. The string can also contain `-` and `_` but must not contain whitespace or any other special characters. The string must be unique among other parameters.

description
The localizable string shown in the GUI.

help
The localizable string shown in the parameter tooltip.

default
The `name` string corresponding to the default value of the parameter.

Each value has:

name
The string used to identify it within the debugger. The string can contain alphanumeric characters `a-z`, `A-Z` and `0-9`. The string can also contain `-` and `_` but must not contain whitespace or any other special characters. The string must be unique among other parameters.

description
The localizable string shown in the GUI.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

How to set the parameter value in DS-5

When you define these parameter settings in the OS awareness extension, you can set the parameter as an Operating System setting, either from the GUI or using the command-line. You can change or view these parameters using the `set os` and `show os` commands respectively, for example `set os my-setting enabled`.

DS-5 debugger shows these settings in the **OS Awareness** tab in the **Debug Configurations** dialog box

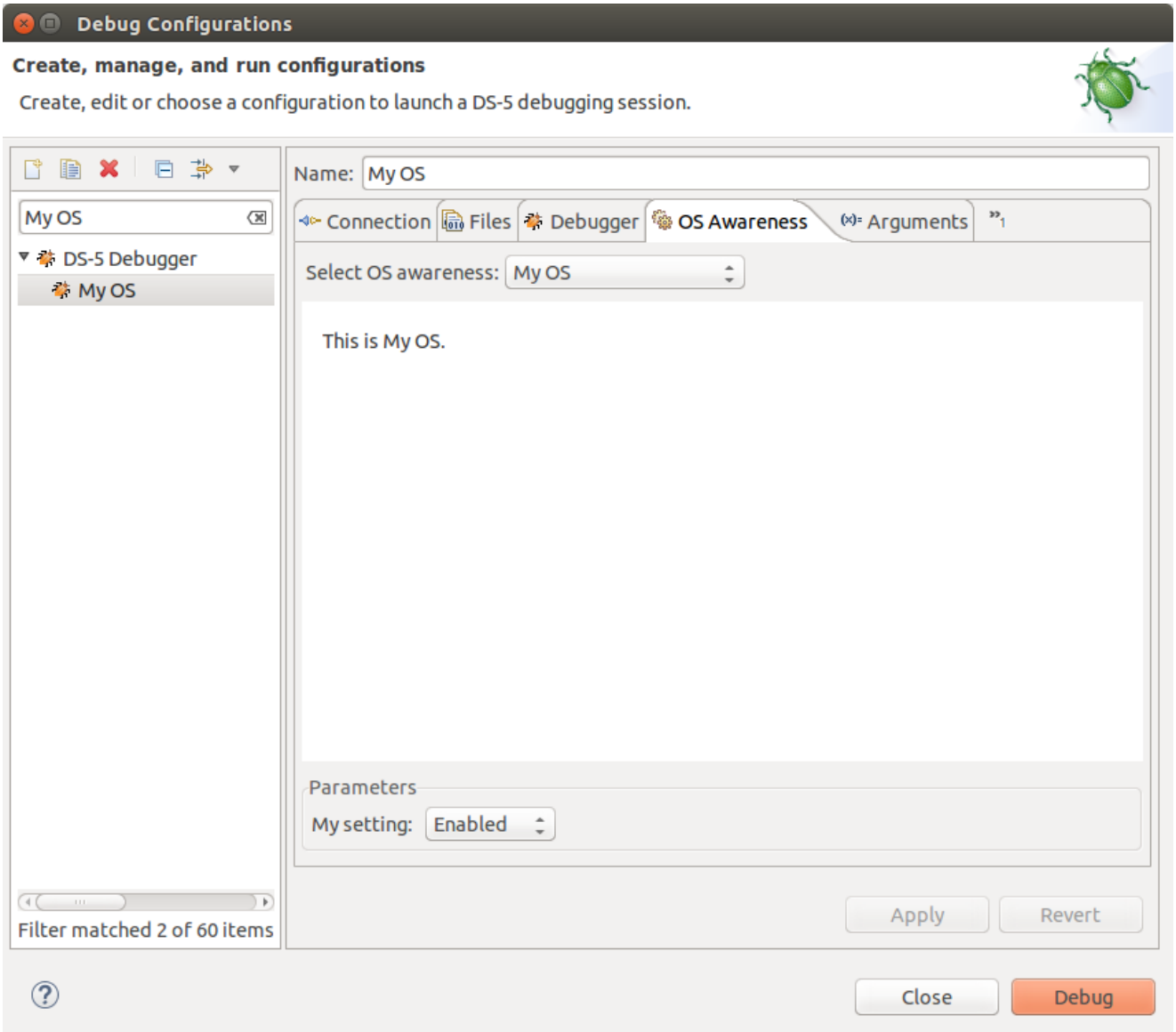


Figure 14-10 OS awareness with parameters

Note

When using the command-line debugger the parameter is set to its default value initially. It is then possible to manually change it after connecting to the target.

The parameters can be read from the OS awareness API using the `getConnectionSetting` method, for example `debugger.getConnectionSetting("os my-setting")`. This returns the `name` string of the selected value, or throws a `DebugSessionException` if the parameter does not exist.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

14.8 Programming advice and noteworthy information

Investigating issues in Python code for an OS awareness extension can sometimes be difficult.

Here are a few recommendations to make debugging easier:

- Start Eclipse from a console.
  Python `print` statements go to the Eclipse process standard output/error streams, which are not visible unless Eclipse is started from a console.
  — On Linux, open a new terminal and run:

  ```
  <DS-5 installation folder>/bin/eclipse
  ```

  — On Windows, open command prompt and run:

  ```
  <DS-5 installation folder>\bin\eclipsec
  ```

  Note the trailing `c` in `eclipsec`.
- Use the **Error Log** view.Most errors that occur in the debugger are logged in details in the **Error Log** view. The full stack trace of an error is particularly useful as it often contains references to the location in the source files that generated the error.
- Turn on `verbose error` logging in the debugger

  Although most errors are logged in the **Error Log** view, any error happening in the debugger event processing logic is not. One alternative is to turn on verbose error logging to print the full stack trace of errors in the **Console** view.

  To turn on verbose error logging, execute the following command early in the debug session:

  ```
  log config infoex
  ```

  Note

  — It is worth understanding that an OS awareness implementation interacts at the deepest level with the debugger, and some errors may cause the debugger to lose control of the target.
  — Also note that semihosting is not available when OS awareness is specified.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 15
Debug and Trace Services Layer (DTSL)

Describes the DS-5 Debugger *Debug and Trace Services Layer* (DTSL).

DTSL is a software layer that sits between the debugger and the RDDI target access API. DS-5 Debugger uses DTSL to:

- Create target connections.
- Configure the target platform to be ready for debug operations.
- Communicate with the debug components on the target.

As a power user of DS-5 Debugger, you might need to use DTSL:

- As part of new platform support.
- To extend the capabilities of DS-5 Debugger.
- To add support for custom debug components.
- To create your own Java or Jython programs which interact with your target.

It contains the following sections:

- *15.1 Additional DTSL documentation and files* on page 15-440.
- *15.2 Need for DTSL* on page 15-441.
- *15.3 DS-5 configuration database* on page 15-446.
- *15.4 DTSL as used by DS-5 Debugger* on page 15-452.
- *15.5 Main DTSL classes and hierarchy* on page 15-454.
- *15.6 DTSL options* on page 15-462.
- *15.7 DTSL support for SMP and AMP configurations* on page 15-468.
- *15.8 DTSL Trace* on page 15-472.
- *15.9 Extending the DTSL object model* on page 15-479.
- *15.10 Debugging DTSL Jython code within DS-5 Debugger* on page 15-484.
- *15.11 DTSL in stand-alone mode* on page 15-488.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.1 Additional DTSL documentation and files

Additional DTSL documents and files are provided in `<DS-5 Install folder>\sw\DTSL`.

The following documents are useful for understanding DTSL. Make sure you have access to them.

DTSL object level documentation

DTSL is mainly written in Java, so the documentation takes the form of Javadoc files. The DTSL Javadoc is provided both as a PDF (`DTSLJavaDocs.pdf`) and as HTML files (inside `com.arm.debug.dtsl.docs.zip`). You can view the HTML files directly in a browser, or use them from within the Eclipse environment.

Certain classes in the DTSL Javadocs are marked as Deprecated. These classes must not be used in new DTSL code. They are only provided in the documentation in case you encounter them when inspecting older DTSL code.

RDDI API documentation

DTSL is designed to use RDDI-DEBUG as its native target connection API. Some of the RDDI-DEBUG API is therefore referred to from within DTSL. For completeness, the RDDI documentation is included with the DTSL documentation.

The RDDI documentation is provided in HTML format in `<DS-5 Install folder>\sw\debugger\RDDI\docs\html`. To access the documentation, open `index.html`.

Also, make sure you have access to `DTSLExamples.zip`. This contains example DTSL code, in addition to the DS-5 configdb entries discussed in this document. This document assumes that you have added the examples to your Eclipse installation by importing the Eclipse projects contained in this file.

Related information

ARM Architecture Reference Manual ARMv7-A and ARMv7-R edition.

ARM Debug Interface Architecture Specification.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.2 Need for DTSL

DTSL addresses the growing complexity and customization of ARM-based SoCs using the CoreSight Architecture. Before the creation of DTSL, most debug tools were designed at a time when SoC debug architecture was much simpler. SoCs typically contained only one core, and if multiple cores were used, they were of different types and were accessed by dedicated debug channels. Debug tools designed during that time, including ARM debuggers, cannot easily be scaled to more modern and complex debug architectures. DTSL is therefore designed to address several problems which older debug tools cannot easily address.

This section contains the following subsections:

- *15.2.1 SoC design complexity* on page 15-441.
- *15.2.2 Debug flexibility* on page 15-442.
- *15.2.3 Integrated tool solutions* on page 15-442.
- *15.2.4 DS-5 Debugger architecture before DTSL* on page 15-442.
- *15.2.5 DS-5 Debugger architecture after DTSL* on page 15-443.
- *15.2.6 DS-5 Debugger connection sequence showing where DTSL fits in* on page 15-445.

15.2.1 SoC design complexity

The debugger must be able to handle complex SoC designs which contain many cores and many debug components. For example, the following figure shows a relatively simple SoC design containing many debug components:

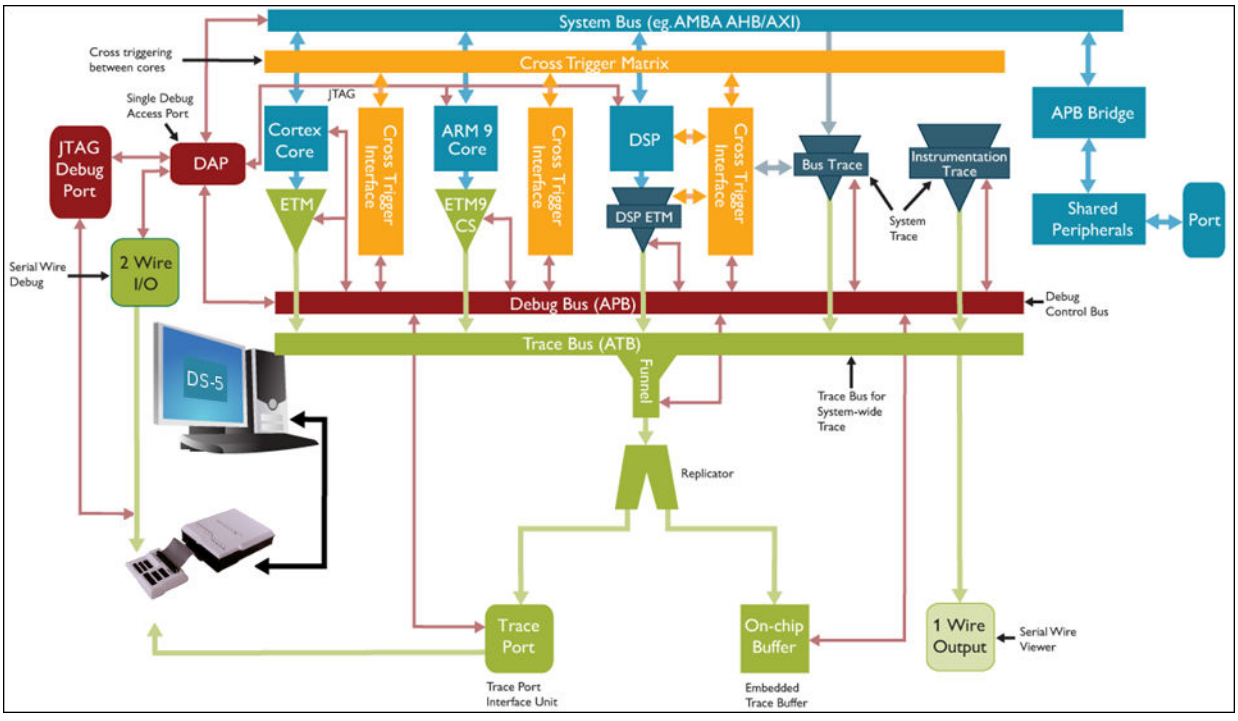


Figure 15-1 A simple CoreSight Design

Such systems are continuing to become more complicated as time goes on. For example, SoC designers might want to use multiple sub-systems which are accessed through multiple DAPs, but which are linked by multiple *Cross Trigger Interfaces* (CTIs) so that they can still be synchronized. Each sub-system would have a similar design to that shown in the figure, but with shared CTIs and possibly shared TPIU.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Because system designs are so complicated, and vary so greatly, DTSL is designed to provide a layer of abstraction between the details of a particular system and the tools which provide debugging functionality to the user. For example, a debug tool using DTSL knows that there is a source of trace data for a particular core, and can access that data, but does not have to handle the complexities of system configuration and tool set-up in order to get that data. It does not have to know how to, for example, program up CoreSight Funnels, collect trace data from a DSTREAM, or demultiplex the TPIU trace protocol.

15.2.2 Debug flexibility

DTSL is designed to address the problems associated with the following:

- SoC designers sometimes add their own components, which are not part of any ARM standard. Debug tools might need to interact with these components to access the target.
- CoreSight designs can be very flexible, and early implementations might have design issues that the debug tool needs to work around.
- CoreSight designs can contain components which can be interconnected in many ways.

15.2.3 Integrated tool solutions

CoreSight designs can contain shared debug resources which need to be managed and used from multiple tools. For example, the system might be able to generate trace from several trace sources, such as ARM cores + DSP. In legacy designs, the trace paths would be independent and each debug tool would have its own connection to the respective sub-system. In a typical CoreSight system, the trace data is merged by a `Funnel` component and delivered to a single trace storage device though a single interface. The trace data is then uploaded and de-multiplexed. The trace data might need to be delivered to several different debug tools, such as ARM DS-5 and DSP Debug Tool.

DTSL addresses the tool integration problem that this situation raises.

15.2.4 DS-5 Debugger architecture before DTSL

Before DTSL first became available, the early DS-5 Debugger Software stack was as shown in the following figure:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

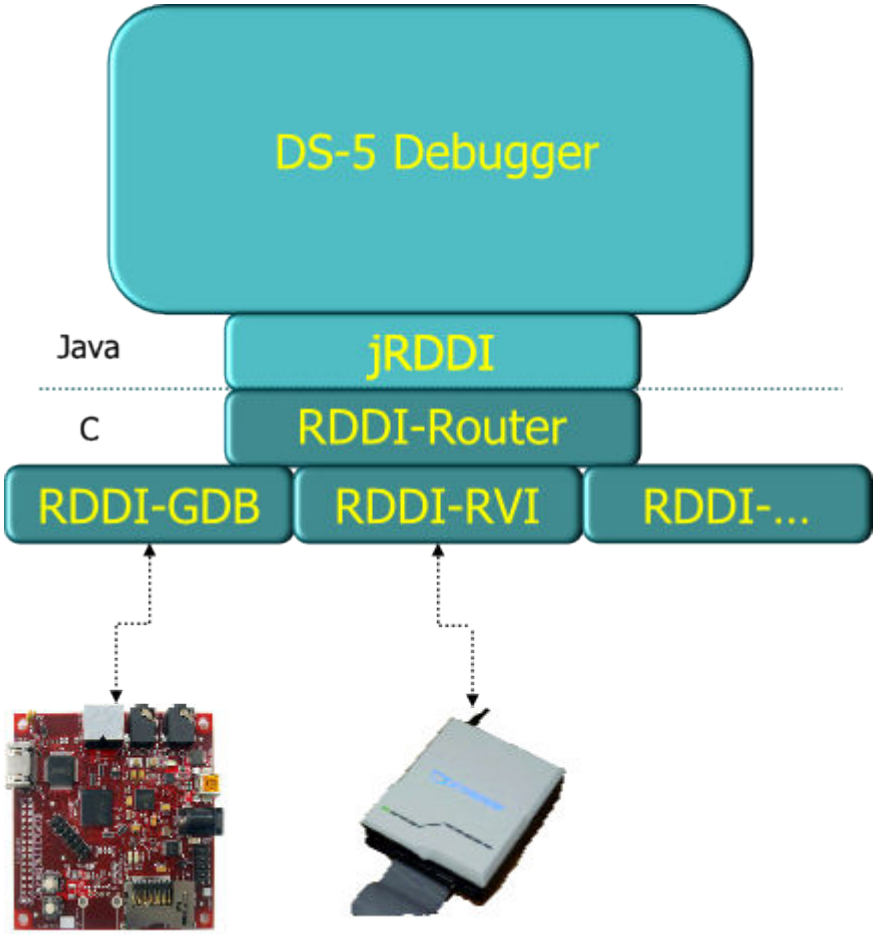


Figure 15-2 Initial DS-5 Debugger SW Stack

From the bottom upwards, the components of the debug stack are:

RDDI-DEBUG API
The debugger uses this API as its standard native connection to a debug controller such as DSTREAM/RVI, CADI Model, or gdbserver. There is an implementation of `RDDI-DEBUG` for each of the supported types of debug controller.

RDDI-Router API
This API is identical to `RDDI-DEBUG`, but it is used to 'vector' the API calls to the appropriate implementation. This is necessary because the debugger can support multiple connections and connection types simultaneously.

jRDDI
This is a Java wrapper for the C `RDDI-DEBUG` API. It is not a true Java layer, but nominally it is the lowest Java layer in the stack.

15.2.5 DS-5 Debugger architecture after DTSL

After DTSL was introduced, the DS-5 Debugger Software stack changed. It is now as shown in the following figure:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

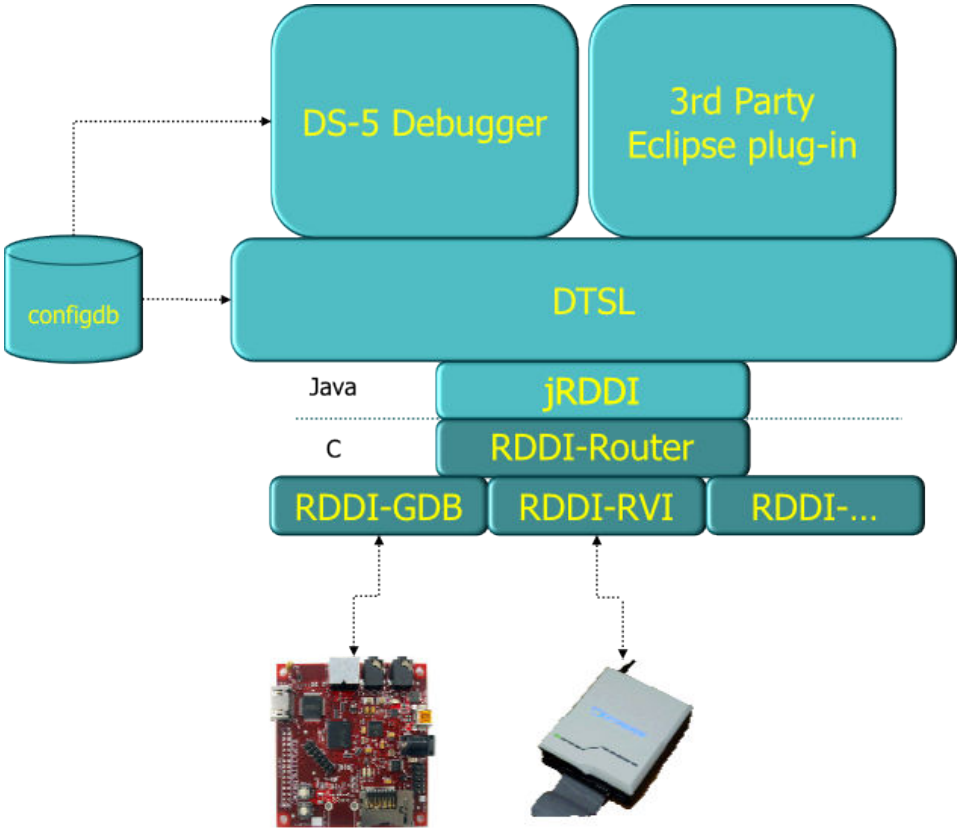


Figure 15-3 Post DTSL DS-5 Debugger SW Stack

In addition to the layers that existed before DTSL, the stack now contains a DTSL layer which does the following:

- Handles system initialization and DTSL-level component creation. This is controlled by DTSL Jython scripts, which are typically contained in a platform configuration database (configdb).

  Note

  Do not confuse DTSL Jython Scripting with DS-5 Debugger Jython Scripting. Both of them use Jython, but they operate at different levels in the software stack. However, a Debugger Jython Script can use DTSL functionality.

