

ARM Lab

Development Environment Setup and First Program

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What is this slide deck about?

- Development Environment Setup
 - ARM DS-5, Eclipse-based IDE
 - Linaro gcc, bare-metal toolchain
- First assembly program
 - Create a project
 - Write the code
 - Build
 - Run/debug

Development Environment Setup

Development Environment

- **ARM DS-5 (Development Studio)**
 - Eclipse-based IDE
 - ARM emulator (Fast Models)
 - Other advanced tools
- **Linaro gcc toolchain**
 - Compiler, Assembler, Linker, Debugger
 - Other tools
- Supported platforms
 - Linux
 - Windows
 - **Apple users need to setup a Linux or Windows VM**

ARM DS-5 (first step)

- How to Setup?
1. First **Complete** DS-5 Community Edition Registration
 - <https://developer.arm.com/tools-and-software/embedded/legacy-tools/ds-5-development-studio/editions/community-edition>
 2. Then you will **receive** an email with the download link
 1. Download DS-5
 2. Install DS-5
 - The following slides guide you through the process



DS-5 Community Edition

Development Studio 5 Community Edition

The Arm Development Studio 5 (DS-5) Community Edition is a free professional quality tool chain developed by Arm to accelerate your first steps in Arm software development. Based on [DS-5 Ultimate Edition](#), this toolkit offers essential debug and system analysis for you to create robust and highly optimized software for Arm processor-based devices.

[Feedback](#)

Arm DS-5 Community Edition includes:

- DS-5 Debugger for Linux native language applications.
- DS-5 Debugger for bare-metal development with Armv8-A Foundation Model.
- Arm Streamline performance analyzer for Linux/Android™ applications - Basic features.
- Online help and Software examples
- Linux and Windows host support (64 bit hosts only)

Some third-party compilers are compatible with DS-5. For example, the GNU Compiler tools enable you to compile bare-metal, Linux kernel, and Linux applications for Arm targets.

[Download](#)[Get Started](#)



DS-5 Community Edition

Download DS-5 Community Edition

To download DS-5 Community Edition, please complete the below form. We will then send you an email with a link to download the product.

Contact Details

First Name

Last Name

Email Address

Phone Number

City

State

[Feedback](#)

Complete all fields

Registration



Last Name

Email Address

Phone Number

City

State

Country

Company Name

Job Description

ARM will process your information in accordance with the Download section of our [Privacy Policy](#).

By ticking this box you confirm you have read and accept our [Privacy Policy](#) and indicate your consent to receiving marketing communications from ARM. Please visit our [Subscription Centre](#) to manage your marketing preferences or unsubscribe from further communications.

Feedback

Student



Submit



Successful form submission

Thanks for Your Interest

Thank you for requesting to download DS-5 Community Edition. Your data was submitted successfully and we will be sending you a link to download via email shortly.

[Feedback](#)

Get Started

Learn how to get started with Arm DS-5 Development Studio.

Tutorials

Step-by-step tutorials on how to setup and use DS-5 and its components.

Sample Code

Learn about the example code that is shipped with DS-5.

Download

Your DS-5 Community Edition download



Arm Developer <arm.emails@arm.com>

To Antonio Barbalice

Sun 9

If there are problems with how this message is displayed, click here to view it in a web browser.



ARM DEVELOPER DS-5 Community Edition

Your DS-5 Community Edition download

Hi Antonio,

Thank you for requesting to download DS-5 Community Edition, ARM's free professional quality tool chain developed to accelerate the development of native (C/C++) embedded software development targeting ARM-based SoCs. Please select the version you need below to start the download.

Best wishes,

Arm

[Download DS-5 Community Edition \(Linux\)](#)

[Download DS-5 Community Edition \(Windows\)](#)

arm Community arm Developer



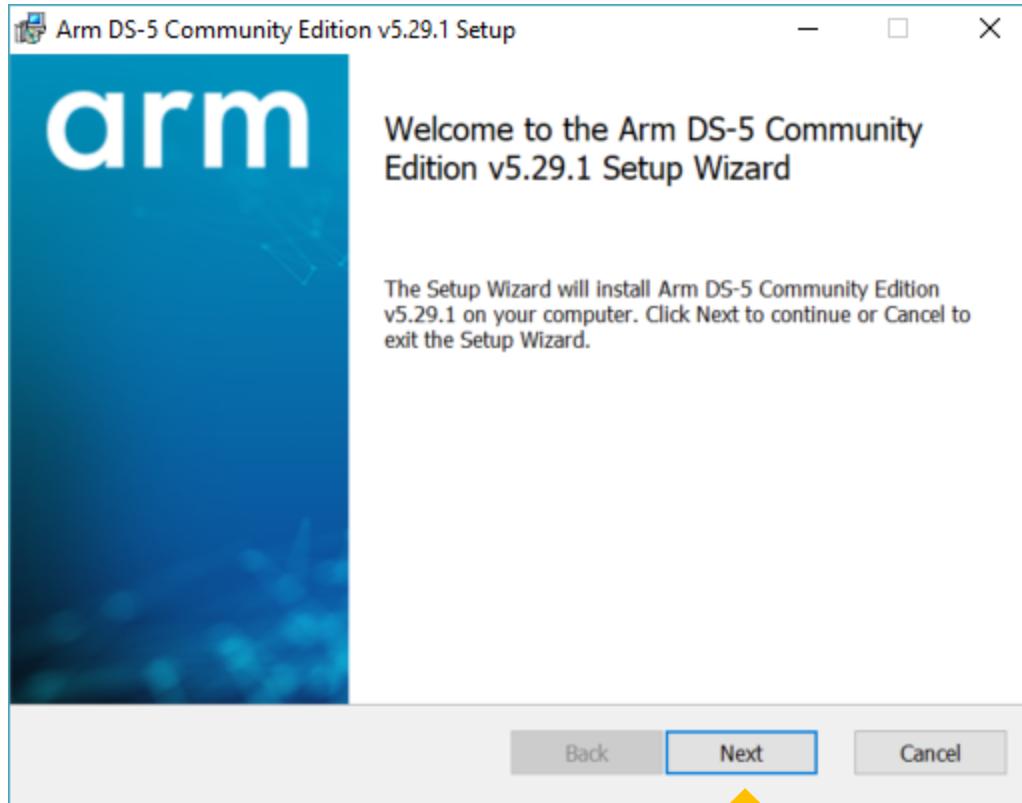
[View as WebPage](#) | [Unsubscribe](#) | [Manage Subscriptions](#) | [Privacy Policy](#) | [Trademarks](#)

Arm Ltd. 110 Fulbourn Road, Cambridge, CB1 9NJ | UK

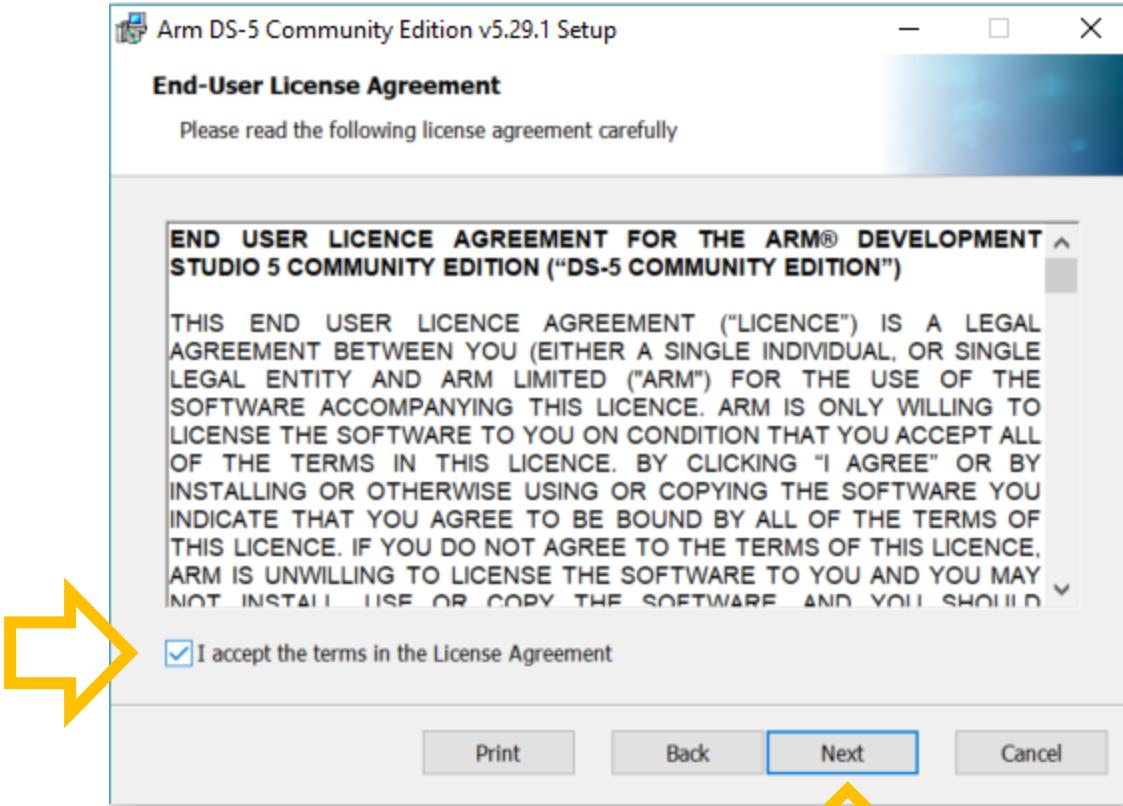
Registered in England 255759

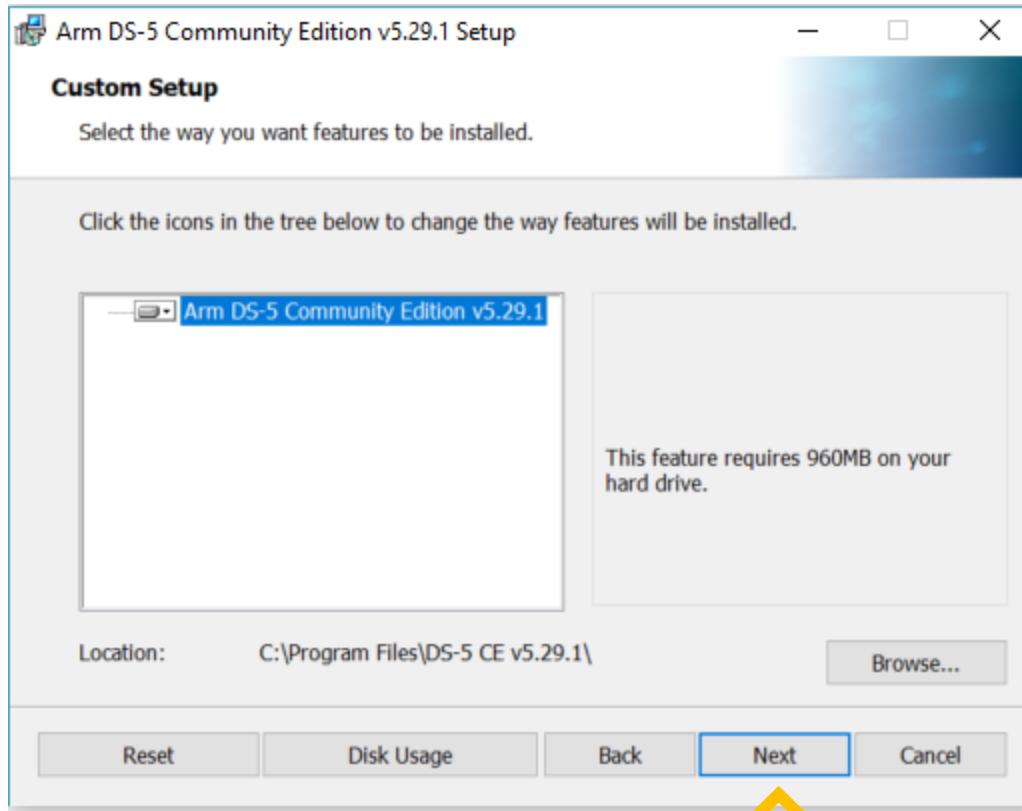
You will receive a similar email; Download the DS-5 suitable for your system