- Provides a common connection interface for several client programs.
- Delivers trace streams to several trace clients.
- Uses the existing native RDDI infrastructure.

The DS-5 Debugger uses DTSL to communicate with the lower layers of the stack. DTSL provides a set of named objects for the debugger (or another tool) to use. The object set consists of the following:

- Debug objects, which control core execution. Their interface looks very similar to the `jRDDI` and `RDDI-DEBUG` interfaces.
- Trace source interfaces, which represent target components which can generate trace data.
- Trace capture interfaces, which are used to start and stop trace collection and to provide notification events to clients.
- Other target components, such as other CoreSight devices or other third-party target devices.
- A Configuration and Connection interface, which instantiates and configures the DTSL objects and queries the configuration to allow clients to discover which top level interfaces are present.

Related concepts

15.4.3 DTSL access from Debugger Jython scripts on page 15-453.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.2.6 DS-5 Debugger connection sequence showing where DTSL fits in

The sequence below outlines the DS-5 Debugger connection sequence when connecting to a target, and where DTSL fits in.

1. The user creates an Eclipse launch configuration by selecting a platform (board) and a debug operation from the DS-5 `configdb`. The user also specifies other debugger configuration parameters such as which file (`.axf`) to debug.
2. The user activates a launch configuration, either from the launch configuration editor or by selecting a previously prepared launch configuration.
3. The debugger launcher code locates the platform (board) entry in the DS-5 Debugger `configdb` and locates the DTSL configuration script. This script is run, and it creates the DTSL configuration.
4. The debugger connects to the DTSL configuration created by the script. It locates, by name, the object or objects identified by the debug operation specified in the `configdb` platform entry. It uses these objects to access the target device, including access to memory, registers, and execution state.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.3 DS-5 configuration database

All use cases of DTSL potentially require the use of the DS-5 configuration database (`configdb`). ARM therefore recommends that you have a basic understanding of the configuration database.

DS-5 Debugger uses a configuration database, called `configdb`, to store information on how to connect to platforms. This information is split across several top-level locations in the database, each of which can contain the following:

Board information
: Manufacturer, name, list of SoCs, list of Flash, DTSL initialization Jython scripts.

SoC information
: Core information. For example, a SoC may contain + Cortex-M3.

Core information
: Register sets for the core, and other information such as TrustZone support.

Flash information
: Information on flash types and programming algorithms.

Common scripts (Jython)
: Jython scripts which might be of use to several database entries.

This information is mainly stored as XML files, located in sub-directories of the top-level locations.

The configuration database is located at `<DS-5 install folder>\sw\debugger\configdb`.

DS-5 allows you to configure one or more extension configdb locations, which are typically used to add more board definitions or flash support to DS-5.

This section contains the following subsections:

- *15.3.1 Modifying DS-5 configdb* on page 15-446.
- *15.3.2 Configdb board files* on page 15-447.
- *15.3.3 About project_types.xml* on page 15-447.
- *15.3.4 About the keil-mcbstm32e.py script* on page 15-448.
- *15.3.5 DTSL script* on page 15-450.

15.3.1 Modifying DS-5 configdb

The DS-5 `configdb` is usually installed into a read-only location, to prevent accidental modification of the installed files. However, DS-5 allows the user to install `configdb` extensions, which can be in a writeable location. The `configdb` extensions can also override the entries in the installed directories. To modify an installed `configdb` board entry (directory), you need to copy the installed entry into your `Documents` folder or `home` directory, modify it, and tell DS-5 to add it as a `configdb` extension.

For example, to modify the Keil MCBSTM32E platform files:

1. Create a `configdb` directory in your `Documents` folder or in another writeable location.
2. Create a `Boards` directory inside the `configdb` directory.
3. Copy the `Keil/MSCSTM32E` directory into the `Boards` directory.
4. Modify the copied `configdb` files.
5. Tell DS-5 about the new `configdb` extension. To do this:
   a. Select **Window** > **Preferences**.
   b. Expand the **DS-5** entry in the **Preferences** window.
   c. Select the **Configuration Database** entry.
   d. Click the **Add...** button to add the location of the new configuration database to the **User Configuration Databases** list.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Note

If you modify any of the XML files in a `configdb` directory, you must tell DS-5 to rebuild the database by clicking the **Rebuild database...** button on the DS-5 **Configuration Database** preferences panel.

15.3.2 Configdb board files

Within the `configdb` is the `Boards` directory. It contains one sub-directory for each board manufacturer, and a `boards.xml` file which optionally provides human-readable display names for boards.

For example, the Keil MCBSTM32E platform is a simple STM32E (Cortex-M3) MCU board. The main `configdb` files are located in `<DS-5 install folder>sw\debugger\configdb\Boards\Keil\MCBSTM32E`, and are as follows:

`project_types.xml`
: This is the main XML file which describes the platform entry to DS-5.

`keil-mcbstm32e.py`
: This is the DTSL platform configuration and setup script, implemented in Jython.

`keil-mcbstm32e.rvc`
: This is the DSTREAM RDDI configuration file for the platform. This file can have an extension of either `.rcf` or `.rvc`. The DS-5 **Platform Configuration Editor** usually creates this file.

`keil-mcbstm32e_flash.xml`
: This contains information on flash devices and algorithms, and their configuration parameters.

15.3.3 About project_types.xml

The `project_types.xml` file defines the project types supported for the platform. Debug operations and activities, which refer to the other files in the platform directory, are defined for each project type.

The following code is part of the `project_types.xml` file for the Keil MCBSTM32E platform.

```
<?xml version="1.0" encoding="UTF-8" standalone="no"?>
<!--Copyright (C) 2009-2013 ARM Limited. All rights reserved.-->
<platform_data xmlns="http://www.arm.com/project_type" xmlns:peripheral="http://
com.arm.targetconfigurationeditor" xmlns:xi="http://www.w3.org/2001/XInclude"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" type="HARDWARE"
xsi:schemaLocation="http://www.arm.com/project_type ../../../Schemas/platform_data-1.xsd">
 <flash_config>CDB://keil-mcbstm32e_flash.xml</flash_config>
 <project_type_list>
  <project_type type="BARE_METAL">
   <name language="en">Bare Metal Debug</name>
   <description language="en">This allows a bare-metal debug connection.</description>
   <execution_environment id="BARE_METAL">
    <name language="en">Bare Metal Debug</name>
    <description language="en">This allows a bare-metal debug connection.</description>
    <param default="CDB://mcbstm32e.rvc" id="config_file" type="string" visible="false"/>
    <param default="CDB://mcbstm32e.py" id="dtsl_config_script" type="string"
             visible="false"/>
    <xi:include href="../../../Include/hardware_address.xml"/>
    <activity id="ICE_DEBUG" type="Debug">
     <name language="en">Debug Cortex-M3</name>
     <xi:include href="../../../Include/ulinkpro_activity_description.xml"/>
     <xi:include href="../../../Include/ulinkpro_connection_type.xml"/>
     <core connection_id="Cortex-M3" core_ref="Cortex-M3" soc="st/stm32f103xx"/>
     <param default="DebugOnly" id="dtsl_config" type="string" visible="false"/>
     <xi:include href="../../../Include/ulinkpro_browse_script.xml"/>
     <xi:include href="../../../Include/ulinkpro_setup_script.xml"/>
    </activity>
    <activity id="ICE_DEBUG" type="Debug">
     <name language="en">Debug Cortex-M3</name>
     <xi:include href="../../../Include/dstream_activity_description_bm.xml"/>
     <xi:include href="../../../Include/dstream_connection_type.xml"/>
     <core connection_id="Cortex-M3" core_ref="Cortex-M3" soc="st/stm32f103xx"/>
     <param default="DSTREAMDebugAndTrace" id="dtsl_config" type="string" visible="false"/>
     <param default="options.traceBuffer.traceCaptureDevice" id="dtsl_tracecapture_option"
              type="string" visible="false"/>
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
      <param default="ITM" id="eventviewer_tracesource" type="string" visible="false"/>
     </activity>
    </execution_environment>
   </project_type>
  </project_type_list>
 </platform_data>
```

The XML file declares a `BARE_METAL` project type. `BARE_METAL` is a term which describes a system not running an OS, where the debug connection takes full control of the core. The file declares an execution environment within the project type, and declares debug activities within that execution environment. The code here shows only one debug activity, but each execution environment can declare several debug activities. The debug activity shown here is a debug and trace session using a DSTREAM target connection.

When DS-5 displays the debug session launcher dialog, it scans the entire configdb and builds a list of supported manufacturers and boards, and the supported project types and debug activities, and lets the user choose which one they want to use. In the following example, the user is assumed to have chosen the highlighted debug activity. When DS-5 Debugger launches the debug session, it creates a DTSL configuration and passes it the `{config_file, dtsl_config_script, dtsl_config}` property set. These parameters are used as follows:

`config_file`
: This value is passed to the RDDI-DEBUG connection DLL or so (DS-5 uses RDDI-DEBUG as its target connection interface, and RDDI-DEBUG needs this file to tell it which devices are in the target system).

`dtsl_config_script`
: This value tells DTSL which Jython script to use to create the DTSL configuration used by the debugger.

`dtsl_config`
: The DTSL Jython script can contain several system configurations, defined by Jython class names which in turn are derived from the DTSLv1 object. This value tells DTSL which class to create. The MCBSTM32E Jython script contains two such classes, one for a debug and trace configuration and one for a debug-only configuration. The class name used for the highlighted example is *`DSTREAMDebugAndTrace`*, so in this example a Jython class named *`DSTREAMDebugAndTrace`* must exist in the *`dtsl_config_script`*.

Some of these entries have a file location prefix of `CDB://`. This indicates that the location is within the platform directory in the configuration database.

DTSL creates an instance of the referenced Jython class, which causes the `def __init__(self, root)` constructor to be run. After this constructor is run, the debugger expects to find a DTSL Device object whose name is the same as the name given in the core setting in the debug activity. In this example, therefore, the debugger expects to find a DTSL object named “Cortex-M3”, and it directs all debug operation requests to this object.

15.3.4 About the keil-mcbstm32e.py script

The complete content of the `keil-mcbstm32e.py` file for the Keil MCBSTM32E platform is included in the `DTSLExampleConfigdb` project in `DTSLExamples.zip`. The important aspects of the script are as follows:

- The script is written in Jython. Jython is an implementation of the Python language which integrates tightly with Java. The integration is tight enough to allow the following:
  - A Jython script can contain Python classes which Java can use, and which appear to Java as though they were Java classes.
  - A Jython script can contain Python classes which can sub-class Java classes.
  - A Jython script can create Java class instances and use them.

  This is why the script contains some `import` statements which import Java classes. Many of these classes are from the `com.arm.debug.dtsl` package.
- DTSL creates an instance of a class named *`DSTREAMDebugAndTrace`*.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

- The constructor *__init__* creates all the DTSL objects required for the connection.
- The RDDI-DEBUG API, which is the native API used by the debugger for target access, assigns each device a unique device index number. The script contains lines which find the index number for a named device and assign that number to a variable. The following is an example of such a line:

  ```
  devID = self.findDevice("Cortex-M3")
  ```

  This line assigns the RDDI device index number for the named device “Cortex-M3” to the variable `devID`.
- The script creates a *ResetHookedDevice* object, derived from *Device*, with the name “Cortex-M3”. This is an example of how Jython can extend the standard DTSL Java classes by sub-classing them.
- The script creates an *AHBCortexMMemAPAccessor* and installs it into the Cortex-M3 object as a memory filter. This is how a custom named memory space is added to the core. When a memory access is requested with an address prefixed by “AHB”, the access is redirected to the *AHBCortexMMemAPAccessor* object which, in this case, uses the CoreSight AHB-AP to access the memory.
- The script creates DTSL objects for the CoreSight components in the SoC.
- The script creates a *DSTREAMTraceCapture* object, which the debugger uses to read trace data.
- The script declares a set of options which provide user configuration data for the script. The Eclipse debug session launcher panel displays these options so that they can be set before making a target connection. After the constructor is called, DTSL passes the option values to the class by calling its *optionValuesChanged()* method.

```
from com.arm.debug.dtsl.configurations import DTSLv1

[snip]
class ResetHookedDevice(Device):
    def __init__(self, root, devNo, name):
        Device.__init__(self, root, devNo, name)
        self.parent = root
    def systemReset(self, resetType):
        Device.systemReset(self, resetType)
        # Notify root configuration
        self.parent.postReset()


class DSTREAMDebugAndTrace(DTSLv1):
    '''A top level configuration class which supports debug and trace'''

    @staticmethod
    def getOptionList():
        '''The method which specifies the configuration options which
           the user can edit via the launcher panel |Edit...| button
        '''
        return [
            DTSLv1.tabSet(
                name='options',
                displayName='Options',
                childOptions=[
                    DSTREAMDebugAndTrace.getTraceBufferOptionsPage(),
                    DSTREAMDebugAndTrace.getETMOptionsPage(),
                    DSTREAMDebugAndTrace.getITMOptionsPage()
                ]
            )
        ]

    @staticmethod
    def getTraceBufferOptionsPage():
        # If you change the position or name of the traceCapture
        # device option you MUST modify the project_types.xml to
        # tell the debugger about the new location/name
        return DTSLv1.tabPage(
            name='traceBuffer',
            displayName='Trace Buffer',
            childOptions=[
                DTSLv1.enumOption(
                    name='traceCaptureDevice',
                    displayName='Trace capture method',
                    defaultValue='DSTREAM',
                    values=[
                        ('none', 'No trace capture device'),
                        ('DSTREAM', 'DSTREAM 4GB Trace Buffer')
                    ]
                ),
                DTSLv1.booleanOption(
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
                    name='clearTraceOnConnect',
                    displayName='Clear Trace Buffer on connect',
                    defaultValue=True
                ),
                DTSLv1.booleanOption(
                    name='startTraceOnConnect',
                    displayName='Start Trace Buffer on connect',
                    defaultValue=True
                ),
                DTSLv1.enumOption(
                    name='traceWrapMode',
                    displayName='Trace full action',
                    defaultValue='wrap',
                    values=[
                        ('wrap', 'Trace wraps on full and continues to store data'),
                        ('stop', 'Trace halts on full')
                    ]
                )
            ]
        )

[snip]
    def __init__(self, root):
        '''The class constructor'''
        # base class construction
        DTSLv1.__init__(self, root)
        # create the devices in the platform
        self.cores = []
        self.traceSources = []
        self.reservedATBIDs = {}
        self.createDevices()
        self.setupDSTREAMTrace()
        for core in self.cores:
            self.addDeviceInterface(core)

    def createDevices(self):
# create MEMAP
    devID = self.findDevice("CSMEMAP")
        self.AHB = CortexM_AHBAP(self, devID, "CSMEMAP")
        # create core
        devID = self.findDevice("Cortex-M3")
        self.cortexM3 = ResetHookedDevice(self, devID, "Cortex-M3")
        self.cortexM3.registerAddressFilters(
                [AHBCortexMMemAPAccessor("AHB", self.AHB, "AHB bus accessed via AP_0")])
        self.cores.append(self.cortexM3)
        # create the ETM disabled by default - will enable with option
        devID = self.findDevice("CSETM")
        self.ETM = V7M_ETMTraceSource(self, devID, 1, "ETM")
        self.ETM.setEnabled(False)
        self.traceSources.append(self.ETM)
        # ITM disabled by default - will enable with option
        devID = self.findDevice("CSITM")
        self.ITM = V7M_ITMTraceSource(self, devID, 2, "ITM")
        #self.ITM = M3_ITM(self, devID, 2, "ITM")
        self.ITM.setEnabled(False)
        self.traceSources.append(self.ITM)
        # TPIU
        devID = self.findDevice("CSTPIU")
        self.TPIU = V7M_CSTPIU(self, devID, "TPIU", self.AHB)
        # DSTREAM
        self.DSTREAM = DSTREAMTraceCapture(self, "DSTREAM")
        self.DSTREAM.setTraceMode(DSTREAMTraceCapture.TraceMode.Continuous)
```

15.3.5 DTSL script

The DTSL script defines the DTSL options using a set of static methods. The option definitions must be available before creating an instance of the configuration class.

To display and modify the DTSL options before connecting, use the Eclipse launcher panel. To display and modify the DTSL options during a DS-5 debug session, use the command line or the Debug Control view.

In Windows 7, the DTSL options values are persisted in your workspace under the directory `C:\Users\<user>\Documents\DS-5 Workspace\.metadata\.plugins\com.arm.ds\DTSL`. In this directory there is a sub-directory for the platform, in which there is another sub-directory for the debug operation. Within the debug operation directory there are one or more `.dtslprops` files, whose names match the names option sets in the DTSL Options Dialog. These files are standard Java properties files. The

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

following is the default properties file for the Keil MCBSTM32E Platform, Bare Metal Project, Debug and Trace Debug operation:

```
options.ETM.cortexM3coreTraceEnabled=true
options.ITM.itmTraceEnabled=true
options.ITM.itmTraceEnabled.itmowner=Target
options.ITM.itmTraceEnabled.itmowner.target.targetITMATBID=2
options.ITM.itmTraceEnabled.itmowner.debugger.DWTENA=true
options.ITM.itmTraceEnabled.itmowner.debugger.PRIVMASK.[15\:8]=true
options.ITM.itmTraceEnabled.itmowner.debugger.PRIVMASK.[23\:16]=true
options.ITM.itmTraceEnabled.itmowner.debugger.PRIVMASK.[31\:24]=true
options.ITM.itmTraceEnabled.itmowner.debugger.PRIVMASK.[7\:0]=true
options.ITM.itmTraceEnabled.itmowner.debugger.STIMENA=0xFFFFFFFF
options.ITM.itmTraceEnabled.itmowner.debugger.TSENA=true
options.ITM.itmTraceEnabled.itmowner.debugger.TSPrescale=none
options.traceBuffer.traceCaptureDevice.clearTraceOnConnect=true
options.traceBuffer.traceCaptureDevice.startTraceOnConnect=true
options.traceBuffer.traceCaptureDevice.traceWrapMode=wrap
options.traceBuffer.traceCaptureDevice=DSTREAM
```

The names of the options exactly match the name hierarchy defined in the DTSL script (see the full DTSL script source code to create the configuration options).

When DS-5 Debugger displays the options, it calls the *`getOptionList()`* method in the DTSL configuration class to retrieve a data description of the options. It matches these options with the persisted values from the `.dtslprops` file and transforms this data into an interactive dialog type display for the user. When the user saves the options, the `.dtslprops` file is updated. After the DTSL configuration instance is created, DTSL calls the *`optionValuesChanged()`* method to inform the instance of the configuration settings values. During the debug session, the user can change any option which is marked with an `isDynamic=True` property.

Related references

15.6 DTSL options on page 15-462.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.4 DTSL as used by DS-5 Debugger

This section contains the following subsections:

- *15.4.1 Eclipse debug session launcher dialog* on page 15-452.
- *15.4.2 Connecting to DTSL* on page 15-452.
- *15.4.3 DTSL access from Debugger Jython scripts* on page 15-453.

15.4.1 Eclipse debug session launcher dialog

The Launcher dialog scans the entire DS-5 configdb, including extension directories, and builds a list of supported manufacturers and boards, along with the supported project types and debug activities, as declared in the `project_types.xml` files in each Board directory. This list is displayed to the user, who then chooses the combination of manufacturer, board, project type and debug activity they want to use. When the user chooses a *`{Manufacturer, Board, Project Type, Debug Operation}`*, the launcher inspects the referenced {dtsl_config_script, dtsl_config}, that is, the script and the class, to see if any DTSL options are specified. If so, the Launcher displays an **Edit...** button so that the user can change the values for the DTSL options.

15.4.2 Connecting to DTSL

To use DTSL, a client must create a *`DTSLConnection`* object using the DTSL *`ConnectionManager`* class (`com.arm.debug.dtsl.ConnectionManager`). *`ConnectionManager`* has static methods that allow the *`DTSLConnection`* object to be created from a set of connection parameters. After a *`ConnectionManager`* object is obtained, calling its *`connect()`* method creates the *`DTSLConfiguration`* object which contains all the target component objects.

When the DTSL *`ConnectionManager`* class creates a new *`DTSLConnection`*, it assigns a unique key to it. It constructs this key from the connection properties:

- *`dtsl_config_script`*: the absolute path to the DTSL Jython script
- *`dtsl_config`*: the Jython DTSL class name
- *`config_file`*: the absolute path to the RDDI configuration file
- *`dtsl_config_options`*: optional DTSL options (a hash of the content of the DTSL options file)
- *`rddi_retarget_address`*: optional re-target address for the RDDI configuration
- possibly other input.

If the DTSL *`ConnectionManager`* detects an attempt to connect to an already existing *`DTSLConnection`* (that is, the connection key matches an existing *`DTSLConnection`* instance) then DTSL returns the already existing instance. There can only be one *`DTSLConnection`* with any given key.

A *`DTSLConnection`* can also be created by obtaining an existing DTSL instance key and requesting a connection to that instance. Both DS-5 Debugger and third-party Eclipse plugins can therefore connect to an existing *`DTSLConnection`* instance. If the DS-5 Debugger creates the *`DTSLConnection`* instance for a platform, then a third-party plugin can connect to the same instance by one of two methods:

- Use an identical set of connection properties.
- Arrange to get the *`DTSLConnection`* instance key from the debugger, and use that key to make the connection.

DTSL reference-counts connections to a platform instance and only closes the *`DTSLConnection`* instance when all clients have disconnected.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.4.3 DTSL access from Debugger Jython scripts

DTSL uses Jython scripting to create the DTSL configuration. The configuration typically stores objects for each debug component in the target system.