Install



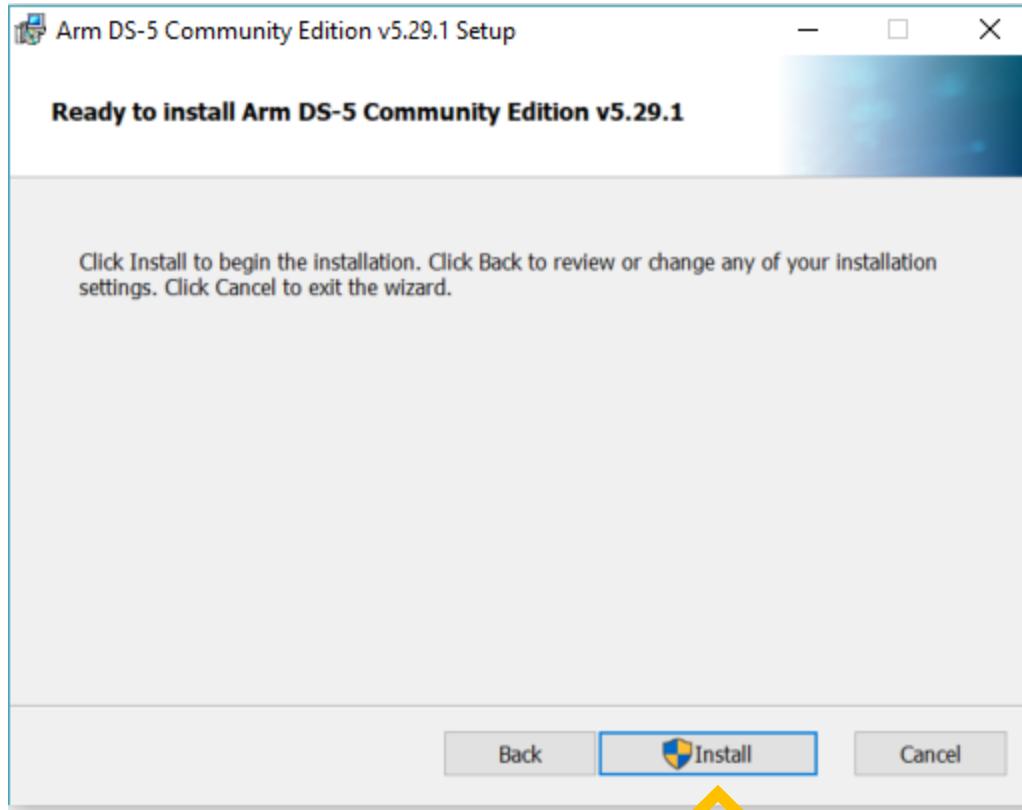
Install



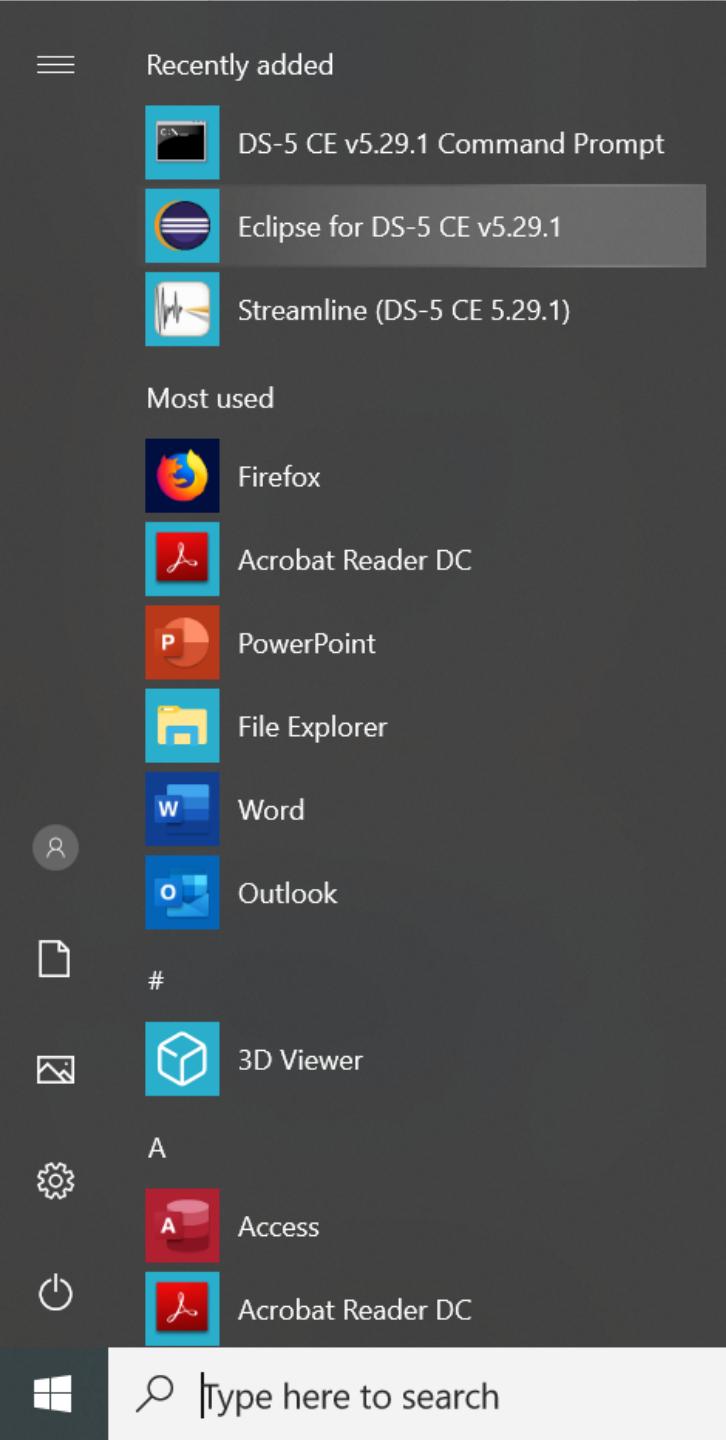


Install

Install



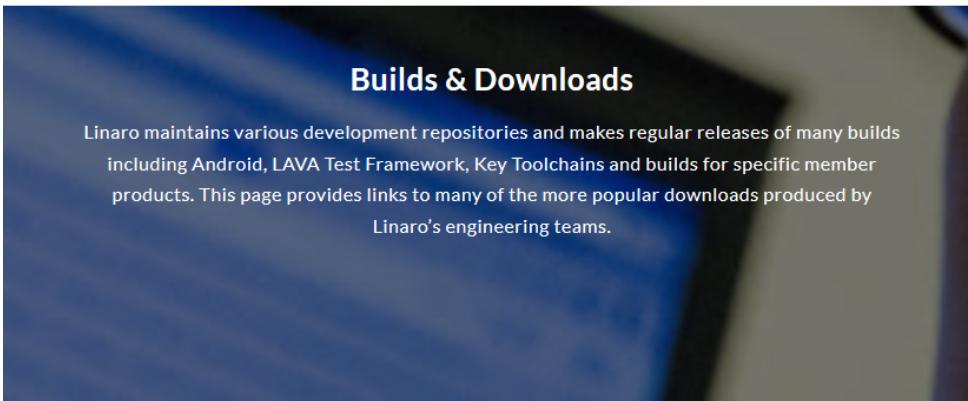
Install



If you find
Eclipse for DS-5
in your
installation is
successful

Linaro gcc Toolchain (second step)

- How to Setup?
- 1. First **download** Linaro gcc Toolchain
 - <https://www.linaro.org/downloads/>
- 2. Then **install** (extract) Linaro gcc Toolchain
- 3. Finally, **integrate** the toolchain and DS-5
- The following slides guide you through the process



Builds & Downloads

Linaro maintains various development repositories and makes regular releases of many builds including Android, LAVA Test Framework, Key Toolchains and builds for specific member products. This page provides links to many of the more popular downloads produced by Linaro's engineering teams.

Linaro Toolchain

The first Arm release of the pre-built GNU cross-toolchain for Cortex-A GCC 8.2-2018.08 is now available on the [Arm Developer website](#).

Linaro provides monthly [GCC source archive](#) snapshots of the current Linaro GCC release branch, as well as quarterly releases of pre-built Linaro [GNU cross-toolchain binary archives](#).

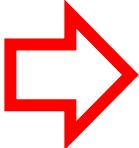
The following tables provide direct access to the most common Linux and bare-metal ABI variants of the Linaro binary cross-toolchain quarterly releases. Both x86_64 Linux and Mingw32 (MS Windows compatible) host binaries are provided:

Latest Linux Targeted Binary Toolchain Releases

| | | | | |
|--|--|-------------------------------|--------------------------|------------------------|
| arm-linux-gnueabihf | 32-bit Armv7 Cortex-A, hard-float, little-endian | Release-Notes | Binaries | Source |
| armv8l-linux-gnueabihf | 32-bit Armv8 Cortex-A, hard-float, little-endian | Release-Notes | Binaries | Source |
| aarch64-linux-gnu | 64-bit Armv8 Cortex-A, little-endian | Release-Notes | Binaries | Source |

Latest Bare-Metal Targeted Binary Toolchain Releases

| | | | | |
|-----------------------------|--|-------------------------------|--------------------------|------------------------|
| arm-eabi | 32-bit Armv7 Cortex-A, soft-float, little-endian | Release-Notes | Binaries | Source |
| aarch64-elf | 64-bit Armv8 Cortex-A, little-endian | Release-Notes | Binaries | Source |



Interested in other target ABIs such as big-endian or soft-float little-endian? All toolchain target ABI and host variants can be seen [here](#). Note: Not all ABI and host variants are supported to the same degree. See the [release-notes](#) for more information.

Bare-Metal
Toolchain
aarch64-elf

| Name | Last modified | Size | License |
|---|-------------------|--------|---------|
| Parent Directory | | | |
| gcc-linaro-7.2.1-2017.11-i686-mingw32_aarch64-elf.tar.xz | 27-Feb-2018 01:07 | 218.0M | open |
| gcc-linaro-7.2.1-2017.11-i686-mingw32_aarch64-elf.tar.xz.asc | 13-Jan-2018 09:10 | 91 | open |
| gcc-linaro-7.2.1-2017.11-i686_aarch64-elf.tar.xz | 27-Feb-2018 01:07 | 50.2M | open |
| gcc-linaro-7.2.1-2017.11-i686_aarch64-elf.tar.xz.asc | 13-Jan-2018 09:10 | 83 | open |
| gcc-linaro-7.2.1-2017.11-linux-manifest.txt | 13-Jan-2018 09:10 | 8.0K | open |
| gcc-linaro-7.2.1-2017.11-win32-manifest.txt | 13-Jan-2018 09:10 | 8.0K | open |
| gcc-linaro-7.2.1-2017.11-x86_64_aarch64-elf.tar.xz | 27-Feb-2018 01:07 | 50.4M | open |
| gcc-linaro-7.2.1-2017.11-x86_64_aarch64-elf.tar.xz.asc | 13-Jan-2018 09:10 | 85 | open |
| gcc-linaro-7.3.1-2018.05-i686-mingw32_aarch64-elf.tar.xz | 18-Dec-2018 00:06 | 225.8M | open |
| gcc-linaro-7.3.1-2018.05-i686-mingw32_aarch64-elf.tar.xz.asc | 17-Dec-2018 10:25 | 91 | open |
| gcc-linaro-7.3.1-2018.05-i686_aarch64-elf.tar.xz | 18-Dec-2018 00:07 | 51.9M | open |
| gcc-linaro-7.3.1-2018.05-i686_aarch64-elf.tar.xz.asc | 17-Dec-2018 10:25 | 83 | open |
| gcc-linaro-7.3.1-2018.05-linux-manifest.txt | 17-Dec-2018 10:25 | 9.4K | open |
| gcc-linaro-7.3.1-2018.05-win32-manifest.txt | 17-Dec-2018 10:25 | 9.4K | open |
| gcc-linaro-7.3.1-2018.05-x86_64_aarch64-elf.tar.xz | 18-Dec-2018 00:07 | 51.1M | open |
| gcc-linaro-7.3.1-2018.05-x86_64_aarch64-elf.tar.xz.asc | 17-Dec-2018 10:25 | 85 | open |
| gcc-linaro-7.4.1-2019.02-i686-mingw32_aarch64-elf.tar.xz | 25-Jan-2019 06:51 | 236.6M | open |
| gcc-linaro-7.4.1-2019.02-i686-mingw32_aarch64-elf.tar.xz.asc | 25-Jan-2019 06:51 | 91 | open |
| gcc-linaro-7.4.1-2019.02-i686_aarch64-elf.tar.xz | 25-Jan-2019 06:51 | 52.2M | open |
| gcc-linaro-7.4.1-2019.02-i686_aarch64-elf.tar.xz.asc | 25-Jan-2019 06:51 | 83 | open |
| gcc-linaro-7.4.1-2019.02-linux-manifest.txt | 25-Jan-2019 06:51 | 9.7K | open |
| gcc-linaro-7.4.1-2019.02-win32-manifest.txt | 25-Jan-2019 06:51 | 9.7K | open |
| gcc-linaro-7.4.1-2019.02-x86_64_aarch64-elf.tar.xz | 25-Jan-2019 06:51 | 52.5M | open |
| gcc-linaro-7.4.1-2019.02-x86_64_aarch64-elf.tar.xz.asc | 25-Jan-2019 06:51 | 85 | open |
| sysroot-newlib-linaro-2017.11-aarch64-elf.tar.xz | 13-Jan-2018 09:10 | 4.1M | open |
| sysroot-newlib-linaro-2017.11-aarch64-elf.tar.xz.asc | 13-Jan-2018 09:10 | 204 | open |
| sysroot-newlib-linaro-2018.05-aarch64-elf.tar.xz | 17-Dec-2018 10:25 | 4.1M | open |
| sysroot-newlib-linaro-2018.05-aarch64-elf.tar.xz.asc | 17-Dec-2018 10:25 | 205 | open |
| sysroot-newlib-linaro-2019.02-aarch64-elf.tar.xz | 25-Jan-2019 06:51 | 4.2M | open |
| sysroot-newlib-linaro-2019.02-aarch64-elf.tar.xz.asc | 25-Jan-2019 06:51 | 145 | open |