DS-5 Debugger also uses Jython scripting, but at a different level, to DTSL, in the debugger software stack. In debugger scripting, the debugger provides an object interface to the debugger features. For example, a debugger script can:

- load `.axf` files
- determine the current execution context
- read registers
- set breakpoints
- control execution.

These operations cause operations on the objects in the DTSL configuration, but there is not always a direct mapping from debugger operations to DTSL object operations. This is especially true for SMP systems.

Sometimes, however, it makes sense for a debugger script to access low level DTSL objects. For example, a user with in-depth CoreSight experience might want to manually program up a PTM sequencer, or directly drive CTI inputs. In such cases, the debugger script can get the DTSL configuration, locate the objects of interest and call their methods directly. Although this is a very powerful feature, it must be used with care, because the debugger has no way of knowing that such operations have taken place. In many cases this does not matter, especially if the DTSL objects being used are not directly used by the debugger. However, more care is required when directly accessing core objects used by the debugger.

The following is an example of how a debugger Jython script might get access to a DTSL object called “PTM”:

```
from arm_ds.debugger_v1 import Debugger
from com.arm.debug.dtsl import ConnectionManager
from com.arm.debug.dtsl.interfaces import IConfiguration

    # Connect to DS-5 Debugger
    debugger = Debugger()
    assert isinstance(debugger, Debugger)
    if not debugger.isConnected():
        return
    # Access the underlying DTSL configuration
    dtslConnectionConfigurationKey = debugger.getConnectionConfigurationKey()
    dtslConnection = ConnectionManager.openConnection(dtslConnectionConfigurationKey)
    dtslConfiguration = dtslConnection.getConfiguration()
    assert isinstance(dtslConfiguration, IConfiguration)
    deviceList = dtslConfiguration.getDevices()
    for device in deviceList:
        assert isinstance(device, IDevice)
        if device.getName() == "PTM":
            …
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.5 Main DTSL classes and hierarchy

There are four basic types of object that DTSL exposes to the Debugger or third-party plugin:

- Connection and Configuration objects, which implement the `IConnection` and `IConfiguration` interfaces respectively.
- Device objects, which implement the `IDevice` interface. Cores, and most CoreSight components, are of this type. If a device needs a connection type operation, which most devices do, then it also implements `IDeviceConnection` (see the `ConnectableDevice` object).
- TraceSource objects, which typically implement both the `IDevice` and `ITraceSource` interfaces. ETM and PTM objects are of this type.
- Trace capture devices, which typically implement the `ITraceCapture` interface. These objects give access to a trace capture device such as a DSTREAM or an ETB.

This section contains the following subsections:

- *15.5.1 DTSL configuration objects* on page 15-454.
- *15.5.2 DTSL device objects* on page 15-455.
- *15.5.3 CoreSight device component register IDs* on page 15-456.
- *15.5.4 DTSL trace source objects* on page 15-456.
- *15.5.5 DTSL trace capture objects* on page 15-458.
- *15.5.6 Memory as seen by a core device* on page 15-459.
- *15.5.7 Physical memory access via CoreSight* on page 15-459.
- *15.5.8 DTSL MEM-AP support* on page 15-460.
- *15.5.9 Linking MEM-AP access to a core device* on page 15-460.

15.5.1 DTSL configuration objects

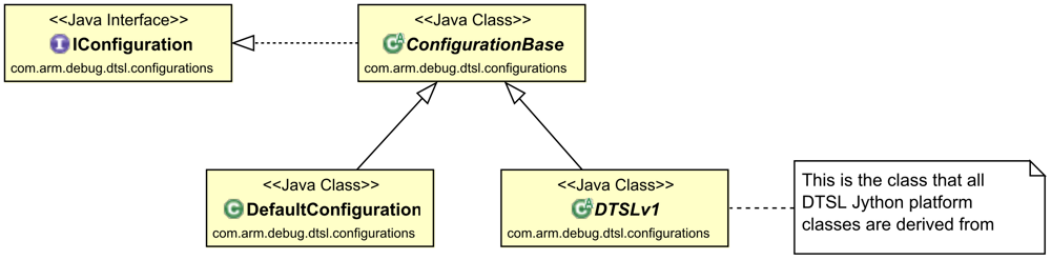


Figure 15-4 DTSL Configuration class hierarchy

The `DTSLConnection` object is the top level DTSL object that allows access to all the other DTSL objects using the platform configuration. Specifically, the `DTSLConnection` allows access to the `ConfigurationBase` instance, for example DTSLv1, which allows access to the rest of the DTSL objects. The content of the platform configuration depends on the associated `ConnectionParameters` set.

If the `ConnectionParameters` instance does not specify a DTSL configuration script, then an object of type `DefaultConfiguration` is created. The configuration content is constructed by creating a `Device` object for each device known to RDDI-DEBUG. For DSTREAM, this means that a `Device` object is created for each device declared in the `.rcf` file or the `.rvc` file, but for other kinds of RDDI this might come from a different data set. This allows for a simple connection to a platform with direct connections to any target devices specified in the RDDI configuration file.

If the `ConnectionParameters` instance does specify a DTSL configuration script, then that script is run to create an instance of a configuration object derived from DTSLv1. When the configuration script is

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

run, it is expected to populate the configuration with the set of known device objects, trace sources and trace capture devices.

Note

- ARM recommends using a configuration script to create a DTSL configuration, because it allows much greater flexibility when creating devices.
- DTSLv1 is named as such to show that the configuration is using the V1 interface and object set. This is the current set. If ARM changes the interface and object set, then it might start using DTSLv2. This allows ARM to maintain backwards compatibility, but also to move forward with new or modified interfaces.

15.5.2 DTSL device objects

`Device` objects are used to interface to any target component that has an RDDI-DEBUG interface. Such components are typically cores or CoreSight devices. All `Device` objects implement the `IDevice` interface, which closely matches the RDDI-DEBUG native interface.

The following is a code sequence from a DTSL Jython script to create the `Device` object for a Cortex-A8 core:

```
1. devID = self.findDevice("Cortex-A8")
2. self.cortexA8 = ConnectableDevice(self, devID, "Cortex-A8")
3. self.addDeviceInterface(self.cortexA8)
```

Line 1 locates the device ID (RDDI-DEBUG device index number) for the named device from the RDDI configuration. Line 2 creates the DTSL `ConnectableDevice` object. Line 3 adds the device object to the DTSL configuration.

The following figure shows part of the Device class hierarchy:

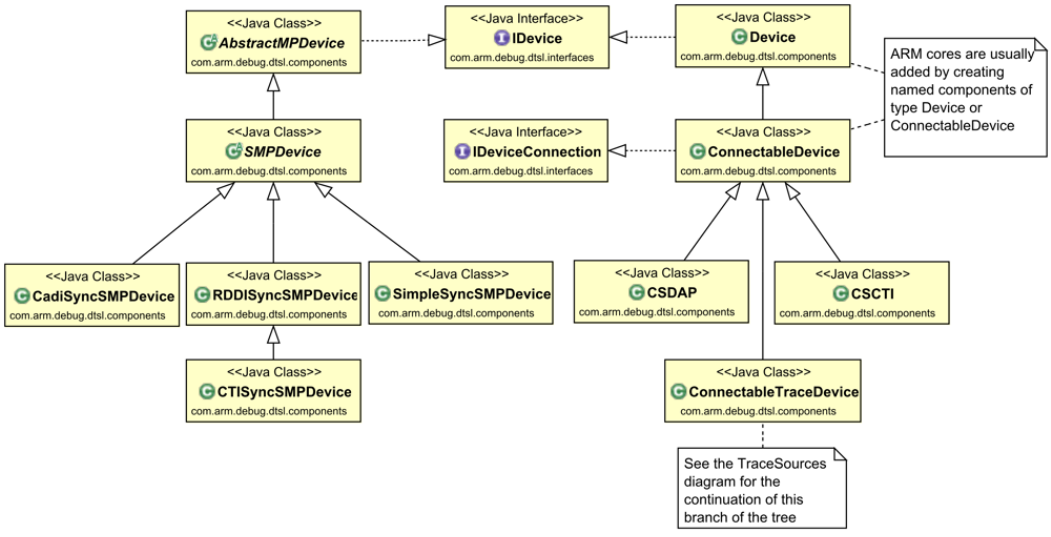


Figure 15-5 DTSL Device object hierarchy

Note

The figure shows the main components used for cores and core clusters.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.5.3 CoreSight device component register IDs

The documentation for a CoreSight component lists its component registers and their address offsets. For example, the CoreSight STM component has a Trace Control and Status Register called `STMTCSR` which has an offset of `0xE80`. To access this register through the *`IDevice`* interface, you need to know its register ID. To determine the ID, divide the documented offset by four. For example, the register ID for the `STMTCSR` register is `0x3A0`, which is `0xE80`/4.

15.5.4 DTSL trace source objects

These objects represent sources of trace data within the platform. These could be ARM devices such as:

- ETM
- PTM
- ITM
- STM
- MTB (previously known as BBB)
- custom trace components that output data onto the CoreSight ATB.

These devices must implement the *`ITraceSource`* interface to be recognized as a trace source and to provide ATB ID information. They typically also implement *`IDevice`*. Most of these types of device only implement the register access methods from *`IDevice`* to allow configuration and control of the device, and they usually have a partner class which defines the names of the registers supported. For example, the *`STMTraceSource`* class has a partner class called *`STMRegisters`* which, for convenience, defines the STM register set IDs and many of their bit fields.

The class hierarchy for trace source objects is shown in the following figure:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

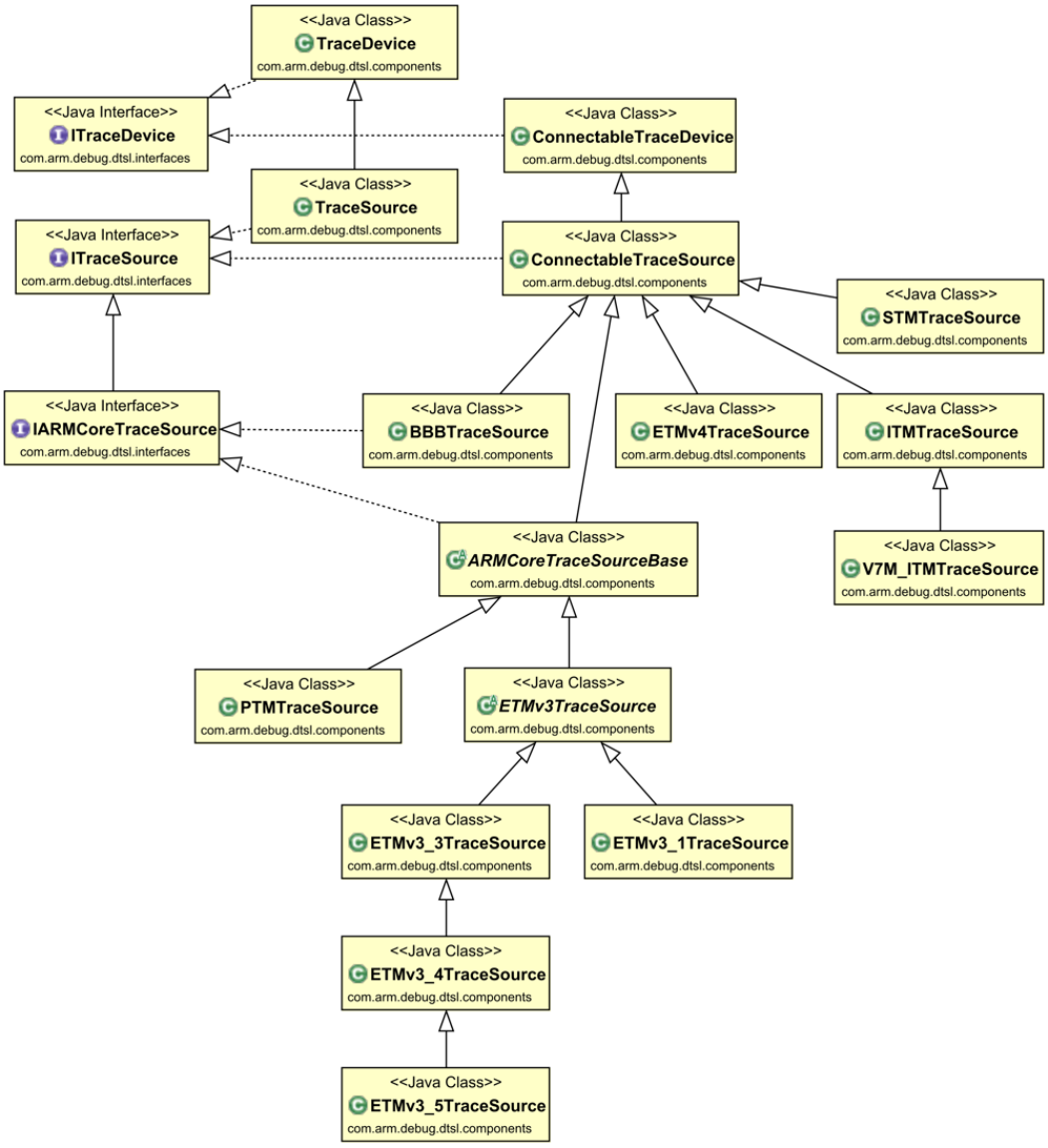


Figure 15-6 DTSL Trace Source class hierarchy

When implementing new trace source objects, you can choose to base them on `TraceDevice`, `ConnectableTraceDevice`, `TraceSource`, or `ConnectableTraceSource`. The choice depends on whether the source needs a connection, and whether it can identify itself in the trace stream with a source ID. As shown in the figure, all the standard ARM trace sources are derived from `ConnectableTraceSource`. This is because they are real devices which can be connected to for configuration, and which have ATB IDs to identify themselves in the received trace stream.

The following is a typical code sequence from a DTSL Jython script to create an ETM trace source:

```
1. devID = self.findDevice("CSETM")
2. etmATBID = 1
3. self.ETM = ETMv3_3TraceSource(self, devID, etmATBID, "ETM")
```

Line 1 locates the CSETM device ID (RDDI-DEBUG device index number) from the RDDI configuration. Line 2 assigns the ATB ID to be used for the ETM. Line 3 creates the DTSL `ETMv3_3TraceSource` object and names it “ETM”. If there are multiple ETMs in the platform, they should have different names, such as “ETM_1” and “ETM_2”, or “ETM_Cortex-A8” and “ETM_Cortex-M3”.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

After creating the trace source objects, you must inform any trace capture device about the set of trace source objects to associate with it. This allows the client program to locate the ATB ID for the source of interest and request delivery of trace data for that source.

Related concepts

15.5.5 DTSL trace capture objects on page 15-458.

15.5.5 DTSL trace capture objects

Trace capture objects are responsible for storing and delivering trace data. Some trace capture devices reside on the platform itself, such as CoreSight ETB, TMC/ETB and TMC/ETR. Some trace capture devices capture trace into off-platform storage, such as DSTREAM with its 4GB trace buffer.

The following figure shows the class hierarchy and interfaces for Trace Capture device.

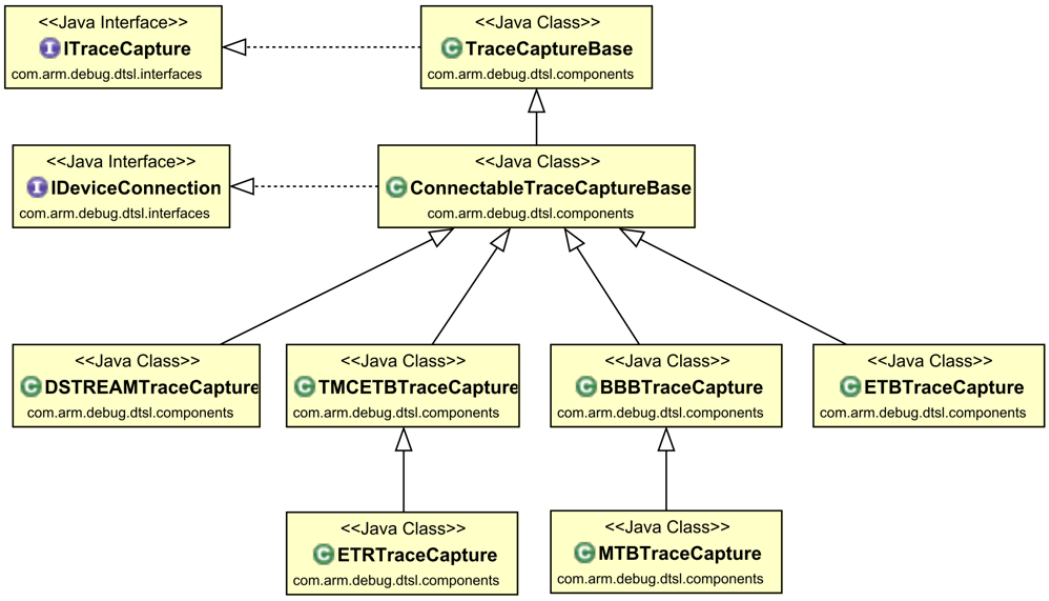


Figure 15-7 DTSL Trace Capture Objects

The following is a typical code sequence from a DTSL Jython script to create an ETB trace capture device:

```
1. devID = self.findDevice("CSETB")
2. self.ETB = ETBTraceCapture(self, devID, "ETB")
3. self.ETB.setFormatterMode(FormatterMode.BYPASS)
4. self.ETB.addTraceSource(self.ETM, self.coretexA8.getID())
5. self.addTraceCaptureInterface(self.ETB)
6. self.setManagedDevices([self.ETM, self.ETB])
```

Line 1 locates the ETB device ID (number) from the RDDI configuration (`.rcf` file or `.rvc` file). Line 2 creates the *`ETBTraceCapture`* object with the name “ETB”. Line 3 configures the formatter mode of the ETB. Line 4 adds an ETM object, such as that created by the code sequence in *15.5.4 DTSL trace source objects* on page 15-456, to the set of trace sources to associate with the trace capture device. This should be done for all trace source objects which deliver trace to the trace capture device. To associate the ETM with a core, the code uses a version of the *`addTraceSource()`* method which allows it to associate the core by its ID. Line 5 adds the trace capture device to the DTSL configuration. Line 6 tells DTSL to automatically manage connection and disconnection to and from the ETM and ETB devices.

When a client program has a reference to the DTSL configuration object, it can query it for its set of trace capture devices. For each trace capture device, it can find out which trace sources feed into the trace capture device.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.5.6 Memory as seen by a core device

When a DTSL configuration creates DTSL device objects for ARM cores, target memory can be accessed by performing memory operations on the device objects. This is how the DS-5 Debugger typically accesses memory during a debug session. However, such memory accesses have certain characteristics and are restricted in certain ways:

- For most ARM cores, memory cannot be accessed through the core when the core is executing.
- For cores with an MMU, the address used to access memory through the memory access methods of a device is the address as seen from the point of view of the core. This means that if the MMU is enabled, then the address is a virtual address, and it undergoes the same address translation as if it had been accessed by an instruction executed by the core. This is usually what a DTSL client, such as a debugger, wants to happen, so that it can present the same view of memory as that which the core sees when executing instructions.
- For cores with enabled caches, the data returned by the memory access methods of a device is the same as would be returned by a memory access by an instruction executed on the core. This means that if the data for the accessed address is currently in a cache, then the cached data value is returned. This value might be different from the value in physical memory. This is usually what a DTSL client, such as a debugger, wants to happen, so that it can present the same view of memory as that which the core sees when executing instructions.

15.5.7 Physical memory access via CoreSight

Although CoreSight does not require it, most CoreSight implementations provide a direct way to access the bus or buses of the target system. They do this by providing a *Memory Access Port* (MEM-AP) which is accessed through the CoreSight DAP. There are several types of MEM-AP depending on the type of the system bus. The three main types are APB-AP, AHB-AP, and AXI-AP, which provide access to APB, AHB, and AXI bus types respectively. Each of these access ports implements the CoreSight MEM-AP interface.

The following figure shows a simple, but typical, arrangement of MEM-APs:

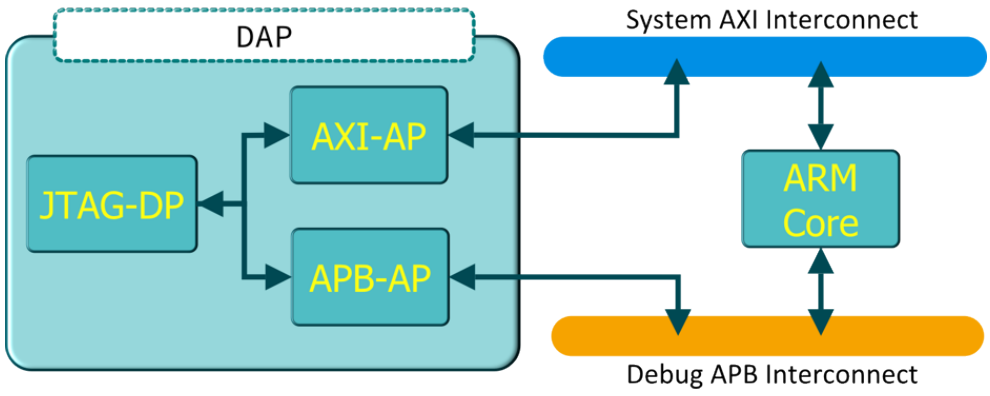


Figure 15-8 MEM-AP Access Ports

To allow direct memory access through one of the MEM-APs, a DTSL configuration can create device objects for the MEM-APs themselves. When the memory access methods are called on such devices, the memory access is directed straight onto the system bus, completely bypassing the core or cores.

Note

The memory access is not processed by the core MMU (so there is no core MMU address translation), and bypasses any cache in the core, which might result in a different value being observed to that observed by the core.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.5.8 DTSL MEM-AP support

DTSL provides special classes for MEM-AP support. The following figure shows the class hierarchy:

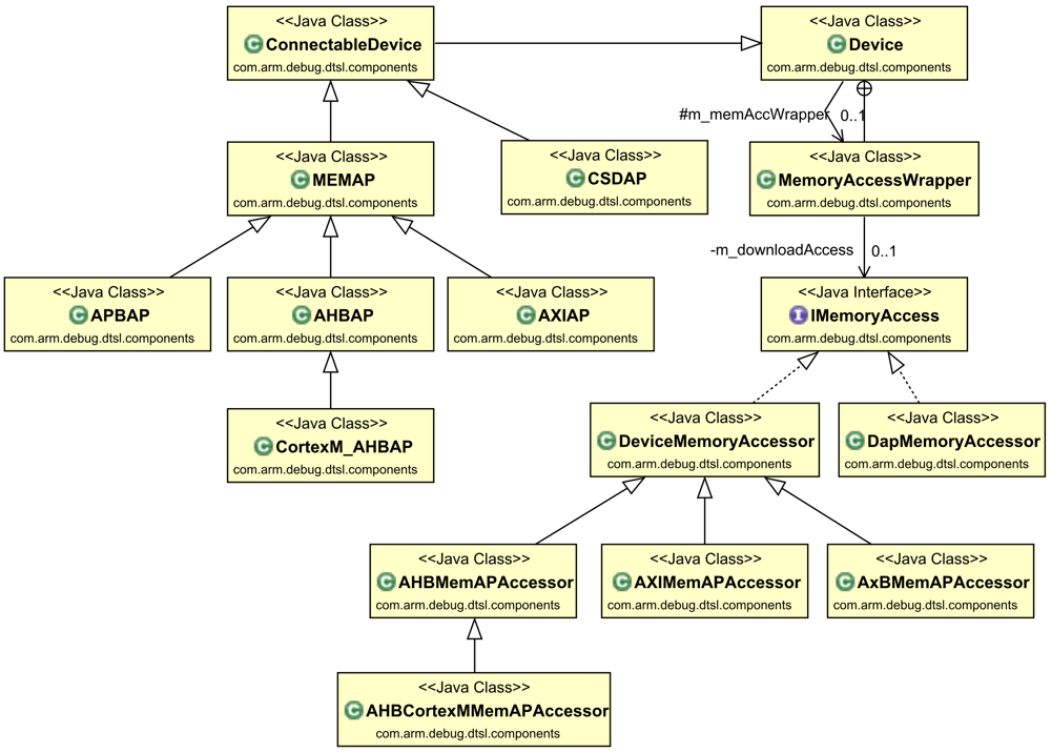


Figure 15-9 MEM-AP Class Hierarchy

The figure shows two main class trees. These are the MEM-AP tree and the *`DeviceMemoryAccessor`* tree. The DTSL configuration typically creates objects for one or more of the MEM-AP class types, suitably specialized for the actual bus type.

In the MCBSTM32E example, there is an AHB-AP which can be used to access memory directly. In the case of Cortex-M3, this bus is also used to access the CoreSight debug components, but for non-Cortex-M cores it is more typical for there to be a separate APB-AP for debug component access. The significant lines of the DTSL configuration script are similar to the following:

```
devID = self.findDevice("CSMEMAP")
self.AHB = CortexM_AHBAP(self, devID, "CSMEMAP")
```

In this case, the RDDI-DEBUG configuration has a device called CSMEMAP, which associates with a *`CortexM_AHBAP`* DTSL object. This object is derived from a DTSL *`Device`*, and so has memory access methods available.

If a client is aware of such DTSL devices, then it can use them to access memory directly.

15.5.9 Linking MEM-AP access to a core device

Not all clients are directly aware of MEM-AP type devices. DS-5 Debugger is an example of such a client. To allow such clients to make use of MEM-AP devices, named address space filters can be added to any DTSL Device object. The purpose of the address space filter is to tell the Device object that, if it sees a memory access with a known address space name, it should carry out the access through another DTSL device, rather than through the core. For example, we can add an address space filter to the Cortex-M3 DTSL Device which detects memory accesses to an address with an address space of “AHB”. When it detects such an access, it performs the access using the AHB device, instead of going through

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

the Cortex-M3. For DS-5 Debugger, this means that the user can prefix an address with `AHB:` (for example, `AHB:0x20000000`), and the access is performed using the AHB-AP.

The following code shows how the address space filter is added to the Cortex-M3 object:

```
devID = self.findDevice("CSMEMAP")
self.AHB = CortexM_AHBAP(self, devID, "CSMEMAP")
devID = self.findDevice("Cortex-M3")
self.cortexM3 = ResetHookedDevice(self, devID, "Cortex-M3")
self.cortexM3.registerAddressFilters(
    [AHBCortexMMemAPAccessor("AHB", self.AHB, "AHB bus accessed via AP_0")])
```

Any number of address filters can be added, but each filter name (DS-5 Debugger address prefix) must be unique.

To determine the supported address spaces for an object which implements *`IDevice`*, call the *`getAddressSpaces()`* method. When a client matches against an address space, it can map the address space to a `rule` parameter which is passed into the *`IDevice`* memory access methods. The `rule` parameter is then used to direct the memory access to the appropriate device.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.6 DTSL options

On many platforms, the debug components allow configuration of their properties. For example, in some CoreSight PTM components, the generation of timestamps within the trace data stream can be turned on or off. Such options are typically accessed and changed by using the DTSL objects that were created as part of the DTSL configuration. For example, the DTSL `PTMTraceSource` object has a `setTimestampingEnabled()` method to control timestamping. In this way, the DTSL objects that a DTSL configuration holds can expose a set of configuration options that you might want to modify. You might also want to create an initial option set to be applied at platform connection time, and then change some of those options after connecting, during a debug session. For example, this allows the PTM timestamp option to have a user setting applied at connection time, while also allowing you to turn the timestamps on and off during a debug session.

This section contains the following subsections:

- *15.6.1 DTSL option classes* on page 15-462.
- *15.6.2 DTSL option example walk-through* on page 15-463.
- *15.6.3 Option names and hierarchy* on page 15-464.
- *15.6.4 Dynamic options* on page 15-466.
- *15.6.5 Option change notification* on page 15-466.
- *15.6.6 Option change notification example walk-through* on page 15-466.

15.6.1 DTSL option classes

To support the concept of DTSL options, a DTSL configuration can expose a set of option objects. These objects allow a client to query the option set and their default values, and to modify the option values before and after connecting. The option objects are arranged hierarchically, and grouped in a way that allows them to be presented in a GUI. The option set must be available before connecting, so the options are exposed by a static method `getOptionList()` on the DTSLv1 derived class within a Jython script.

Note

The `getOptionList()` static method is not part of any defined Java interface. The DTSL configuration script manager uses Jython introspection at run time to determine whether the method exists.

The object set returned from `getOptionList()` should be an array of option objects. It is very common to partition the set of options into logical groups, each of which has its own tab page within a `TabSet`. Each tab page contains the options for its associated group.

The following figure shows the supported options types and class hierarchy:

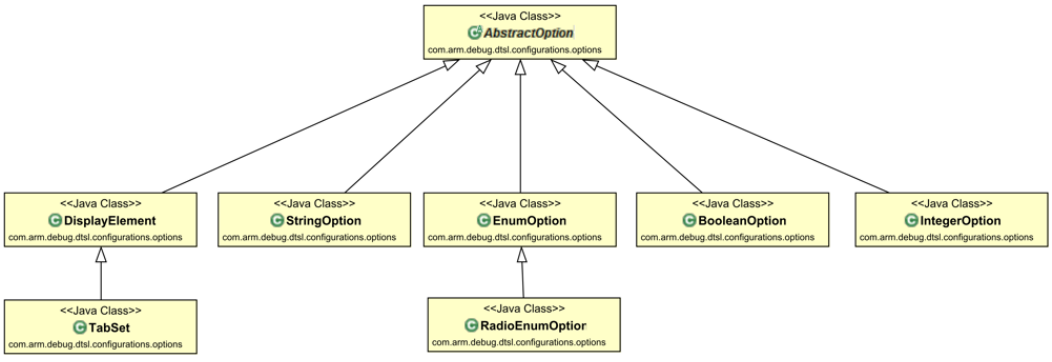


Figure 15-10 DTSL Option Classes

The DTSLv1 class provides many static helper methods for creating the options, and it is more usual for these methods to be used rather than directly creating the objects.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.6.2 DTSL option example walk-through

The following is a simplified example from the Keil MCBSTM32E platform Jython script:

```
1.     class DSTREAMDebugAndTrace(DTSLv1):
2.         '''A top level configuration class which supports debug and trace'''
3.
4.         @staticmethod
5.         def getOptionList():
6.             '''The method which specifies the configuration options which
7.                the user can edit via the launcher panel |Edit...| button
8.             '''
9.             return [
10.                 DTSLv1.tabSet(
11.                     name='options',
12.                     displayName='Options',
13.                     childOptions=[
14.                         DSTREAMDebugAndTrace.getTraceBufferOptionsPage(),
15.                         DSTREAMDebugAndTrace.getETMOptionsPage(),
16.                         DSTREAMDebugAndTrace.getITMOptionsPage()
17.                     ]
18.                 )
19.             ]
```

Line 4 marks the method as a static method of the containing class. This allows it to be called before an instance of the class exists. It also implies that any methods that are called are also static methods, because there is no self (this) associated with an instance of the class. Line 5 defines the static method with the name *`getOptionList`*. If this static method is present, then the configuration has options, otherwise it does not. Line 10 creates a *`TabSet`* object with name 'options', display name 'Options', and an array of child options, which in this example are each created by calling another static method.

Note

You might find it helpful to provide child options using several static methods. This prevents the nesting level of brackets from becoming too deep and difficult to understand, and makes it easier for you to avoid using the wrong type of bracket in the wrong place.

The following code extract shows the *`getTraceBufferOptionsPage`* method:

```
@staticmethod
def getTraceBufferOptionsPage():
    return DTSLv1.tabPage(
        name='traceBuffer',
        displayName='Trace Buffer',
        childOptions=[
            DTSLv1.enumOption(
                name='traceCaptureDevice',
                displayName='Trace capture method',
                defaultValue='none',
                values=[
                    ('none', 'No trace capture device'),
                    ('DSTREAM', 'DSTREAM 4GB Trace Buffer')
                ]
            ),
            DTSLv1.booleanOption(
                name='clearTraceOnConnect',
                displayName='Clear Trace Buffer on connect',
                defaultValue=True
            ),
            DTSLv1.booleanOption(
                name='startTraceOnConnect',
                displayName='Start Trace Buffer on connect',
                defaultValue=True
            ),
            DTSLv1.enumOption(
                name='traceWrapMode',
                displayName='Trace full action',
                defaultValue='wrap',
                values=[
                    ('wrap', 'Trace wraps on full and continues to store data'),
                    ('stop', 'Trace halts on full')
                ]
            )
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
35.             ]
36.     )
```

Note

The code uses nesting and indentation to help keep track of closing bracket types.

Line 3 creates a tab page named 'traceBuffer', which has an array of child options. These child options are displayed on the tab page within a GUI. Working through the child options might help you understand how they are displayed to the user. Line 7 creates an enum option. This is an option whose value is one of a set of pre-defined values, and which is typically presented to the user as a drop down list box. The list box shows the pre-defined values, and the user selects one of them. The values are given as pairs of strings. The first string is the internal value, and the second string is the text displayed to the user. Lines 16 to 21 create boolean options. These are options which are true or false, or on or off, and are usually shown to the user as a check box GUI element.

The following figure shows how DS-5 renders the tab set and tab page:

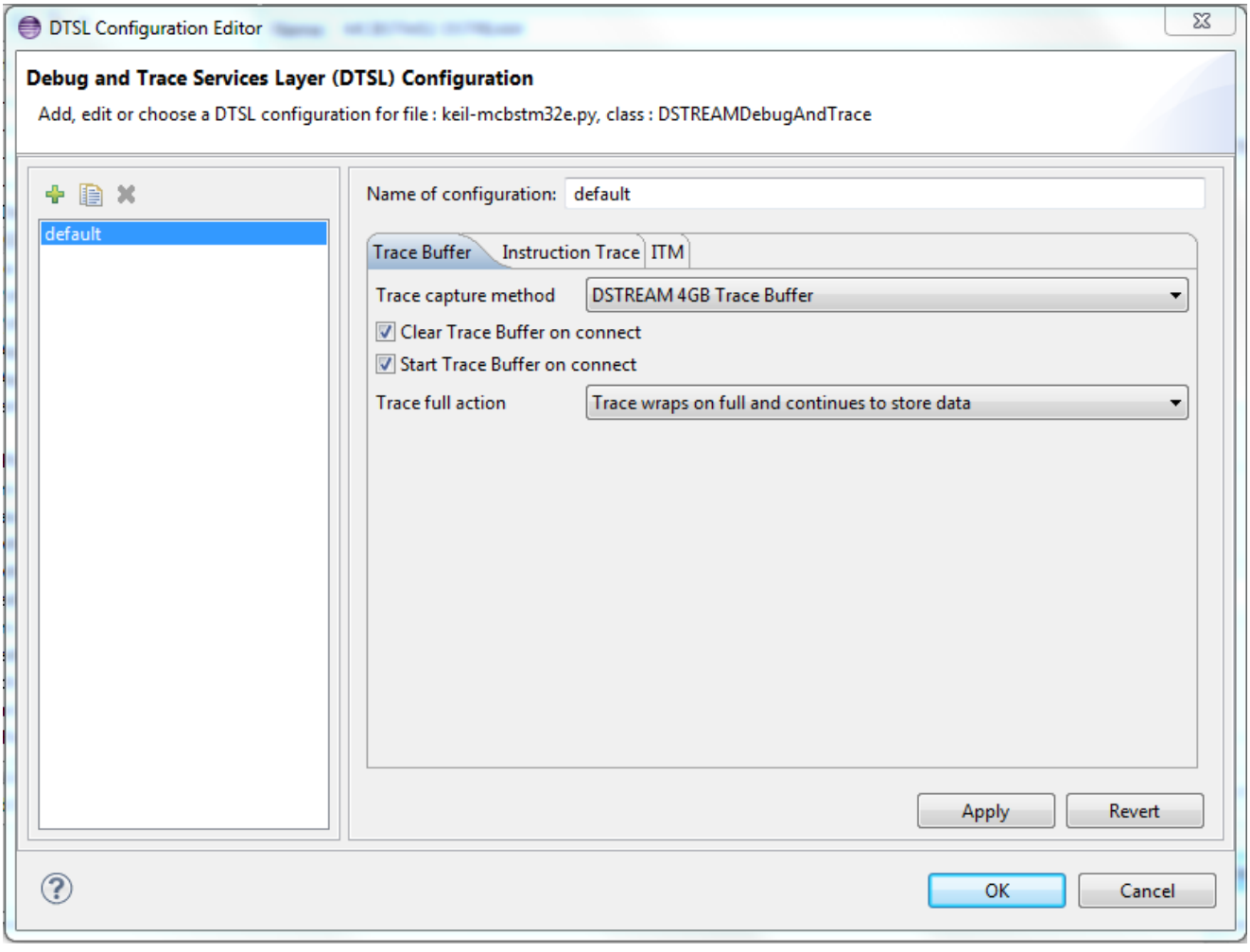


Figure 15-11 DSTREAM Trace Options

For more examples, see the full source code for the Keil example in the DTSLExampleConfigdb project.

15.6.3 Option names and hierarchy

All options are part of an option hierarchy. Starting at the outermost level, the `TabSet` object is usually named 'options'. All other options are then created in a `childOptions` path, starting from this outermost

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

level. The 'name path' for an option consists of all the internal names (not the display names) in the hierarchy between the outermost level and the option in question, joined by the '`.`' character. For example, in the previous code samples, the option which indicates the currently selected trace capture device has the name path '`options.traceBuffer.traceCaptureDevice`'. The components of this name path, joined by '`.`', are as follows:

options
: The internal name of the outermost *`TabSet`*.

traceBuffer
: The internal name of the child option for the trace buffer tab page object.

traceCaptureDevice
: The internal name of the *`EnumOption`* for the currently selected trace capture device.

The full path name is important for at least three reasons:

- It can be used from the DS-5 Debugger command line, to read or modify the option value, using the commands `show dtsl-options` or `set dtsl-options`.
- It can be used in the `project_types.xml` file to direct the DS-5 Debugger to relevant options, such as which trace capture device to use (if any).
- It can be used in the *`getOptionValue`* and *`setOptionValue`* methods of the configuration, to read or modify an option's value.

Note

The full path option name is case sensitive.

Here is an example output from the `show dtsl-options` command to see the list of available DTSL options and their current values.

```
Command: show dtsl-options
dtsl-options options.ETM.cortexM3coreTraceEnabled:                      value is "true"
dtsl-options options.ITM.itmTraceEnabled:                               value is "true"
dtsl-options options.ITM.itmTraceEnabled.itmowner:                      value is "Target"
                                                                          (read only)
dtsl-options options.ITM.itmTraceEnabled.itmowner.debugger.DWTENA:          value is "true"
dtsl-options options.ITM.itmTraceEnabled.itmowner.debugger.PRIVMASK.[15:8]:   value is "true"
dtsl-options options.ITM.itmTraceEnabled.itmowner.debugger.PRIVMASK.[23:16]:  value is "true"
dtsl-options options.ITM.itmTraceEnabled.itmowner.debugger.PRIVMASK.[31:24]:  value is "true"
dtsl-options options.ITM.itmTraceEnabled.itmowner.debugger.PRIVMASK.[7:0]:    value is "true"
dtsl-options options.ITM.itmTraceEnabled.itmowner.debugger.STIMENA:     value is "0xFFFFFFFF"
dtsl-options options.ITM.itmTraceEnabled.itmowner.debugger.TSENA:           value is "true"
dtsl-options options.ITM.itmTraceEnabled.itmowner.debugger.TSPrescale:      value is "none"
dtsl-options options.ITM.itmTraceEnabled.itmowner.target.targetITMATBID:value is "2"
                                                                          (read only)
dtsl-options options.traceBuffer.clearTraceOnConnect:                   value is "true"
                                                                          (read only)
dtsl-options options.traceBuffer.startTraceOnConnect:                   value is "true"
                                                                          (read only)
dtsl-options options.traceBuffer.traceCaptureDevice:                    value is "DSTREAM"
                                                                          (read only)
dtsl-options options.traceBuffer.traceWrapMode:                         value is "wrap"
                                                                          (read only)
dtsl-options options.ucProbe.ucProbeEnabled:                            value is "false"
dtsl-options options.ucProbe.ucProbeEnabled.PORT:                       value is "9930"
                                                                          (read only)
```

Here is an example of the `set dtsl-options` command to change the current value of any non read-only option:

```
Command: set dtsl-options options.ITM.itmTraceEnabled false
DTSL Configuration Option "options.ITM.itmTraceEnabled" set to false
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.6.4 Dynamic options

Some option values can be modified dynamically, after connecting to the platform. For a DS-5 Debug session, this means the option can be changed during the debug session, using either the DS-5 Debugger command line or the **DTSL Options...** menu selection with the Debug Control View.

Not all options can be modified after connecting. For example, the trace capture device cannot typically change during the debug session, although the option to enable ITM trace can change. Even if an option can be changed, it might not apply the change immediately. For example, most trace-related dynamic options apply changes only when tracing is started or restarted.

To mark an option as dynamic, add the '`isDynamic=True`' parameter to the option constructor. For example, the ITM option to generate timestamps could be created as follows:

```
DTSLv1.booleanOption(
    name='TSENA',
    displayName = 'Enable differential timestamps',
    defaultValue=True,
    isDynamic=True
)
```

When DS-5 Debugger displays the options during a debug session, it only allows the dynamic options to be changed. All the options are shown to the user, but the non-dynamic ones are grayed out and cannot be changed.

15.6.5 Option change notification

Shortly after the DTSL configuration instance (the object derived from DTSLv1) is created, the option values are given to the instance by calling its *`optionValuesChanged`* method. This method inspects the current option values and configures the platform components accordingly.

Note

The *`optionValuesChanged`* method is called after the constructor is called, but before the DTSL components are connected to the target platform. This means that the DTSL objects can be configured with their settings, but cannot send the settings to the target components.

If the options are changed during a debug session, then the *`optionValuesChanged`* method is called again, to inform the DTSL components that the options have changed.

Note

Currently, the call to the *`optionValuesChanged`* method does not indicate which options have changed. A future version of DTSL will address this.

15.6.6 Option change notification example walk-through

These Jython code snippets are from the Keil MCBSTM32E platform Jython script and the *`DSTREAMDebugAndTrace`* class:

```
    def optionValuesChanged(self):
        '''Callback to update the configuration state after options are changed.
           This will be called:
              * after construction but before device connection
              * during a debug session should the user change the DTSL options
        '''
        obase = "options"
        if self.isConnected():
            self.updateDynamicOptions(obase)
        else:
            self.setInitialOptions(obase)
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Line 1 declares the *optionValuesChanged* method, which is called to tell the DTSL components that the options have changed. Line 7 assigns the top level options name path value. Lines 8 to 11 call one of two methods depending on whether the configuration is connected yet.