See next what
to download

Running linaro-license-protection 23e5453.

<https://releases.linaro.org/components/toolchain/binaries/latest-7/aarch64-elf/>

Download



[gcc-linaro-
7.4.1-2019.02-
i686-
mingw32_aarc
h64-elf.tar.xz](#)

25-Jan-2019
06:51

236.6M

open

Suggested
download for
Windows

Download



[gcc-linaro-
7.4.1-2019.02-
x86_64_aarch
64-elf.tar.xz](#)

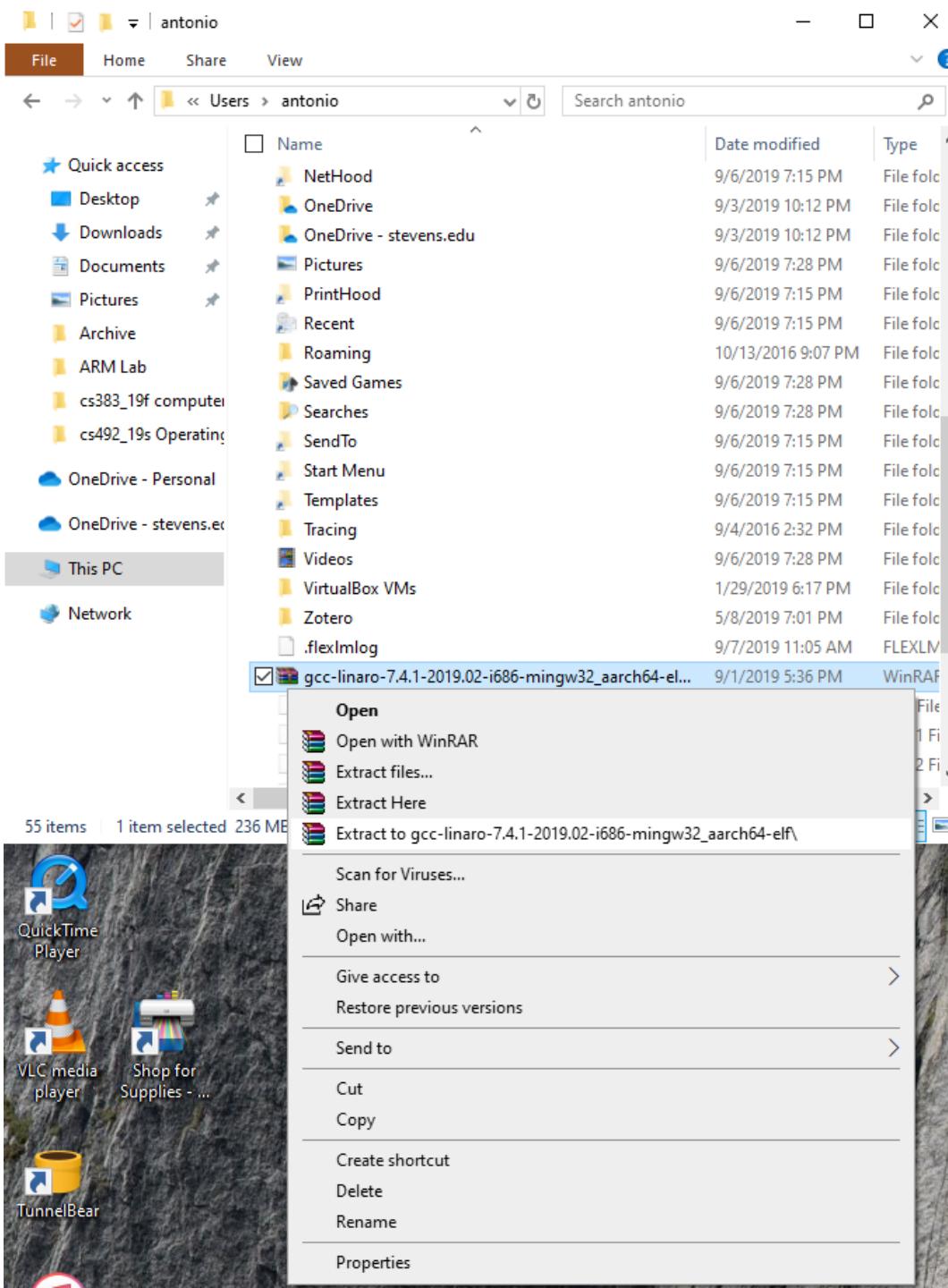
25-Jan-2019
06:51

52.5M

open

Suggested
download for
Linux

Install



Extract the tarball in your computer everywhere you like (but note down the path)

Integration

DS-5 Workspace - C/C++ - Eclipse Platform

File Edit Source Refactor Navigate Search Project Run Window Help

Welcome to DS-5

DS-5 Development

What's new in this release

Recently added

Articles, Examples, Tutorials

Debug Tools

Streamline

Mali Graphics Debugger

New Window

Editor >

Appearance >

Show View >

Perspective >

Navigation >

Preferences

OS-5 v5.29.1 Release Notes

The release notes for this version of DS-5.

Arm Jul 18, 2018

Getting Started with DS-5 Development S...

This tutorial takes you through the process of downloading and installing the evaluation version of ARM DS-5 Development Studio. It then guides you through creating a simple bare-metal "Hello World" application and finally debugging it.