```
1.     def setInitialOptions(self, obase):
2.         '''Takes the configuration options and configures the
3.            DTSL objects prior to target connection
4.            Param: obase the option path string to top level options
5.         '''
6.         if self.traceDeviceIsDSTREAM(obase):
7.             self.setDSTREAMTraceEnabled(True)
8.             self.setDSTREAMOptions(obase+".traceBuffer")
9.             obaseETM = obase+".ETM"
10.            obaseITM = obase+".ITM"
11.            self.setETMEnabled(self.getOptionValue(
12.                                obaseETM+".cortexM3coreTraceEnabled"))
13.            self.reservedATBIDs = {}
14.            self.setITMEnabled(self.getOptionValue(obaseITM+".itmTraceEnabled"))
15.            obaseITMOwner = obaseITM+".itmTraceEnabled.itmowner"
16.            if self.debuggerOwnsITM(obaseITMOwner):
17.                self.setITMOwnedByDebugger(True);
18.                self.setITMOptions(obaseITMOwner+".debugger")
19.            else:
20.                self.setITMOwnedByDebugger(False);
21.                self.reservedATBIDs["ITM"] =
22.                self.getOptionValue(obaseITMOwner+".target.targetITMATBID")
23.            self.updateATBIDAssignments()
24.        else:
25.            self.setDSTREAMTraceEnabled(False)
26.            self.setETMEnabled(False)
27.            self.setITMEnabled(False)
```

In this code example, note the following:

- The value for an option is retrieved using the `self.getOptionValue` method, which takes the full option path name to the option value.
- The code builds up the full option path names, which allows the options to be moved more easily. This can be seen in the way that the *obaseITMOwner* value is constructed and passed to the `self.setITMOptions` method. This allows `self.setITMOptions` to be written without having to hard code the full option name path into it. Instead, it only needs to know the path extensions from the passed base to determine its option values.

For completeness, the following shows the dynamic option update method:

```
1.     def updateDynamicOptions(self, obase):
2.         '''Takes any changes to the dynamic options and
3.            applies them. Note that some trace options may
4.            not take effect until trace is (re)started
5.            Param: obase the option path string to top level options
6.         '''
7.         if self.traceDeviceIsDSTREAM(obase):
8.             obaseETM = obase+".ETM"
9.             self.setETMEnabled(self.getOptionValue(
10.                obaseETM+".cortexM3coreTraceEnabled"))
11.            obaseITM = obase+".ITM"
12.            if self.getOptionValue(obaseITM+".itmTraceEnabled"):
13.                self.setITMEnabled(True)
14.                obaseITMOwner = obaseITM+".itmTraceEnabled.itmowner"
15.                if self.debuggerOwnsITM(obaseITMOwner):
16.                    self.setITMOptions(obaseITMOwner+".debugger")
17.            else:
18.                self.setITMEnabled(False)
```

For the dynamic option changes, only the options marked as dynamic need inspecting.

Note

The option values are passed on to the corresponding DTSL objects, but the option changes might not be applied immediately. In many cases, the change only applies when execution or trace is next started. Whether the option change is applied immediately is determined by the implementation of the DTSL object.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.7 DTSL support for SMP and AMP configurations

From the point of view of DS-5 Debugger, *Symmetric Multi Processing* (SMP) refers to a set of architecturally identical cores which are tightly coupled together and used as a single multi-core execution block. From the point of view of the debugger, they must be started and halted together.

In larger systems, there may be several SMP sets, each of which is referred to as a cluster. Typically, a cluster is a set of 4 cores in an SMP configuration. All cores in the SMP cluster also have the same view of memory and run the same image.

From the point of view of DS-5 Debugger, *Asymmetric Multi Processing* (AMP) refers to a set of cores which are operating in an uncoupled manner. The cores can be of different architectures { Cortex-A8, Cortex-M3}, or of the same architecture but not operating in an SMP configuration. From the point of view of the debugger, it depends on the application whether the cores need to be started or halted together.

From the point of view of DTSL, the cores in the set (SMP or AMP) are part of the same configdb platform. Using `project_types.xml`, the platform exposes a set of debug operations which cover the supported use cases. All of these use cases must be provided for by the same Jython DTSL configuration class. This is because, although there can be multiple clients using DTSL (for example, one debugger controlling a Cortex-A8 and another controlling a Cortex-M3), there is only one set of target debug hardware (for example, only one TPIU). There must therefore be a single DTSL instance in control of the debug hardware.

In SMP systems, there is usually a hardware mechanism which keeps the set of cores at the same execution state. Some AMP systems must also have synchronized execution state, and the multi-client, single DTSL instance architecture supports this. The single DTSL instance is always aware of the target execution state, and can typically arrange for a single execution state between all AMP cores.

This section contains the following subsections:

- *15.7.1 AMP systems and synchronized execution* on page 15-468.
- *15.7.2 Execution synchronization levels* on page 15-469.
- *15.7.3 Software synchronization* on page 15-469.
- *15.7.4 Tight synchronization* on page 15-469.
- *15.7.5 Hardware synchronization* on page 15-469.
- *15.7.6 SMP states* on page 15-470.
- *15.7.7 Use of CTI for SMP execution synchronization* on page 15-470.

15.7.1 AMP systems and synchronized execution

If a platform contains multiple cores, then when the first DTSL client connects, the DTSL configuration creates devices for all of the cores. The client uses the devices for the cores it wants to control. When a second client connects to the same platform, it must present an identical set of connection parameters. The DTSL connection manager therefore returns the same DTSL configuration instance that was created by the first client connection. The second client can use the devices for the cores it wants to control. In this way, two clients can use the same DTSL configuration instance, including any DTSL options.

If execution synchronization is not required, a simple DTSL configuration is enough, with core execution state being independent. However, if synchronized execution state is required, then the created object model must provide this. The execution synchronization can be implemented with features in the hardware, or by creating a software object model hierarchy which arranges for a shared execution state.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.7.2 Execution synchronization levels

The level at which DTSL can perform synchronized execution status depends heavily on both the execution controller (for example, the JTAG control box) and the on-chip debug hardware. However, there are roughly three different levels (or qualities) of synchronization:

- Software synchronization
- Tight synchronization
- Hardware synchronization

15.7.3 Software synchronization

This is the lowest level or quality of synchronization. 'Software' refers to the DTSL software running on the host debugger computer. At this level, the synchronization is of the following form:

Synchronized start
This is achieved by asking each device to start executing, by calling the `go()` method on each device in turn.

Synchronized stop
This is achieved by asking each device to stop executing, by calling the `stop()` method on each device in turn. If one device is seen to be stopped (by DTSL receiving a `RDDI_EVENT_TYPE.RDDI_PROC_STATE_STOPPED` stopped event), then the DTSL configuration must request all other devices to stop.

This synchronization is done on the host computer, so there can be hundreds of milliseconds between each core actually stopping. Whether this is a problem depends on how the target application handles other cores not responding (if they communicate with each other at all).

15.7.4 Tight synchronization

With tight synchronization, the execution controller (JTAG box such as DSTREAM) can manage the synchronization. This can typically be further divided into several sub-levels of support:

- The execution controller supports the RDDI `Debug_Synchronize()` call. In this case, the synchronized start and stop functionality is implemented in the execution controller. The controller is much 'closer' to the target system, so it can typically synchronize down to sub-millisecond intervals.
- The execution controller can define one or more sets of cores which form a cluster. When any one of the cores in a set is seen to halt execution, the others are automatically halted. This typically provides synchronized stop down to a sub-millisecond interval. DSTREAM supports this technique.
- The execution controller supports `Debug_Synchronize()`, but cannot define clusters. In this case, the DTSL configuration must be written so that if it sees any core in a synchronized group as halted, it issues the RDDI `Debug_Synchronize()` call to halt the others in the group. In a group of several devices, the time interval between the first halting and the others halting may be hundreds of milliseconds, but the interval between the others halting is typically sub-millisecond.

15.7.5 Hardware synchronization

With hardware synchronization, the target provides synchronization features on-chip. This is typically the case for ARM CoreSight systems that use the *Cross Trigger Interface* (CTI) to propagate debug halt and go requests between cores. This ability relies on the hardware design implementing this feature, and so might not be available on all CoreSight designs.

Related concepts

15.7.7 Use of CTI for SMP execution synchronization on page 15-470.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.7.6 SMP states

For SMP systems, DTSL presents a single device to the client (see `SMPDevice` and its relations in the DTSL Java docs), and the client controls execution state through this device. This `SMPDevice` is a 'front' for the set of real devices which form an SMP group. When the `SMPDevice` reports the execution state to the client, there is the possibility of inconsistent states. Ideally, for an SMP group, all the cores have the same state, either executing or halted. In practice, this might not be the case. To allow for this possibility, the `SMPDevice` can report an inconsistent state to the client (debugger). This represents the case when not all cores are in the same state. Normally, DTSL provides a time window within which it expects all cores to get into the same state. If all cores become consistent within this time window, then DTSL reports a consistent state to the client, otherwise it reports an inconsistent state. This allows the client to reflect the true state of the system to the user, but still allows the state to be reported as consistent if consistency is achieved at some future time.

15.7.7 Use of CTI for SMP execution synchronization

Cross Trigger Interface (CTI) is part of the ARM *Embedded Cross Trigger* (ECT) system. Each component in the system can have a CTI which allows inputs and outputs to be routed (or channeled) between the components. The channeling is done by the *Cross Trigger Matrix* (CTM), which is part of the ECT. The CTM supports a fixed number of channels onto which the CTIs can output or input signals. There may be many signals in the system which can be routed between components, and the CTIs can be told which signals to route by assigning them to a channel.

For example, in many systems, each core in the SMP group has a CTI connected to the following signals:

Table 15-1 CTI Signal Connections

Name	Direction	Purpose
DBGTRIGGER	Output from core to CTI	Indicates that the core is going to enter debug state (is going to stop executing)
EDBGRQ	Input to core from CTI	An external request for the core to enter debug state (stop executing)
DBGRESTART	Input to core from CTI	An external request for the core to exit debug state (start executing)

For synchronized execution to work, the DTSL configuration assigns two channels, one of which is for stop requests and the other of which is for start requests. The CTI or CTIs are configured to connect the above signals onto these channels.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

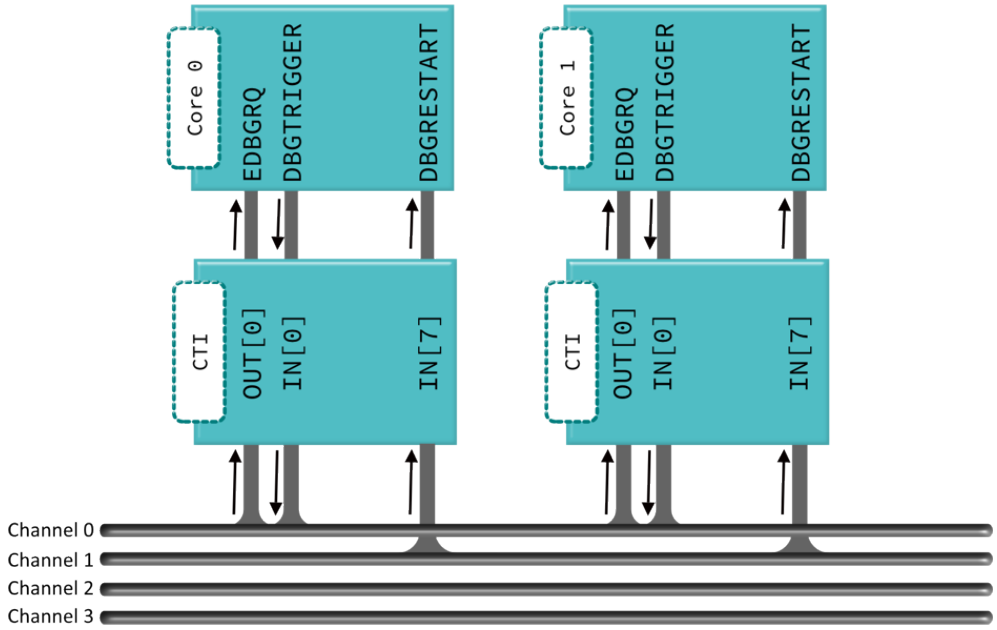


Figure 15-12 Example use of CTI for H/W execution synchronization

With this configuration:

- When a debug tool wants to halt all cores, it sends a CTI pulse. Sending a pulse from any CTI onto the stop channel sends a EDBGRQ to all cores, which causes them to halt. This provides the synchronized stop functionality for stop requests instigated by the debug tool.
- When any core halts (hits a breakpoint), the DBGTRIGGER signal outputs onto the stop channel and sends a EDBGRQ signal to all the other cores, which causes them to halt. This provides the synchronized stop functionality for breakpoints and watchpoints, for example.
- When all cores are ready to restart, sending a pulse from any CTI onto the start channel sends a DBGRESTART signal to all cores. This provides the synchronized start functionality.

The convention for DTSL configurations is that channel 0 is used for the stop channel and channel 1 is used for the start channel. DTSL configuration scripts usually allow this to be modified by changing the following constants, which are assigned near the top of the configuration script:

```
CTM_CHANNEL_SYNC_STOP = 0 # use channel 0 for sync stop
CTM_CHANNEL_SYNC_START = 1 # use channel 1 for sync start
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.8 DTSL Trace

DTSL is designed to support many different trace capture devices, such as DSTREAM, ETB, TMC/ETB and TMC/ETR. It is also possible to extend DTSL to support other trace capture devices. Each of these capture devices can present its data to DTSL in a different format.

Within a platform, trace data can originate from several trace sources. This data is mixed together into the data stream which the trace capture device collects. For simplicity, trace clients (software packages which receive or read trace data from DTSL) are usually designed based on the assumption that the only trace data they receive from the trace source is data which they know how to decode. For example, if a trace client knows how to decode PTM data, then it only expects to receive PTM data when it reads trace data from DTSL.

This section contains the following subsections:

- *15.8.1 Platform trace generation* on page 15-472.
- *15.8.2 DTSL trace decoding* on page 15-473.
- *15.8.3 DTSL decoding stages* on page 15-473.
- *15.8.4 DTSL trace client read interface* on page 15-474.
- *15.8.5 Supporting multiple trace capture devices* on page 15-475.
- *15.8.6 Decoding STM STPv2 output* on page 15-476.
- *15.8.7 Example STM reading code* on page 15-476.
- *15.8.8 STM objects* on page 15-477.
- *15.8.9 DTSL client time-stamp synchronization support* on page 15-478.

15.8.1 Platform trace generation

The following figure shows a simplified diagram of trace generation within a platform. There are several trace sources outputting trace data onto a trace bus. The bus takes the data through a frame generator and outputs it to a trace capture device.

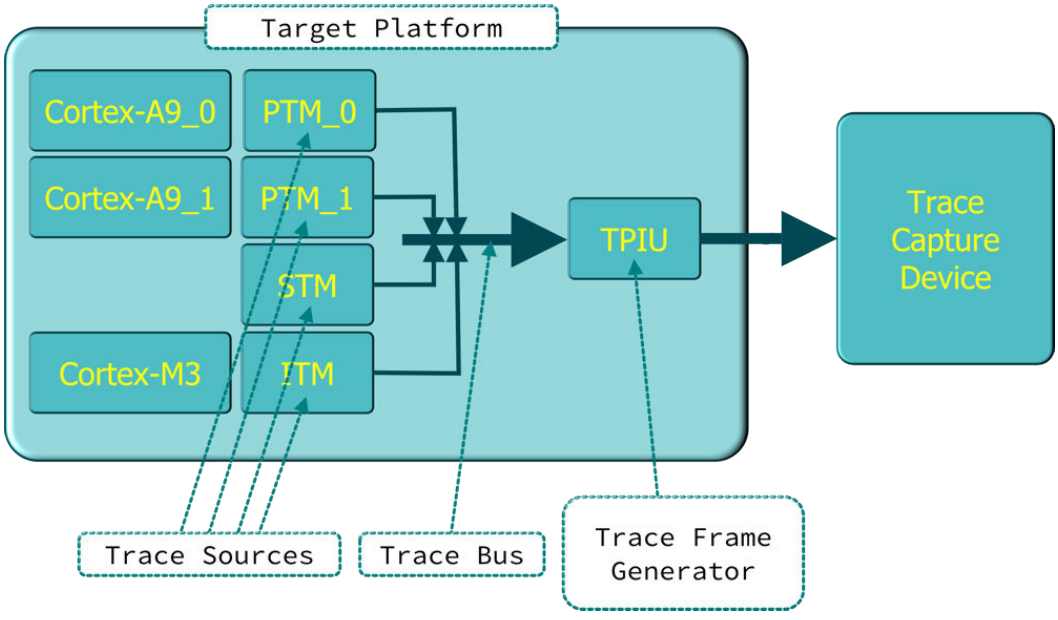


Figure 15-13 Trace Generation

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.8.2 DTSL trace decoding

To process the raw trace data from the trace capture device into a format which is suitable for trace clients to consume, DTSL pushes the raw trace data through a pipeline of trace decoders. The following figure shows an example of this flow for DSTREAM trace data:

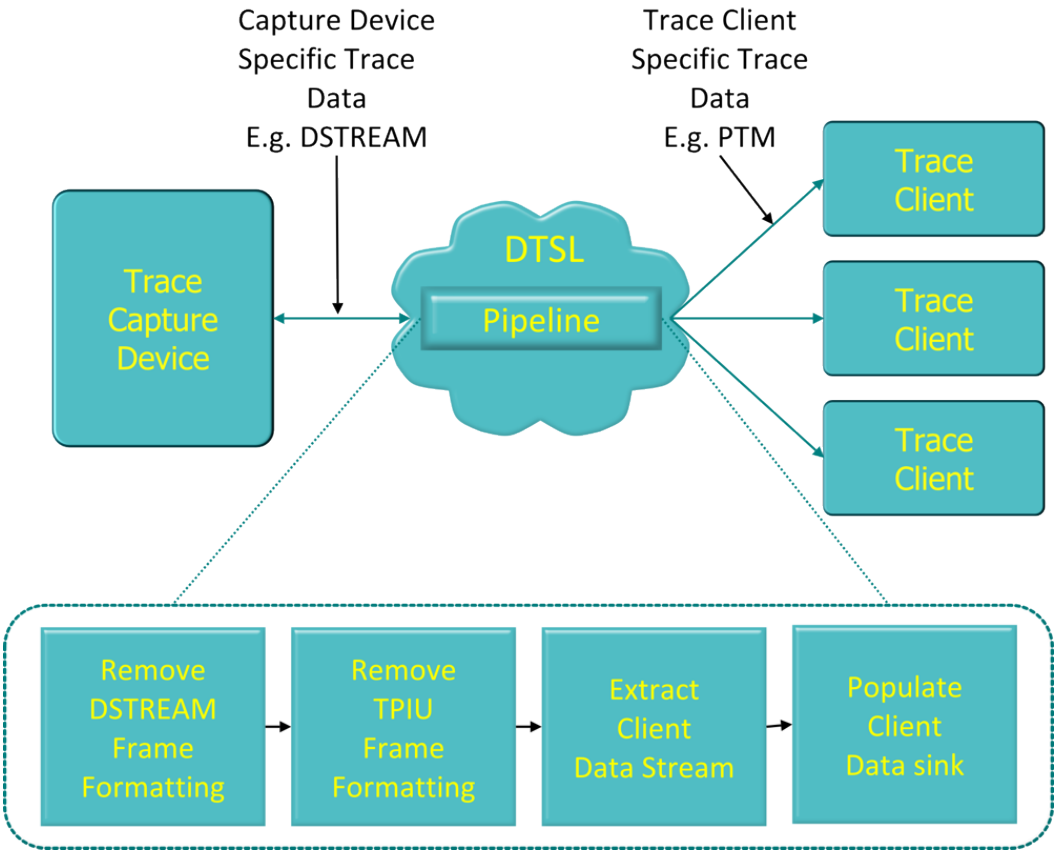


Figure 15-14 DTSL Trace Decoding Stages for DSTREAM

The number and type of the pipeline decoding blocks depends on the format of the trace capture device and the trace data format. However, the final stage should always be to place client compatible data (raw trace source data) into a `DataSink`, ready for the trace client to consume.

15.8.3 DTSL decoding stages

The minimal pipeline decoder does nothing to the data from the trace capture device, except to write it into a `DataSink` for the trace client to read. You can use this pipeline when you know that the data from the trace capture device is already in the format required by a trace client. For example, if you have a disk file which contains raw PTM trace data (that is, the data exactly as output from the PTM onto the system ATB, which you might have captured from a simulation), then you can create a PTM-file-based trace capture device. The decoding pipeline would contain only a `DataSink`, into which you would write the content of the file. The PTM trace client could then read the PTM data directly from the `DataSink`.