Arm Jun 26, 2018

Announcing DS-5 v5.28

Arm is pleased to announce the release of a new version of DS-5.

Arm Dec 1, 2017

DS-5 v5.27 Now Available

Today ARM releases a new version of ARM Development Suite, DS-5.27. We have added new IP support, OS awareness and several exciting features.

IDE, Compiler, Fixed Virtual Platforms

We have focused heavily on enabling customers to use the many useful features in development suite. One of the ways we are doing this is to create a separate Release Page which will allow updated information about the latest releases to be easily accessible. The latest release is developing a model instead of hardware. Fixed Virtual Platforms are available now via VLSI.

DS-5 Debugger

An off-the-shelf release, DS-5 includes support for the latest processors announced by ARM. It

Key changes DS-5 v5.27

Today ARM releases a new version of ARM Development Suite, DS-5.27. We have added new IP support, OS awareness and several exciting features.

Arm May 17, 2017

DSTREAM-ST: new lower cost DSTREA...

Today ARM announced a lower cost, very high performance debug and trace unit to complement the existing ARM DSTREAM and Keil ULINK product families.

Open DS-5
Go to
Window->Preferences



File Edit Source Refactor Navigate Search Project Run Window Help

Welcome to DS-5

DS-5 Development Studio

arm DS

What's new in this release

Recently added

Preferences

type filter text

- > General
- > Ant
- > C/C++
- > DS-5
 - Arm Assembler
 - Configuration Database
 - > Debugger
 - Developer Account
 - General
 - Scatter File Editor
 - Target Configuration Editor
 - Toolchains
 - Tutorials and videos
 - Updates
- > Help
- > Install/Update
- > Java
- Library Hover

Toolchains

Add/Remove toolchains

Add... 

Name: No Toolchain Selected

Path:

Apply OK Cancel

Today ARM announced a lower cost, very high performance debug and trace unit to complement the existing ARM DSTREAM and Keil ULINK product families.

DS-5 v5.29.1 Release Notes
The release notes for this version of DS-5.

Jul 18, 2018
Development S...
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Jun 26, 2018
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Dec 1, 2017
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May 17, 2017
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Select DS-5->Toolchains
Then click Add...

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DS-5 Development Studio

arm DS

What's new in this release

Recently added

Add a new Toolchain

Select Toolchain Path

Please enter the path to the toolchain's binaries directory.

Path to toolchain binaries:

[Download toolchains from developer.arm.com/products/software-development-tools/compilers](https://developer.arm.com/products/software-development-tools/compilers)

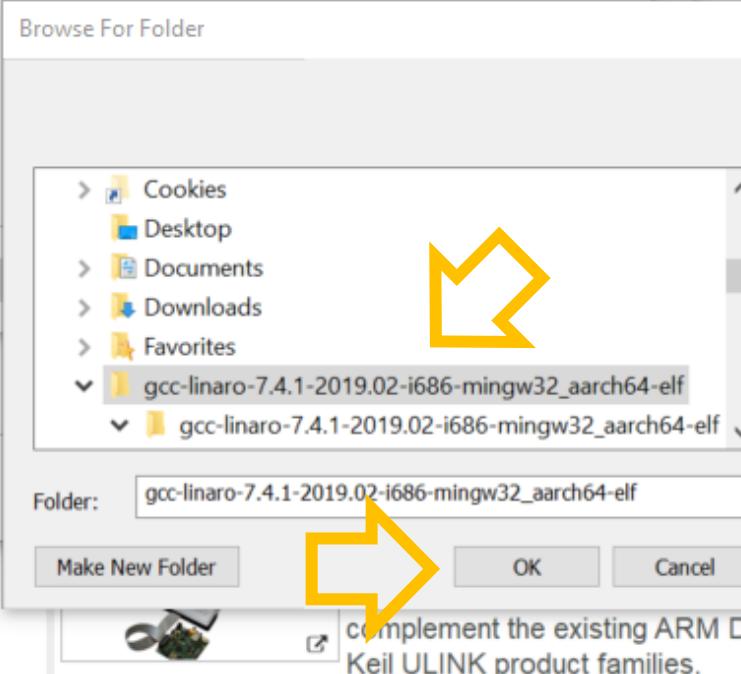
< Back

> Install/Update

> Java

Library Hover

Path:



DS-5 v5.29.1 Release Notes

The release notes for this version of DS-5.

Jul 18, 2018

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Dec 1, 2017

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July 17,

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Select the
location of the
gcc toolchain
and click OK

then do Next >

Integration

File Edit Source Refactor Navigate Search Project Run Window Help

Welcome to DS-5

DS-5 Development Studio

arm DS

What's new in this release

Recently added

Add a new Toolchain

Discovered Toolchain Information

Toolchain GCC 7.4.1 [aarch64-elf] was discovered from
C:\Users\antonio\gcc-linaro-7.4.1-2019.02-i686-mingw32_aarch64-elf\gcc-linaro-7.4.1-2019.02-i686-mingw32_aarch64-elf\bin

Target: aarch64-elf
C Compiler: aarch64-elf-gcc.exe
C Linker: aarch64-elf-gcc.exe
C++ Compiler: aarch64-elf-g++.exe
C++ Linker: aarch64-elf-g++.exe
Assembler: aarch64-elf-as.exe
Archiver: aarch64-elf-ar.exe
Image Converter: aarch64-elf-objdump.exe

If this information is correct, click Finish to add the toolchain, otherwise click Next to edit/correct this information.



< Back Next > Finish Cancel

Welcome to DS-5

DS-5 Development Studio

arm DS

What's new in this release

Recently added

 Add a new Toolchain

DS-5 v5.29.1 Release Notes

The release notes for this version of DS-5.