For less straightforward pipelines, a chain of objects must be constructed, each of which must implement the `IDataPipelineStage` interface.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

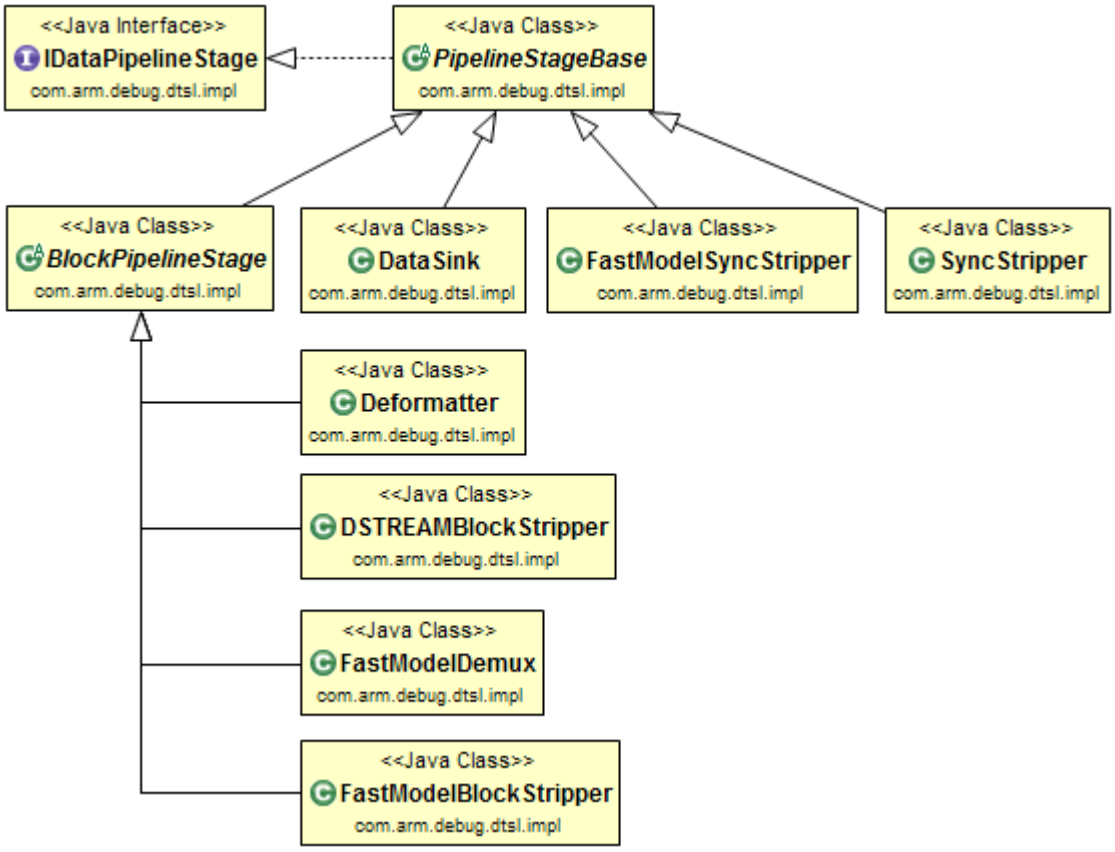


Figure 15-15 DTSL Trace Pipeline Hierarchy

For ARM based trace systems which use a TPIU Formatter (CoreSight ETB, TMC/ETB and TMC/ETR), two further pipeline stages must be added. These are the `SyncStripper` and `Deformatter` stages, which remove the TPIU sync frames and extract data for a particular trace source ID respectively.

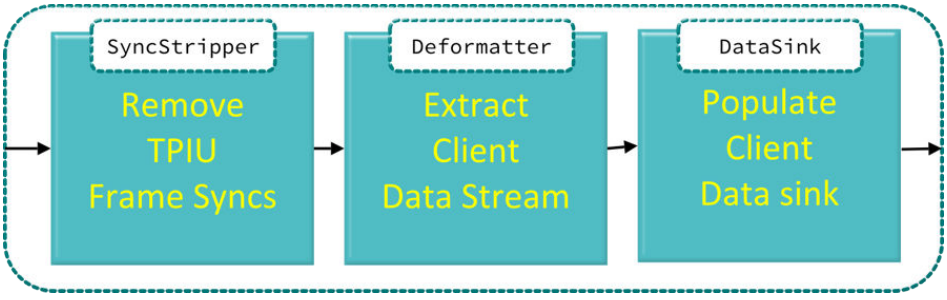


Figure 15-16 ETB Trace Decode Pipeline Stages

By implementing new pipeline stages, it is possible to provide trace support for any trace capture device, as long as the final output stage can be reduced to data which is compatible with the expectations of a trace client.

15.8.4 DTSL trace client read interface

Before a trace client can read trace data, it must get a `TraceSourceReader` object from the trace capture device. In practice, this means querying the DTSL configuration for the correct trace capture device, several of which might be available within a configuration, and calling the `borrowSourceReader()` method to get an appropriate `TraceSourceReader`. Trace data can then be retrieved from the `TraceSourceReader`. When it finishes reading trace data, the client must then return the

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

`TraceSourceReader` object to the trace capture device. This is so that the trace capture device knows when there are no clients reading trace, and therefore when it is free to start, or restart, trace collection.

15.8.5 Supporting multiple trace capture devices

A DTSL configuration can contain several trace capture devices. The following are some possible reasons for this:

- The target platform contains several CoreSight ETB components.
- The target platform can output to an external DSTREAM device, in addition to an internal CoreSight ETB.

In some cases, there can only be one active trace capture device. In this case, you can choose whether to use the DSTREAM or the ETB. In other cases, there can be several trace capture devices active at the same time. This is common when the platform contains multiple clusters of cores, each of which outputs trace to its own CoreSight ETB.

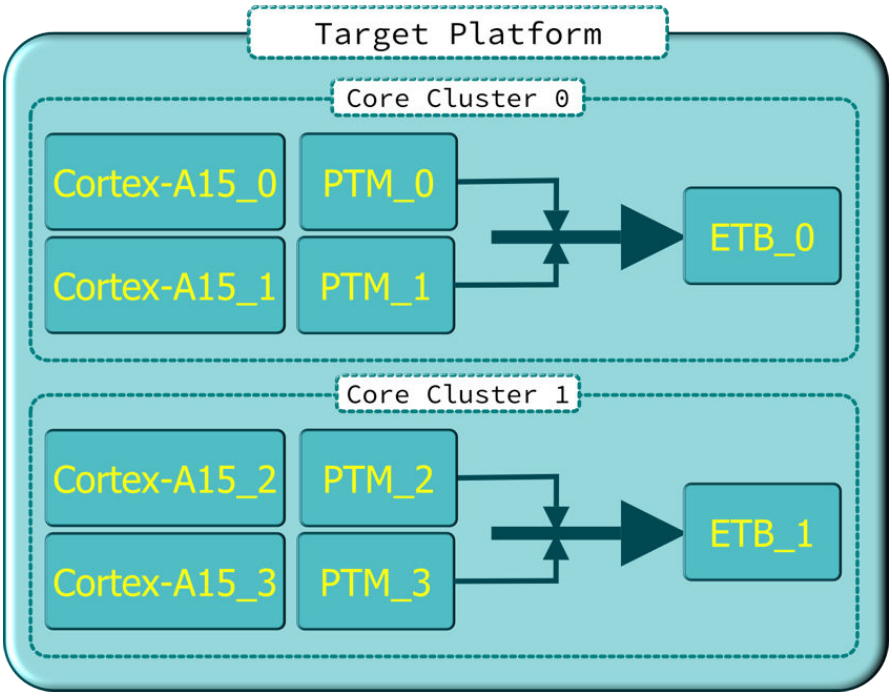


Figure 15-17 Example of Multiple Trace Capture Devices

To allow trace clients to receive trace data from a trace source, the DTSL configuration can be told about the association between a trace source and one or more trace capture devices. In the figure, for example, the trace source named PTM_2 is associated with the trace capture device named ETB_1. If a client wants to display the trace data for PTM_2, it can ask DTSL which trace capture devices are associated with that trace source, and direct its trace read requests to the correct trace capture device.

Note

It is possible for a trace source to be associated with multiple trace capture devices, such as an internal ETB and an external DSTREAM. In such cases, you might need to provide more information to the client about which trace capture device to use when reading trace data.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.8.6 Decoding STM STPv2 output

The ARM STM CoreSight component generates a STPv2 compatible data stream as its output. The STPv2 specification is a MIPI Alliance specification which is not publicly available. To allow clients to consume STM output, DTSL has a built-in decoder which turns STPv2 into an STM object stream.

To consume STM output, a client should do the following:

- Create an object which implements the `ISTMSourceMatcher` interface. This object tells the decoder which STM master IDs and channel IDs to decode. The STM package includes three implementations of the `ISTMSourceMatcher` interface. These are `STMSourceMatcherRange`, `STMSourceMatcherSet`, and `STMSourceMatcherSingle`. If none of these implementations covers your needs, you can also create a new class which implements the `ISTMSourceMatcher` interface.
- Create an `STMChannelReader` object, specifying the trace capture device object and the source matcher object.
- Create an object which implements the `ISTMObjectReceiver` interface, to receive the STM objects.
- When trace data is available, get hold of an `ISourceReader` object. Pass this, along with the `ISTMObjectReceiver` object, to the `read` method on the `STMChannelReader` object. The `read` method decodes the trace into an STM object stream, and passes these objects to the `ISTMObjectReceiver`.

Related concepts

15.8.4 DTSL trace client read interface on page 15-474.

15.8.7 Example STM reading code

The following is some Java code which shows an example of STM Object reading. This could also be implemented in Jython.

In this case, the `STMTraceReader` object implements the `ISTMObjectReceiver` interface itself. This means that the code can pass the object to the `STMChannelReader` `read` method as the class to receive the `STMObject`s.

The example code creates an `STMSourceMatcherRange` object with a parameter set which matches against all Masters and Channels.

The STPv2 packet protocol outputs a SYNC packet which allows the decoder to synchronize the binary data stream to the start of a packet. When decoding arbitrary data streams, the decoder needs to synchronize to the stream before starting to decode the STPv2 packets. Once the stream is synchronized, there is no need to resynchronize, as long as contiguous data is being decoded.

The decoder has two ways to handle errors in the STPv2 packets stream:

- Throw an `STMDecodeException` or an `STMParseException`. The advantage of this method is that the errors are detected immediately, but the disadvantage is that you cannot continue processing STPv2 packets (there is no way to resume decoding after the last error position).
- Insert an `STMDecodeError` object into the generated `STMObject` set. The advantage of this method is that the full data stream is decoded, but the disadvantage is that the error is not processed by the client until the generated `STMDecodeError` is processed.

```
/**
 * Class to read STM trace data and to get it processed into a
 * text stream.
 */
public class STMTraceReader implements ISTMObjectReceiver {
    /**
     * The trace device - ETB or DSTREAM or .....
     */
    private ITraceCapture traceDevice;
    /**
     * A list of STMObjects that gets generated for us
     */
    private List<STMObject> stmObjects;
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
[snip – other attribute declarations]

    public void decodeSTMTrace() {
        STMSourceMatcherRange stmSourceMatcher = new STMSourceMatcherRange(0, 128, 0, 65535);
        STMChannelReader stmChannelReader = new STMChannelReader(
            "STM Example",
            this.traceDevice,
            stmSourceMatcher);
        ISourceReader reader = this.traceDevice.borrowSourceReader(
            "STM Reader", this.stmStreamID);
        if (reader != null) {
            try {
[snip - code to figure out if trace is contiguous from last read.]
                if (!traceDataIsContiguous) {
                    stmChannelReader.reSync();
                }
[snip - code to figure out how much trace to read and from where. Also assign values to
nextPos[] and readSize.]
                this.stmObjects.clear();
                try {
                    stmChannelReader.read(nextPos[0], readSize, this, nextPos, reader);
                } catch (DTSLException e) {
                    System.out.println("Caught DTSLException during STPv2 decode:");
                    System.out.println(e.getLocalizedMessage());
                    stmChannelReader.reSync();
                }
            }
            catch (DTSLException e) {
                System.out.println("DTSLException:");
                e.printStackTrace();
            }
            finally {
                /* Must return the trace reader to DTSL so that it knows we have finished
reading
                 */
                this.traceDevice.returnSourceReader(reader);
            }
        }
    }

    /* (non-Javadoc)
     * @see
com.arm.debug.dtsl.decoders.stm.stmobjects.ISTMObjectReceiver#write(com.arm.debug.dtsl.decode
rs.stm.stmobjects.STMObject)
     */
    @Override
    public boolean write(STMObject stmObject) {
        this.stmObjects.add(stmObject);
        return true;
    }
```

15.8.8 STM objects

The following figure shows the STM object model. All objects generated by the decoder are derived from *STMObject*. All *STMObject*s can contain a timestamp (*STMTimestamp*) if one was generated, otherwise the timestamp attribute is `null`.

The most common form of object generated is the *STMData* objects, which can hold multiple 4-bit, 8-bit, 16-bit, 32-bit, or 64-bit data payloads. Each data packet can also have a marker attribute, in which case it holds only one data payload.

Not all STM object types can be generated from an ARM STM component. {*STMTime*, *STMXSync*, *STMTrig*, *STMUser*} are not generated in ARM STM output.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

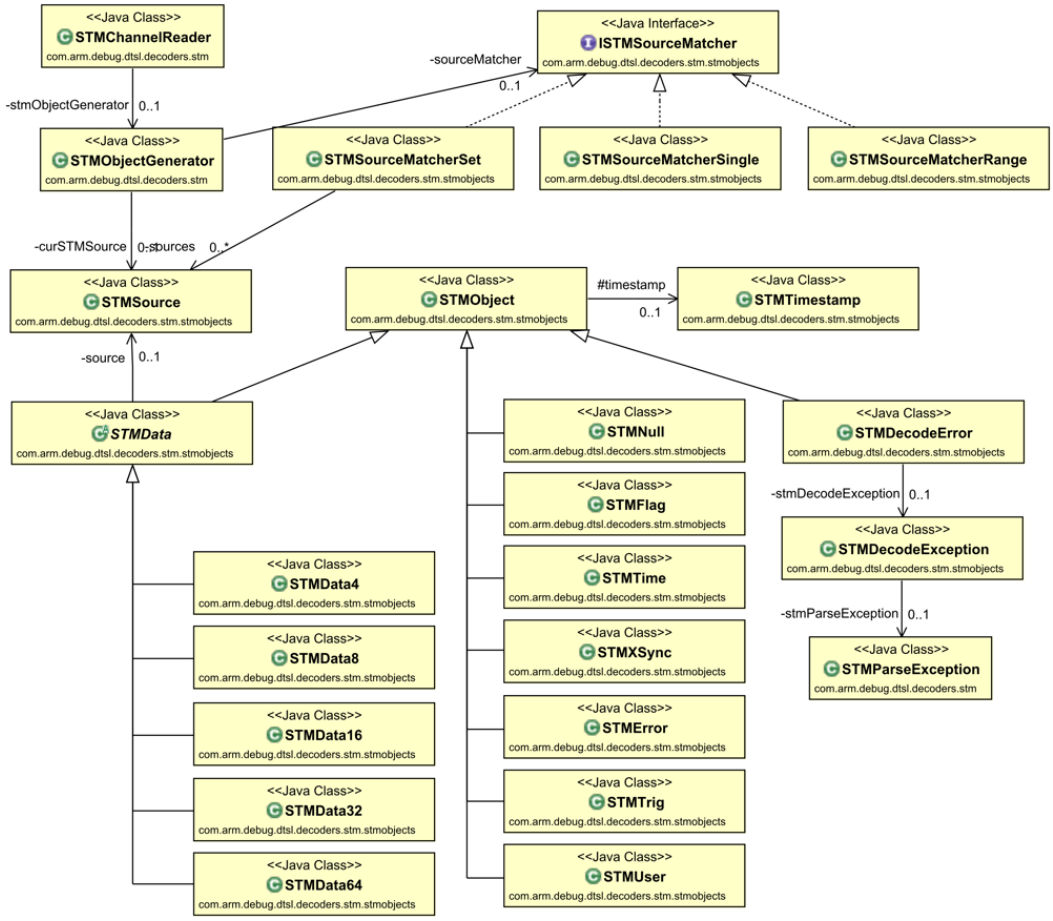


Figure 15-18 STM Object Model

15.8.9 DTSL client time-stamp synchronization support

Some trace sources have the concept of time-stamping certain trace records or events. If all trace sources are using a common, synchronized time system, them it is possible to synchronize all the client trace displays about the same real-time location. To support this, DTSL allows trace clients to request view synchronization at a particular time value. When DTSL receives such a request, it passes it on to all registered trace clients. The trace clients can receive the request and reposition their displays to show data at or around the requested time.

For a client to use the time-stamp synchronization facility, it must register an observer with the DTSL configuration. An observer is an object which implements the *`ITraceSyncObserver`* interface. See `ConfigurationBase.registerTraceSyncObserver` for details of how to register an observer. If, after registering an observer, the trace client requests time-stamp synchronization, then the observer receives an object. This object implements either the *`ITraceSyncEvent`* interface or the *`ITraceSyncDetailedEvent`* interface. The *`ITraceSyncEvent`* interface only allows reading the requested time value. The *`ITraceSyncDetailedEvent`* interface, however, extends this, by identifying the trace capture device and buffer location which contained the time position from the point of view of the requesting client. This might be useful to the receiving client as a hint to where they can start searching for the time value in their own trace stream.

If a client wants to request other clients to synchronize to a time value, it must use one of the `ConfigurationBase.reportTraceSyncEvent` methods.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.9 Extending the DTSL object model

For most platform configurations, the DTSL configuration class creates standard Java DTSL components, such as CoreSight devices or ARM cores, represented as Device objects. Sometimes, the behavior of these standard components needs to be changed, or new DTSL components need to be created.

DS-5 Debugger uses the Java components that the DTSL configuration script creates. Since there is a high level of integration between Java and Jython, the DTSL configuration can create new Jython objects which extend the standard Java DTSL objects. And DS-5 Debugger can also use these Jython objects to access the target platform. This is because of the very tight integration between Java and Jython. This way of modifying behavior is straightforward if you are familiar with object oriented techniques, especially in Java. The only new technique might be the way in which a Java object can by modified by extending it in Jython. This is possible because Jython code is compiled down to Java byte code, so the system does not know whether the code was written in Java or Jython.

This section contains the following subsections:

- *15.9.1 Performing custom actions on connect* on page 15-479.
- *15.9.2 Overriding device reset behavior* on page 15-480.
- *15.9.3 Adding a new trace capture device* on page 15-481.

15.9.1 Performing custom actions on connect

On some platforms, it might be necessary to configure the system to enable access by a debugger. For example, some platforms have a scan chain controller that controls which devices are visible on the JTAG scan chain.

On other platforms, it might be necessary to power up subsystems by writing control registers. The DTSL configuration provides several hooks that can be overridden to perform such actions.

Each DTSL configuration class is derived from a parent class, usually `DTSLv1`. The derived class gets all the methods the parent class implements and can replace the methods of the parent class to modify the behavior. When replacing a method, the original implementation can be called by `DTSLv1.<method_name>()`.

postRDDIConnect

This is called immediately after the RDDI interface has been opened. At this point, the RDDI interface has been opened, but no connection to the debug server has been made. This method should be implemented to perform low-level configuration, for example, using the JTAG interface to configure a TAP controller to make debug devices visible on the JTAG scan chain.

```
class DtslScript(DTSLv1):
    '''A top-level configuration class which supports debug and trace'''

 [snip]

    def postRDDIConnect(self):
        DTSLv1.postRDDIConnect(self)
        self.jtag_config()

    def jtag_config(self):
        jtag = self.getJTAG()
        pVer = zeros(1, 'i')
        jtag.connect(pVer)
        try:
            jtag.setUseRTCLK(0)
            jtag.setJTAGClock(1000000)
            # perform target configuration JTAG scans here
        finally:
            jtag.disconnect()
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

postDebugConnect

This is called after the RDDI debug interface has been opened. At this point, the RDDI debug interface has been opened, but no connection to any device has been made. This method should be implemented to perform any configuration required to access devices. For example, writes using a DAP to power on other components could be performed here.

```
class DtslScript(DTSLv1):
    '''A top-level configuration class which supports debug and trace'''

 [snip]

    def postDebugConnect(self):
        DTSLv1.postDebugConnect(self)
        self.power_config()

    def power_config(self):
        self.ahb.connect()
        # power up cores
        self.ahb.writeMem(0xA0001000, 1)
        self.ahb.disconnect()
```

postConnect

This is called after the connection and all devices in the managed device list have been opened. This method should be implemented to perform any other configuration that isn't required to be done at an earlier stage, for example, trace pin muxing.