Edit toolchain info

| | |
|-------------------------|-------------------------|
| Family: | GCC |
| Version (major): | 7 |
| Version (minor): | 4 |
| Version (patch/update): | 1 |
| Version (build): | |
| Target: | aarch64-elf |
| C Compiler: | aarch64-elf-gcc.exe |
| C Linker: | aarch64-elf-gcc.exe |
| C++ Compiler: | aarch64-elf-g++.exe |
| C++ Linker: | aarch64-elf-g++.exe |
| Assembler: | aarch64-elf-as.exe |
| Archiver: | aarch64-elf-ar.exe |
| Image Converter: | aarch64-elf-objdump.exe |



< Back

Next >

Finish

Cancel

Integration

DS-5 Workspace - C/C++ - Eclipse Platform

File Edit Source Refactor Navigate Search Project Run Window Help

Welcome to DS-5

DS-5 Development Studio

arm DS

What's new in this release

Recently added

Preferences

type filter text

- > General
- > Ant
- > C/C++
- > DS-5
 - Arm Assembler
 - Configuration Database
 - > Debugger
 - Developer Account
 - General
 - Scatter File Editor
 - Target Configuration Editor
 - Toolchains
 - Tutorials and videos
 - Updates
- > Help
- > Install/Update
- > Java
- Library Hover

Toolchains

Add/Remove toolchains

Name: GCC 7.4.1 [aarch64-elf]

Add... Remove

Name: No Toolchain Selected

Path:

Apply

OK Cancel

Jul 18, 2018

Development S...
gh the process of
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Jun 26, 2018

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Dec 1, 2017

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May 17, 2017

cost DSTREA...

Today ARM announced a lower cost, very high performance debug and trace unit to complement the existing ARM DSTREAM and Keil ULINK product families.



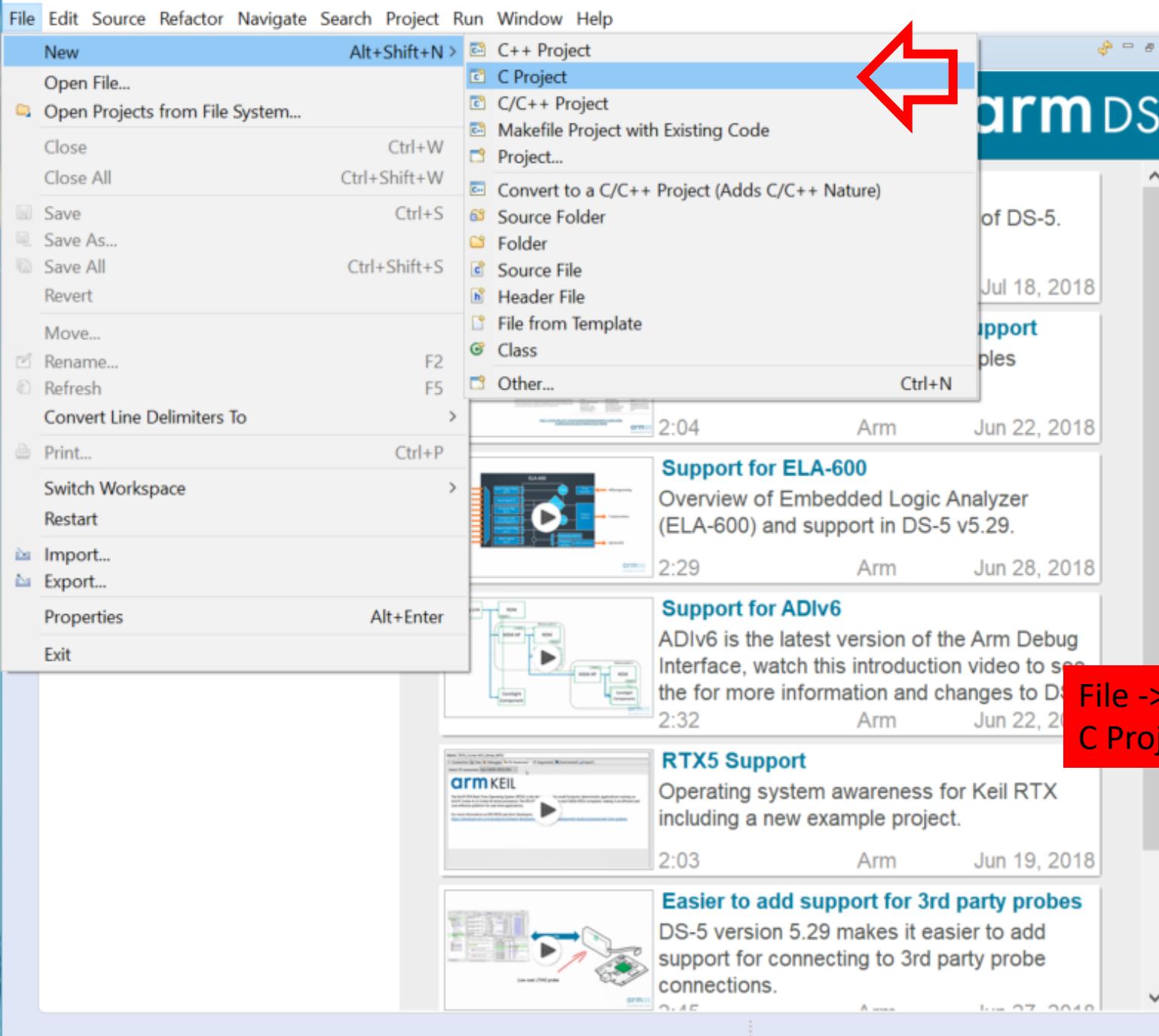
Click OK and acknowledge to restart Eclipse