```
class DtslScript(DTSLv1):
    '''A top-level configuration class which supports debug and trace'''

 [snip]

    def postConnect(self):
        DTSLv1.postConnect(self)
        self.tpiu_config()

    def tpiu_config(self):
        # select trace pins
        self.ahb.writeMem(0xB0001100, 0xAA)
```

Related concepts

15.5.2 DTSL device objects on page 15-455.

15.9.2 Overriding device reset behavior

For a DSTREAM class device, the default operation for a *System Reset* request is to drive `nSRST` on the JTAG connector. On some platforms, this pin is not present on the JTAG connector. So, some other method must be used to perform the reset.

Sometimes, the reset is performed by writing to another system component, such as a *System Reset Controller* device. If this is not available, another approach is to cause a system watchdog timeout, which in turn causes a system reset. Whichever approach is taken, the default reset behavior must be modified. To override the default reset behavior, the `resetTarget` method can be overridden to perform the necessary actions.

The following code sequence is an example of this:

```
from com.arm.debug.dtsl.components import ConnectableDevice
[snip]

 class DtslScript(DTSLv1):
    '''A top-level configuration class which supports debug and trace'''

  [snip]

     def setupPinMUXForTrace(self):
         '''Sets up the IO Pin MUX to select 4 bit TPIU trace'''
         addrDBGMCU_CR = 0xE0042004
         value = self.readMem(addrDBGMCU_CR)
         value |=  0xE0 # TRACE_MODE=11 (4 bit port), TRACE_IOEN=1
         self.writeMem(addrDBGMCU_CR, value)

     def enableSystemTrace(self):
         '''Sets up the system to enable trace
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
18.             For a Cortex-M3 system we must make sure that the
19.             TRCENA bit (24) in the DEMCR registers is set.
20.             NOTE: This bit is normally set by the DSTREAM Cortex-M3
21.                   template - but we set it ourselves here in case
22.                   no one connects to the Cortex-M3 device.
23.         '''
24.         addrDEMCR = 0xE000EDFC
25.         bitTRCENA = 0x01000000
26.         value = self.readMem(addrDEMCR)
27.         value |= bitTRCENA
28.         self.writeMem(addrDEMCR, value)
29.
30.     def postReset(self):
31.         '''Makes sure the debug configuration is re-instated
32.            following a reset event
33.         '''
34.         if self.getOptionValue("options.traceBuffer.traceCaptureDevice") == "DSTREAM":
35.             self.setupPinMUXForTrace()
36.         self.enableSystemTrace()
37.
38.     def resetTarget(self, resetType, targetDevice):
39.         # perform the reset
40.         DTSLv1.resetTarget(self, resetType, targetDevice)
41.         # perform the post-reset actions
42.         Self.postReset()
```

Line `38` declares the `resetTarget` method. This calls the normal reset method to perform the reset and then calls the custom `postReset` method to perform the actions required after a reset.

The implementation of `resetTarget` in `DTSLv1` is to call the `systemReset` method of the `targetDevice`.

15.9.3 Adding a new trace capture device

DS-5 Debugger has built in support for reading trace data from DSTREAM, ETB, TMC/ETM and TMC/ETR devices. Adding support for a new trace capture device is not very difficult, however, and can be done entirely with DTSL Jython scripts.

The DTSL trace capture objects class hierarchy shows that all DTSL trace capture objects are derived from the *`ConnectableTraceCaptureBase`* class. This base class implements two interfaces, *`ITraceCapture`* and *`IDeviceConnection`*. *`ITraceCapture`* defines all the methods that relate to controlling and reading trace data from a capture device, and *`IDeviceConnection`* defines the methods for a component that needs to be connected to. The *`ConnectableTraceCaptureBase`* class contains stub implementations for all the methods in both interfaces.

To create a new trace capture class:

1. Create a new class derived from the *`ConnectableTraceCaptureBase`* class, or the *`TraceCaptureBase`* class if appropriate.
2. Implement the class constructor, making sure to call the base class constructor in your implementation.
3. Override the *`startTraceCapture()`* and *`stopTraceCapture()`* methods. The default implementations of these methods throw an exception when DTSL calls them, so you must override them to avoid this.
4. Override the *`getCaptureSize()`* method to return the size of raw trace data in the device.
5. Override the *`getSourceData()`* method to return trace data for a specified trace source.
6. If your trace device requires a connection, override the *`connect()`*, *`disconnect()`*, and *`isConnected()`* methods.
7. In your platform DTSL Jython script, create an instance of your new trace capture device class and add it to the DTSL configuration.

The following example Jython code implements a new trace capture device which reads its trace data from an ETB dump file (the raw content of an ETB buffer). It is assumed that this code is in `FileBasedTraceCapture.py`.

```
from java.lang import Math
from com.arm.debug.dtsl.impl import DataSink
from com.arm.debug.dtsl.impl import Deformatter
from com.arm.debug.dtsl.impl import SyncStripper
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
from com.arm.debug.dtsl.components import ConnectableTraceCaptureBase
from com.arm.debug.dtsl.configurations import ConfigurationBase
import sys
import os
import jarray

class FileBasedTraceCaptureDevice(ConnectableTraceCaptureBase):
    '''
    Base class for a trace capture device which just returns
    a fixed data set from a file. The amount of trace data captured
    is just the size of the file.
    '''
    def __init__(self, configuration, name):
        '''Construction
        Params: configuration
                    the top level DTSL configuration (the
                    class you derived from DTSLv1)
                name
                    the name for the trace capture device
        '''
        ConnectableTraceCaptureBase.__init__(self, configuration, name)
        self.filename = None
        self.fileOpened = False
        self.hasStarted = False
        self.trcFile = None

    def setTraceFile(self, filename):
        '''Sets the file to use as the trace data source
        Params: filename
                    the file containing the trace data
        '''
        self.filename = filename

    def connect(self):
        '''We interpret connect() as an opening of the trace data file
        '''
        self.trcFile = file(self.filename, 'rb')
        self.fileOpened = True
        self.fileSize = os.path.getsize(self.filename)

    def disconnect(self):
        '''We interpret disconnect() as a closing of the trace data file
        '''
        if self.trcFile != None:
            self.trcFile.close()
        self.fileOpened = False
        self.fileSize = 0

    def isConnected(self):
        return self.fileOpened

    def startTraceCapture(self):
        self.hasStarted = True

    def stopTraceCapture(self):
        self.hasStarted = False

    def getMaxCaptureSize(self):
        return self.fileSize

    def setMaxCaptureSize(self, size):
        return self.getMaxCaptureSize()

    def getCaptureSize(self):
        return self.fileSize

    def getNewCaptureSize(self):
        return self.getCaptureSize()

    def hasWrapped(self):
        return True

class ETBFileBasedTraceCaptureDevice(FileBasedTraceCaptureDevice):
    '''
    Creates a trace capture device which returns ETB trace
    data from a file.
    '''
    def __init__(self, configuration, name):
        '''Construction
        Params: configuration
                    the top level DTSL configuration (the
                    class you derived from DTSLv1)
                name
                    the name for the trace capture device
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

```
        '''
        FileBasedTraceCaptureDevice.__init__(self, configuration, name)

    def getSourceData(self, streamID, position, size, data, nextPos):
        '''Reads the ETB trace data from the file
        Params: streamID
                    for file formats which contain multiple
                    streams, this identifies the stream for which
                    data should be returned from
                position
                    the byte index position to read from
                size
                    the max size of data (in bytes) we should return
                data
                    where to write the extracted data
                nextPos
                    an array into which we set entry [0] to the
                    next position to read from i.e. the position parameter
                    value which will return data that immediately follows
                    the last entry written into data
        '''
        # We assume that size is small enough to allow to read an entire
        # data block in one operation
        self.trcFile.seek(position)
        rawdata = jarray.array(self.trcFile.read(size), 'b')
        nextPos[0] = position+size
        dest = DataSink(0, 0, size, data)
        # We assume the file contains TPIU frames with sync sequences
        # Se we set up a processing chain as follows:
        # file data -> strip syncs -> de formatter -> to our caller
        deformatter = Deformatter(dest, streamID)
        syncStripper = SyncStripper(deformatter)
        syncStripper.forceSync(True)
        syncStripper.push(rawdata)
        syncStripper.flush()
        return dest.size()
```

We can use the new trace capture device in the platform DTSL Jython code:

```
from FileBasedTraceCapture import ETBFileBasedTraceCaptureDevice
[snip]
        self.etbFileCaptureDevice = ETBFileBasedTraceCaptureDevice(self, 'ETB(FILE)')
        self.etbFileCaptureDevice.setTraceFile('c:\\etbdump.bin')
        self.addTraceCaptureInterface(self.etbFileCaptureDevice)
```

We can add it to the configuration as though it were an ETB or DSTREAM device.

Related concepts

15.5.5 DTSL trace capture objects on page 15-458.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.10 Debugging DTSL Jython code within DS-5 Debugger

When DS-5 connects to a platform, it automatically loads the platform Jython script and creates an instance of the configuration class. The Jython scripts which are shipped with DS-5 should not contain any errors, but if you create your own scripts, or make modifications to the installed scripts, then you might introduce errors. These errors have two common forms:

- Syntax or import errors
- Functional errors.

This section contains the following subsections:

- *15.10.1 DTSL Jython syntax errors* on page 15-484.
- *15.10.2 Errors reported by the launcher panel* on page 15-484.
- *15.10.3 Errors reported at connection time* on page 15-485.
- *15.10.4 DTSL Jython functional errors* on page 15-485.
- *15.10.5 Walk-through of a DTSL debug session* on page 15-485.
- *15.10.6 Starting a second instance of DS-5 for Jython debug* on page 15-486.
- *15.10.7 Preparing the DTSL script for debug* on page 15-486.
- *15.10.8 Debugging the DTSL code* on page 15-487.

15.10.1 DTSL Jython syntax errors

These can occur in two situations:

1. Attempting to change the DTSL options from within the Launcher Panel.
2. Attempting to connect the DS-5 Debugger to the platform.

15.10.2 Errors reported by the launcher panel

These errors usually appear in the area where the **Edit...** button for the DTSL options would normally appear, replacing it with a message:

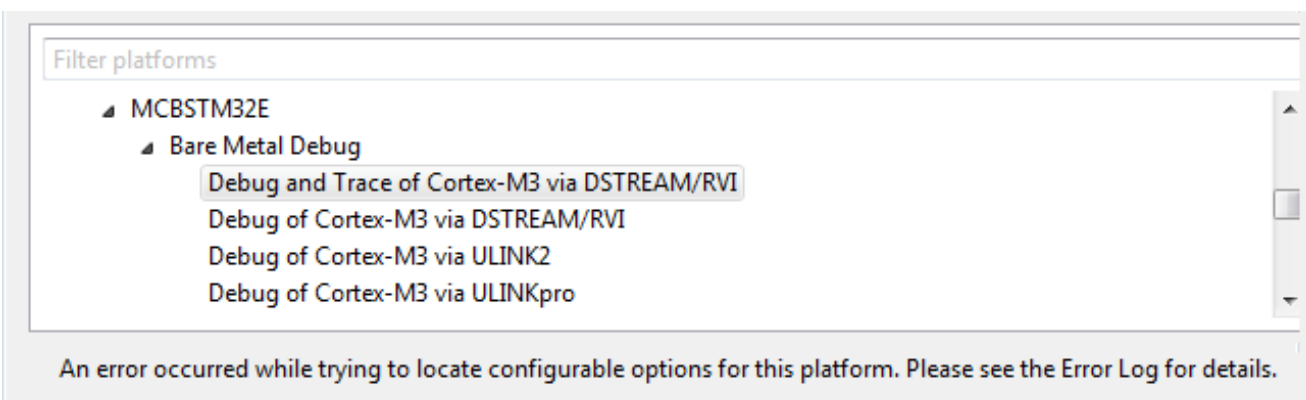


Figure 15-19 Launcher panel reporting DTSL Jython script error

To find the cause of the error, try inspecting the Error Log. If the Error Log is not visible, select **Window** > **Show View** > **Error Log** to show it.

The following is an example of some Error Log text:

```
Python error in script \\NAS1\DTSL\configdb\Boards\Keil\MCBSTM32E\keil-mcbstm32e.py at line
11: ImportError: cannot import name V7M_ETMTraceSource when creating configuration
DSTREAMDebugAndTrace
```


Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

After resolving any issues, close and reopen the Launcher Panel to make DS-5 reinspect the Jython script. If an error still occurs, you get more entries in the Error Log. If the error is resolved, then the **Edit...** button for the DTSL options will appear as normal.

15.10.3 Errors reported at connection time

If you try to connect to a platform which contains an error in its Jython script, DS-5 displays an error dialog indicating the cause of the error:

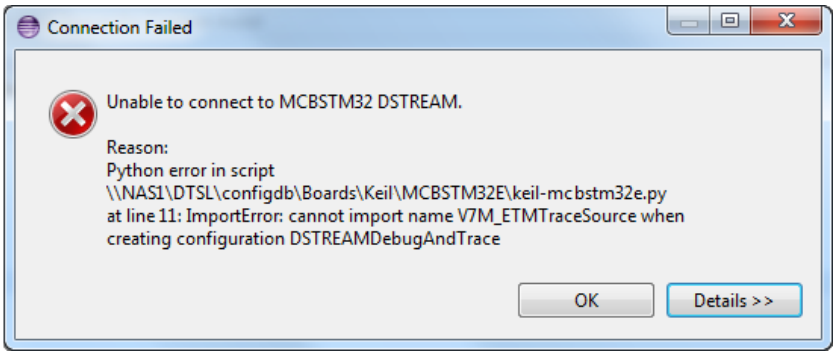


Figure 15-20 Connection Error Dialog

Note

Sometimes, the error message shown in the dialog might not be helpful, especially for run-time errors rather than syntax or import errors. DS-5 also places an entry in the Error Log, so that you can inspect the error after dismissing the error dialog. This error log entry might contain more information. You can typically find this information by scrolling down the Exception Stack Trace until you see the error reported at the point the Jython code was run.

After editing the Jython script to resolve any issues, try connecting again.

Note

You do not need to tell DS-5 that the configdb has changed when you make changes only to Jython scripts.

15.10.4 DTSL Jython functional errors

If the Jython script error you are tracking down cannot be resolved by code inspection, then you might need to use a Jython debugger. For some use cases, you can use the debugger which is built in to DS-5 as part of PyDev. Other use cases, however, display modal dialog boxes within DS-5, preventing the use of the same instance of DS-5 to debug the scripts. ARM therefore recommends that you use another instance of DS-5, or another Eclipse installation which also contains the PyDev plugin or plugins.

Note

Although you can run multiple instances of Eclipse at the same time, the instances cannot use the same Workspace.

15.10.5 Walk-through of a DTSL debug session

Make sure that DS-5 is using your intended workspace.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

The debug session involves modifying a DTSL Jython script, so make sure that you are using a writeable copy of the DS-5 configdb.

Related concepts

15.3.1 Modifying DS-5 configdb on page 15-446.

15.10.6 Starting a second instance of DS-5 for Jython debug

When you start a second instance of DS-5, with the first instance still running, you are asked to use a different workspace. Choose a suitable location for this second workspace.

In this second instance of DS-5, switch to the PyDev perspective. To enable the toolbar buttons that allow you to start and stop the PyDev debug server:

- Select **Window** > **Customize Perspective...**.
- Click the **Command Groups Availability** tab.
- Scroll down through the Available Command Groups and select the PyDev Debug entry.
- Click the **Tool Bar Visibility** tab.
- Make sure that the PyDev Debug entry, and the two End Debug Server and Start Debug Server entries, are selected.

On the toolbar, you should see two new icons to stop and start the debug server.

Click the green P-bug icon to start the PyDev debug server. You should see a console view reporting the port number on which the debugger is listening (5678 by default). The DS-5 instance is ready to accept remote debug connections.

Switch to the Debug perspective. Eclipse does not automatically switch to the Debug perspective when a connection is made to the PyDev debugger. So if you do not switch to the Debug perspective yourself, then you cannot notice the connection.

15.10.7 Preparing the DTSL script for debug

When a Jython script is being debugged, it is normally launched by PyDev, and PyDev can optionally create a debug session for the script. When DS-5 launches the Jython script, however, this does not happen. This is not a problem, however, because the script itself can register with the PyDev debugger after it is launched. To do this in your script:

- Extend the import list for the script to import pydevd. If you are using a second DS-5 instance to host the PyDev debugger, then add the following to the top of the DTSL script:

  ```
  import pydevd
  ```

  If you are using another Eclipse (non-DS-5) to host the PyDev debugger, then import the pydevd from that Eclipse instance. Locate the pydev plugin `pysrc` directory and add its path to the import path before importing pydevd. For example, if the Eclipse is installed in `C:\Users\john\eclipse`, then the code would be as follows:

  ```
  import sys;
  sys.path.append(r'C:\Users\john\eclipse\plugins\org.python.pydev_2.7.4.2013051601\pysrc')
  import pydevd
  ```

  where `pydev_xyz` depends on the version of pydev installed within Eclipse.
- Insert the following line at the location where you want the PyDev debugger to gain control of the script:

  ```
  pydevd.settrace(stdoutToServer=True, stderrToServer=True)
  ```

  This causes a break into the debugger at that location, and redirects all standard output from the script to the debugger console. This allows you to place print statements into the script and see them in the

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

debugger, whereas normally DS-5 would discard any such print output. Good places to insert this statement are:

— In the constructor (*__init__*) for the DTSL configuration class.
— In the *optionValuesChanged* method.

The function documentation for the *settrace* call in pydev 2.7.4 is as follows:

```
def settrace(host=None, stdoutToServer=False, stderrToServer=False, port=5678, suspend=True,
trace_only_current_thread=True):
    '''Sets the tracing function with the pydev debug function and initializes needed
facilities.
    @param host: the user may specify another host, if the debug server is not in the
        same machine (default is the local host)
    @param stdoutToServer: when this is true, the stdout is passed to the debug server
    @param stderrToServer: when this is true, the stderr is passed to the debug server
        so that they are printed in its console and not in this process console.
    @param port: specifies which port to use for communicating with the server (note that
        the server must be started in the same port).
        @note: currently it's hard-coded at 5678 in the client
    @param suspend: whether a breakpoint should be emulated as soon as this function
        is called.
    @param trace_only_current_thread: determines if only the current thread will be
        traced or all future threads will also have the tracing enabled.
    '''
```

15.10.8 Debugging the DTSL code

In your main instance of DS-5 (not the PyDev debug instance), launch the connection to the platform. When the DTSL script reaches the *settrace* call, the second DS-5 instance halts the execution of the script immediately after the call. This allows you to use the PyDev debugger for tasks such as stepping through the code, examining variables, and setting breakpoints. While you are debugging, your main DS-5 instance waits for the Jython script to complete.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.11 DTSL in stand-alone mode

DTSL is commonly used by DS-5 Debugger, both within the Eclipse environment and in the console version of the debugger. However, it can also be used in 'stand-alone' mode, completely outside of Eclipse. This allows you to use the DTSL API to take care of the target connection and configuration when writing your program. The rest of your program can concentrate on the main function of your application.

DTSL is mainly written in Java and Jython. There are therefore two kinds of stand-alone program, those written in Jython and those in Java. The `DTSLExamples.zip` file contains examples of both kinds of program, which you can look at to help you decide the best route for your application. The programs are easy to compare because they both do essentially the same things.

This section contains the following subsections:

- *15.11.1 Comparing Java with Jython for DTSL development* on page 15-488.
- *15.11.2 DTSL as used by a stand-alone Jython program* on page 15-489.
- *15.11.3 Installing the Jython example within Eclipse* on page 15-489.
- *15.11.4 Running the Jython program* on page 15-490.
- *15.11.5 Invoking the Jython program* on page 15-490.
- *15.11.6 About the Jython program* on page 15-490.
- *15.11.7 DTSL as used by a stand-alone Java program* on page 15-491.
- *15.11.8 Installing the Java example within Eclipse* on page 15-491.
- *15.11.9 Running the Java program* on page 15-492.
- *15.11.10 Invoking the Java program* on page 15-493.
- *15.11.11 About the Java program* on page 15-493.

15.11.1 Comparing Java with Jython for DTSL development

The advantages of Java are:

- The Javadoc for DTSL is directly available, which helps greatly when writing DTSL Java programs in environments such as Eclipse.
- Java programs seem to have faster start-up times than Jython programs.
- The Eclipse Java development environment might be considered more mature than the Python PyDev Eclipse development environment.

The advantages of Jython are:

- There are probably more people familiar with Python than with Java.
- Python is not a statically-typed language. So it is easier to write Python code without always having to create variables of specific types.

The disadvantages of Jython are:

- There is no DTSL Javadoc support, because the PyDev editor does not understand how to extract the Javadoc information from the Java `.jar` files.
- Python is not a statically-typed language, so it is hard for the PyDev editor to know the type of a variable. Using '`assert isinstance(<variable>,<type>)`' works around this to an extent, and this code appears many times in the example. After the PyDev editor sees it, it knows the type of the variable and so can provide code completion facilities. However, you still do not get access to the Javadoc within the editor. If you want to access the Javadoc, you must do it by some other method, such as through a web browser.
- Jython can be slower than Java. For example, if Jython is used as part of a trace decoding pipeline, it can significantly slow down trace processing.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.11.2 DTSL as used by a stand-alone Jython program

The example Jython application demonstrates how to do the following:

- Create a DTSL configuration instance for the requested platform.
- Connect to a core device, such as a Cortex-M3 or other such ARM core.
- Perform the following operations:
  - Get control of the core following a reset.
  - Read and write registers on the core.
  - Read and write memory through the core.
  - Single step instructions on the core.
  - Start and stop core execution.

The example application connects to and controls the ARM core only. However, it can just as easily connect to any of the devices in the configuration, such as CoreSight components (PTM or ETB), and configure and control those devices as well.

Note

The example is a complete stand-alone application. It cannot be run when a DS-5 Debugger connection is made to the same target. However, a DS-5 Debugger Jython script can access the DTSL configuration. If you do this, take care not to interfere with the debugger.

15.11.3 Installing the Jython example within Eclipse

Make sure you have Jython installed. To download Jython, and for installation instructions, go to http://www.jython.org/. This document is written with reference to Jython 2.5.3, but later versions should also work.

Make sure you have the PyDev plugin installed into your Eclipse IDE. To download PyDev, and for installation instructions, go to http://pydev.org/. Make sure you configure PyDev to know about the Jython version you have installed.

The example project DTSLPythonExample is in the `DTSLExamples.zip` file. You can import `DTSLPythonExample` directly into your Eclipse workspace. You must also import `DTSL.zip` into your Eclipse workspace. After importing them, change the project configuration to refer to your DTSL library location:

1. Select the DTSLPythonExample within the Eclipse Project Explorer, right click it, and select **Properties**.
2. Select 'PyDev – PYTHONPATH' from the properties list.
3. Click the **String Substitution Variables** tab.
4. Replace the DTSL variable value with the path to your DTSL library location.

The example project also contains two launch configurations for running the program. One configuration uses the DS-5 configdb board specification, and the other refers directly to the files in the configdb. The project contains a configdb extension, which contains the Keil MCBSTM32 entries compatible with this project.

Note

If you use your own Eclipse (non DS-5) installation, then you must set the DS-5 installation location within the DS-5 preferences. This value is used within the provided launch configurations.

The `readme.txt` file contained within the project has more information.

Related references

15.1 Additional DTSL documentation and files on page 15-440.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.11.4 Running the Jython program

To run the example in Eclipse:

1. Import the supplied launch configurations.
2. Modify the program arguments to refer to your installed DS-5 location.
3. Run or debug the application.

To run the example use:

- `dtslexample.bat` from Windows
- `dtslexample` from Linux.

Before running the file, edit it and change the program parameters to suit the target system you are connecting to. You might need to make the following changes:

- Change the location of `jython.bat` to match your Jython installation. DS-5 does contain part of a Jython installation, but it lacks the main `jython.bat` executable, so you must install your own.
- Change the defined location of the Eclipse workspace.
- Change the location of the DS-5 configuration database to include the database installed by DS-5 and any further extensions you require (the location within a workspace of `DTSLExampleConfigdb \configdb` is an extension required to run the example).
- Change the connection address for the DSTREAM box to match your box. If you are using a USB connection then the code `--connectionAddress "USB"` can be left unchanged, but if you are using a TCP connection then you must change it to be of the form `--connectionAddress "TCP:<host-name|ip-address>"`, for example `--connectionAddress "TCP:DS-Tony"` or `--connectionAddress "TCP:192.168.1.32"`.
- Change the manufacturer to match the directory name of your platform in the `Boards` sub-directory of the DS-5 config database.
- Change the board name to match the name of the board directory within the manufacturer directory.
- Change the debug operation to match one of the activity names contained in a bare metal debug section of the `project_types.xml` file. For example:

```
<activity id="ICE_DEBUG" type="Debug">

<name language="en">Debug Cortex-M3</name>
```

When you run the `dtslexample.py` script, it connects to the target and runs through a series of register, memory, and execution operations. By default, the script assumes that there is RAM at `0x20000000`, and that there is 64KB of it. This is correct for the Keil MCBSTM32 board. To change these values, use the `--ramStart` and `--ramSize` options.

15.11.5 Invoking the Jython program

For information on the full set of program arguments, run the program with the `--help` parameter.

There are two ways to invoke the program:

- Specify the DTSL connection properties directly, using the {`--rddiConfigFile`, `--dtslScript`, `--dtslClass`, `--connectionType`, `--connectionAddress`, `--device`} parameters.
- Specify the DS-5 configdb parameters (equivalent to using the Eclipse launcher) using the {`--configdb`, `--manufacturer`, `--board`, `--debugOperation`, `--connectionType`, `--connectionAddress`} parameters, and let the program extract the DTSL connection properties from the DS-5 configdb.

15.11.6 About the Jython program

- The main program is in the `dtslexample.py` source file.
- The project is set up to use the DTSL libraries from the DTSL Eclipse project.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

- The DTSL interaction flow is as follows:
  1. Connecting to DTSL. This involves forming the *`ConnectionParameters`* set and passing it to the DTSL static `ConnectionManager.openConnection()` method. See the Python method *`connectToDTSL()`* for details.
  2. Accessing the DTSL connection configuration and locating the DTSL object with the name requested in either:
     — the `--device` parameter
     — the core specified in the DS-5 configdb platform debug operation.
  3. Connecting to the core located in step 2.
  4. Performing the operations on the core, which is represented by a DTSL object that implements the *`IDevice`* interface. The DTSL Javadoc lists the full set of operations available on such an object. The example uses some of the more common operations, but does not cover all of them.
  5. Disconnecting from the core.
  6. Disconnecting from DTSL.
- The *`IDevice`* interface is a Java interface, so there are some operations which take Java parameters such as *`StringBuilder`* objects. This is not a problem for Jython because you can create such Java objects within your Jython program. Most of the memory operations use Java `byte[]` arrays to transport the data. Interfacing these between Jython and Java is relatively simple, but be sure to inspect the example code carefully if you want to understand how to do this.
- The *`IDevice`* Java interface wraps the RDDI-DEBUG C interface thinly, which means that many of the RDDI constants are used directly rather than being wrapped. This is why the example uses constants such as `RDDI_ACC_SIZE.RDDI_ACC_DEF`.

15.11.7 DTSL as used by a stand-alone Java program

The example Java application shows you how to do the following:

- Create a DTSL configuration instance for the requested platform.
- Connect to a core device, such as a Cortex-M3 or other such ARM core.
- Perform the following operations:
  — Get control of the core following a reset.
  — Read and write registers on the core.
  — Read and write memory through the core.
  — Single step instructions on the core.
  — Start and stop core execution.

The example application connects to and controls the ARM core only. However, it can just as easily connect to any of the devices in the configuration, such as CoreSight components (PTM or ETB), and configure and control those devices as well.

Note

The example is a complete stand-alone application. It cannot be run when a DS-5 Debugger connection is made to the same target. However, a DS-5 Debugger Jython script can access the DTSL configuration. If you do this, take care not to interfere with the debugger.

15.11.8 Installing the Java example within Eclipse

The example project DTSLJavaExample is in the `DTSLExamples.zip` file. You can import `DTSLJavaExample` directly into your Eclipse workspace. You must also import `DTSL.zip` into your Eclipse workspace. After importing it, change the project configuration to refer to your DTSL library location:

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

1. Select the DTSLJavaExample within the Eclipse Project Explorer, right click it, and select **Properties**.
2. Select 'Java Build Path' from the properties list.
3. Click the **Libraries** tab.
4. Replace all the referenced `DTSL\libs .jar` files with new entries which have the correct paths.

The example project also contains two launch configurations for running the program. One configuration uses the DS-5 configdb board specification, and the other refers directly to the files in the configdb. The project contains a configdb extension, which contains the Keil MCBSTM32 entries compatible with this project.

Note

If you use your own Eclipse (non DS-5) installation, then you must set the DS-5 installation location within the DS-5 preferences. This value is used within the provided launch configurations.

The `readme.txt` file contained within the project has more information.

Related references

15.1 Additional DTSL documentation and files on page 15-440.

15.11.9 Running the Java program

To run the example in Eclipse:

1. Import the supplied launch configurations.
2. Modify the program arguments to refer to your installed DS-5 location.
3. Run or debug the application.

To run the example use:

- `dtslexample.bat` from Windows
- `dtslexample` from Linux.

Before running the batch file, edit it and change the program parameters to suit the target system you are connecting to. You might need to make the following changes:

- Change the defined location of the Eclipse workspace.
- Change the location of the DS-5 configuration database to include the database installed by DS-5.
- Change the connection address for the DSTREAM box to match your box. If you are using a USB connection then the code `--connectionAddress "USB"` can be left unchanged, but if you are using a TCP connection then you must change it to be of the form `--connectionAddress "TCP:<host-name|ip-address>"`, for example `--connectionAddress "TCP:DS-Tony"` or `--connectionAddress "TCP:192.168.1.32"`.
- Change the manufacturer to match the directory name of your platform in the `Boards` sub-directory of the DS-5 config database.
- Change the board name to match the name of the board directory within the manufacturer directory.
- Change the debug operation to match one of the activity names contained in a bare metal debug section of the `project_types.xml` file. For example:

```
<activity id="ICE_DEBUG" type="Debug">

<name language="en">Debug Cortex-M3</name>
```

When you run the `DTSLExample.java` program, it connects to the target and runs through a series of register, memory, and execution operations. By default, the program assumes that there is RAM at `0x20000000`, and that there is 64KB of it. This is correct for the Keil MCBSTM32 board. To change these values, use the `--ramStart` and `--ramSize` options.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

15.11.10 Invoking the Java program

For information on the full set of program arguments, run the program with the `--help` parameter.

There are two ways to invoke the program:

- Specify the DTSL connection properties directly, using the {`--rddiConfigFile`, `--dtslScript`, `--dtslClass`, `--connectionType`, `--connectionAddress`, `--device`} parameters.
- Specify the DS-5 configdb parameters (equivalent to using the Eclipse launcher) using the {`--configdb`, `--manufacturer`, `--board`, `--debugOperation`, `--connectionType`, `--connectionAddress`} parameters, and let the program extract the DTSL connection properties from the DS-5 configdb.

15.11.11 About the Java program

- The main program is in the `DTSLExample.java` source file.
- The project is set up to use the DTSL libraries from the DTSL Eclipse project.
- The DTSL interaction flow is as follows:
  1. Connecting to DTSL. This involves forming the *`ConnectionParameters`* set and passing it to the DTSL static `ConnectionManager.openConnection()` method. See the *`connectToDTSL()`* method for details.
  2. Accessing the DTSL connection configuration and locating the DTSL object with the name requested in either:
     — the `--device` parameter
     — the core specified in the DS-5 configdb platform debug operation.
  3. Connecting to the core located in step 2.
  4. Performing the operations on the core, which is represented by a DTSL object that implements the *`IDevice`* interface. The DTSL Javadoc lists the full set of operations available on such an object. The example uses some of the more common operations, but does not cover all of them.
  5. Disconnecting from the core.
  6. Disconnecting from DTSL.
- The *`IDevice`* Java interface (used for all target devices) wraps the RDDI-DEBUG C interface thinly, which means that many of the RDDI constants are used directly rather than being wrapped. That is why the example uses constants such as `RDDI_ACC_SIZE.RDDI_ACC_DEF`.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Chapter 16
Reference

Lists other information that might be useful when working with DS-5 Debugger.

It contains the following sections:

- *16.1 Standards compliance in DS-5 Debugger* on page 16-495.
- *16.2 DS-5 Debug perspective keyboard shortcuts* on page 16-496.
- *16.3 About loading an image on to the target* on page 16-497.
- *16.4 About loading debug information into the debugger* on page 16-499.
- *16.5 About passing arguments to main()* on page 16-501.
- *16.6 Running an image* on page 16-502.
- *16.7 Updating multiple debug hardware units* on page 16-503.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

16.1 Standards compliance in DS-5 Debugger

DS-5 Debugger conforms to various formats and protocols.

Executable and Linkable Format (ELF)
The debugger can read executable images in ELF format.

DWARF
The debugger can read debug information from ELF images in the DWARF 2, DWARF 3, and DWARF 4 formats.

Note

The DWARF 2 and DWARF 3 standards are ambiguous in some areas such as debug frame data. This means that there is no guarantee that the debugger can consume the DWARF produced by all third-party tools.

Trace Protocols
The debugger can interpret trace that complies with the Embedded Trace Macrocell (ETM) (v3 and above), Instrumentation Trace Macrocell (ITM), and System Trace Macrocell (STM) protocols.

Related information

ELF for the ARM Architecture.
DWARF for the ARM Architecture.
The DWARF Debugging Standard.
International Organization for Standardization.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

16.2 DS-5 Debug perspective keyboard shortcuts

You can use various keyboard shortcuts in the DS-5 Debug perspective.

You can access the dynamic help in any view or dialog box by using the following:

- On Windows, use the **F1** key
- On Linux, use the **Shift+F1** key combination.

The following keyboard shortcuts are available when you connect to a target:

Commands view

You can use:

Ctrl+Space
Access the content assist for autocompletion of commands.

Enter
Execute the command that is entered in the adjacent field.

DOWN arrow
Navigate down through the command history.

UP arrow
Navigate up through the command history.

Debug Control view

You can use:

F5
Step at source level including stepping into all function calls where there is debug information.

ALT+F5
Step at instruction level including stepping into all function calls where there is debug information.

F6
Step at source or instruction level but stepping over all function calls.

F7
Continue running to the next instruction after the selected stack frame finishes.

F8
Continue running the target.

Note

A **Connect only** connection might require setting the PC register to the start of the image before running it.

F9
Interrupt the target and stop the current application if it is running.

Related tasks

2.2 Launching DS-5 and connecting to DS-5 Debugger on page 2-36.

Related references

11.6 Commands view on page 11-275.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

16.3 About loading an image on to the target

Before you can start debugging your application image, you must load the files on to the target. The files on your target must be the same as those on your local host workstation. The code layout must be identical, but the files on your target do not require debug information.

You can manually load the files on to the target or you can configure a debugger connection to automatically do this after a connection is established. Some target connections do not support load operations and the relevant menu options are therefore disabled.

After connecting to the target you can also use the **Debug Control** view menu entry **Load...** to load files as required. The following options for loading an image are available:

Load Image Only
Loads the application image on to the target.

Load Image and Debug Info
Loads the application image on to the target, and loads the debug information from the same image into the debugger.

Load Offset
Specifies a decimal or hexadecimal offset that is added to all addresses within the image. A hexadecimal offset must be prefixed with `0x`.

Set PC to entry point
Sets the PC to the entry point when loading image or debug information so that the code runs from the beginning.

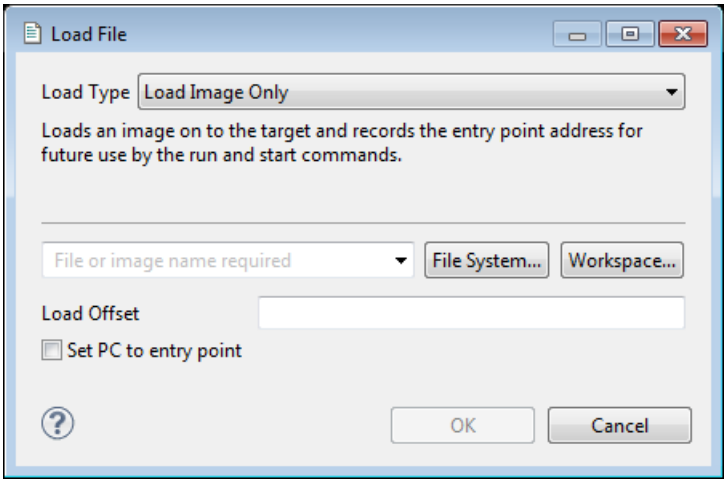


Figure 16-1 Load File dialog box

Related concepts

16.4 About loading debug information into the debugger on page 16-499.

Related tasks

2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.
2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.
2.6 Configuring a connection to a Linux kernel on page 2-48.
2.3 Configuring a connection to a bare-metal hardware target on page 2-38.
2.9 Configuring an Events view connection to a bare-metal target on page 2-63.

Related references

11.6 Commands view on page 11-275.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

16.4 About loading debug information into the debugger

An executable image contains symbolic references, such as function and variable names, in addition to the application code and data. These symbolic references are generally referred to as debug information. Without this information, the debugger is unable to debug at the source level.

To debug an application at source level, the image file and shared object files must be compiled with debug information, and a suitable level of optimization. For example, when compiling with either the ARM or the GNU compiler you can use the following options:

```
-g -O0
```

Debug information is not loaded when an image is loaded to a target, but is a separate action. A typical load sequence is:

1. Load the main application image.
2. Load any shared objects.
3. Load the symbols for the main application image.
4. Load the symbols for shared objects.

Loading debug information increases memory use and can take a long time. To minimize these costs, the debugger loads debug information incrementally as it is needed. This is called on-demand loading. Certain operations, such as listing all the symbols in an image, load additional data into the debugger and therefore incur a small delay. Loading of debug information can occur at any time, on-demand, so you must ensure that your images remain accessible to the debugger and do not change during your debug session.

Images and shared objects might be preloaded onto the target, such as an image in a ROM device or an OS-aware target. The corresponding image file and any shared object files must contain debug information, and be accessible from your local host workstation. You can then configure a connection to the target loading only the debug information from these files. Use the **Load symbols from file** option on the debug configuration **Files** tab as appropriate for the target environment.

After connecting to the target you can also use the view menu entry **Load...** in the **Debug Control** view to load files as required. The following options for loading debug information are available:

Add Symbols File
: Loads additional debug information into the debugger.

Load Debug Info
: Loads debug information into the debugger.

Load Image and Debug Info
: Loads the application image on to the target, and loads the debug information from the same image into the debugger.

Load Offset
: Specifies a decimal or hexadecimal offset that is added to all addresses within the image. A hexadecimal offset must be prefixed with `0x`.

Set PC to entry point
: Sets the PC to the entry point when loading image or debug information so that the code runs from the beginning.

Note

The option is not available for the **Add Symbols File** option.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

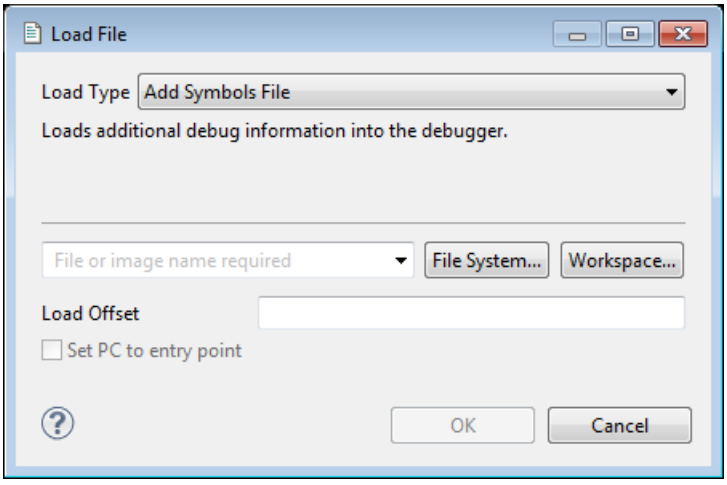


Figure 16-2 Load additional debug information dialog box

The debug information in an image or shared object also contains the path of the sources used to build it. When execution stops at an address in the image or shared object, the debugger attempts to open the corresponding source file. If this path is not present or the required source file is not found, then you must inform the debugger where the source file is located. You do this by *setting up a substitution rule* on page 3-99 to associate the path obtained from the image with the path to the required source file that is accessible from your local host workstation.

Related concepts

16.3 About loading an image on to the target on page 16-497.

Related tasks

2.7.2 Configuring a connection to a built-in Fixed Virtual Platform (FVP) model for Linux application debug on page 2-53.

2.5 Configuring a connection to a Linux application using gdbserver on page 2-46.

2.6 Configuring a connection to a Linux kernel on page 2-48.

2.3 Configuring a connection to a bare-metal hardware target on page 2-38.

2.9 Configuring an Events view connection to a bare-metal target on page 2-63.

Related references

11.6 Commands view on page 11-275.

3.19 Configuring the debugger path substitution rules on page 3-99.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

16.5 About passing arguments to main()

ARM DS-5 Debugger enables you to pass arguments to the `main()` function of your application.

You can use one of the following methods:

- Using the **Arguments** tab in the **Debug Configuration** dialog box.
- On the command-line (or in a script), you can use either:
  - `set semihosting args <arguments>`
  - `run <arguments>`.

Note

Semihosting must be active for these to work with bare-metal images.

Related references

3.17 Using semihosting to access resources on the host computer on page 3-95.
3.18 Working with semihosting on page 3-97.
11.44 Debug Configurations - Arguments tab on page 11-368.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

16.6 Running an image

This describes how to run an application image on a target.

Use the Debug Configurations dialog box to set up a connection and define the run control options that you want the debugger to do after connection. To do this select **Debug Configurations...** from the **Run** menu.

After connection, you can control the debug session by using the toolbar icons in the **Debug Control** view.

Prerequisites

Before you can run an image it must be loaded onto the target. An image can either be preloaded on a target or loaded onto the target as part of the debug session.

Note

The files that resides on the target do not have to contain debug information, however, to be able to debug them you must have the corresponding files with debug information on your local host workstation.

Related references

11.6 Commands view on page 11-275.
11.40 Debug Configurations - Connection tab on page 11-358.
11.41 Debug Configurations - Files tab on page 11-361.
11.42 Debug Configurations - Debugger tab on page 11-364.
11.44 Debug Configurations - Arguments tab on page 11-368.
11.45 Debug Configurations - Environment tab on page 11-370.

Related information

DS-5 Debugger commands.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential

16.7 Updating multiple debug hardware units

To update multiple debug hardware units, use the `dbghw_batchupdater` command line utility.

The command line utility, `dbghw_batchupdater`, enables you to:

- Install firmware on a group of DSTREAM or RVI units.
- View the firmware versions on a group of DSTREAM or RVI units.

The input to `dbghw_batchupdater` is a file containing a list of DSTREAM or RVI units. Each line in the input file is a string that specifies a single DSTREAM or RVI connection. Firmware images are available within a subdirectory of the DS-5 installation.

Syntax

`dbghw_batchupdater -list` *`file`* `[-`*`option`*`]...`

Where:

`list` *`file`* Specifies the file containing a list of DSTREAM or RVI connection strings.

`option`:

`log` *`file`*
: Specifies an output file to log the status of the update.

`updatefile` *`file`*
: Specifies a file containing the path to the firmware.

`i`
: Installs the firmware on the units. To install the firmware, you must also specify the `updatefile` option.

`v`
: Lists the firmware versions.

`h`
: Displays help information. This is the default if no arguments are specified.

Example 16-1 Examples

```
# Input file C:\input_file.txt contains:
# TCP:ds-sheep1
# TCP:DS-Rhubarb
```

```
# List firmware versions.
dbghw_batchupdater -list "C:\input_file.txt" -v
Versions queried on 2014-06-10 10:42:36
TCP:ds-sheep1: 4.18.0 Engineer build 3
TCP:DS-Rhubarb: 4.17.0 build 27
```

```
# Install firmware on DSTREAMs
dbghw_batchupdater.exe –list “C:\input_file.txt” -i –updatefile “C:\Program Files\DS-5\sw
\debughw\firmware\ARM-RVI-4.17.0-27-base.dstream” –log out.log
```

Related references

11.54 Debug Hardware Configure IP view on page 11-382.
11.55 Debug Hardware Firmware Installer view on page 11-384.

Copyright © 2010-2016 ARM Limited or its affiliates. All rights reserved.
Non-Confidential