First Assembly Program

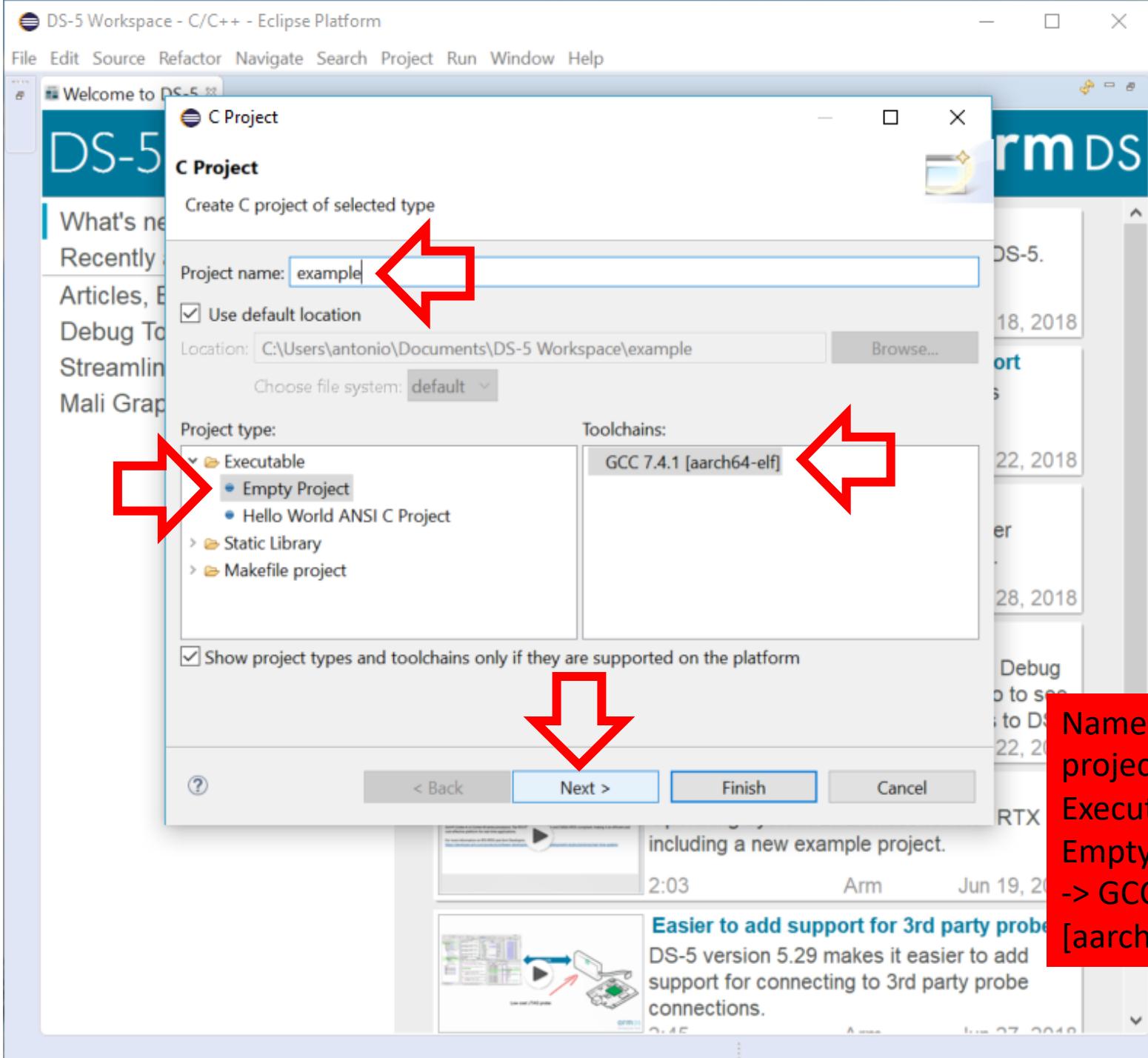
Your First Assembly Program

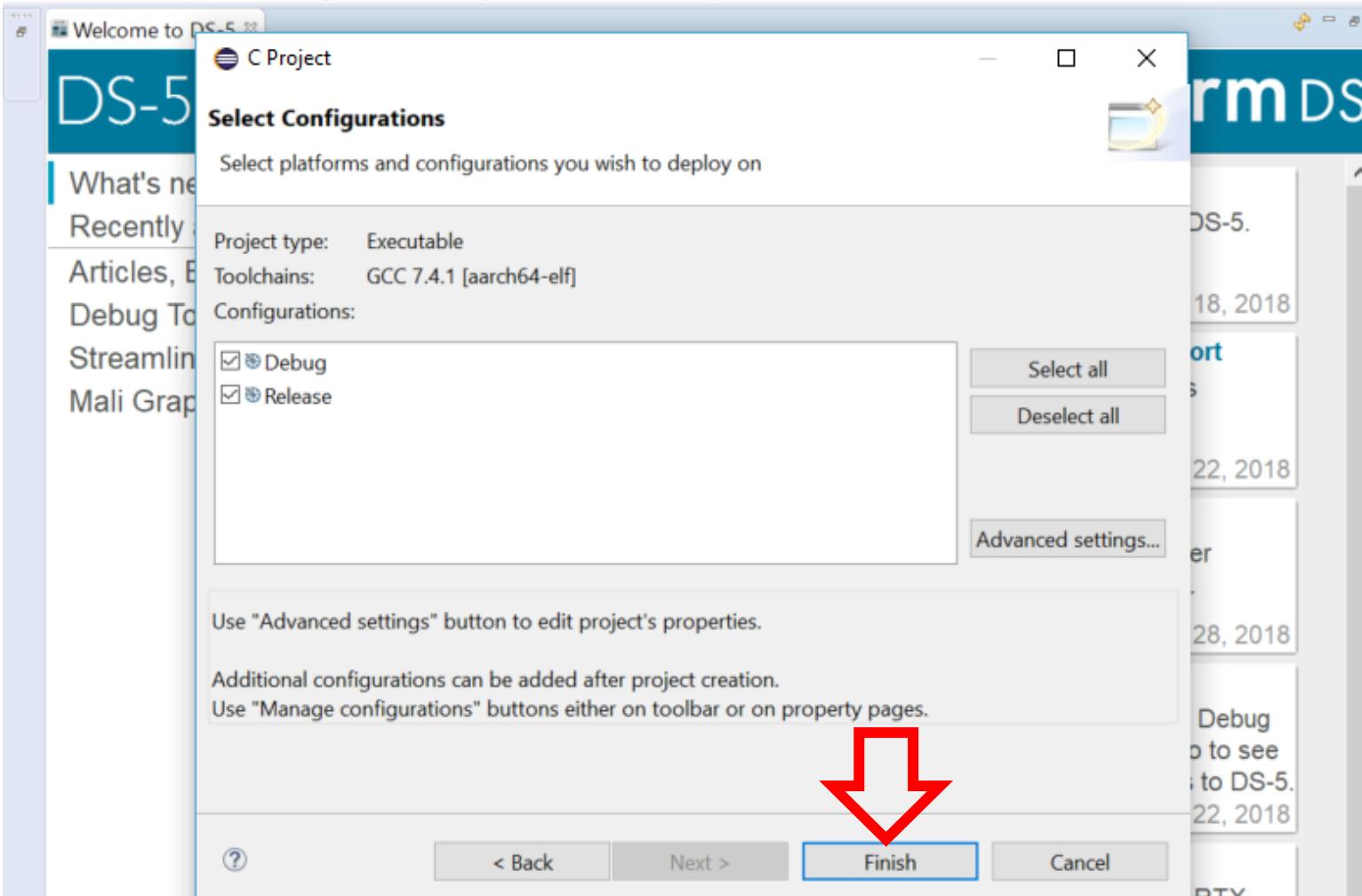
- How to?
 1. Create a project
 2. Write the code
 3. Configure, Assemble and Link
 4. Configure, Debug

Create the project



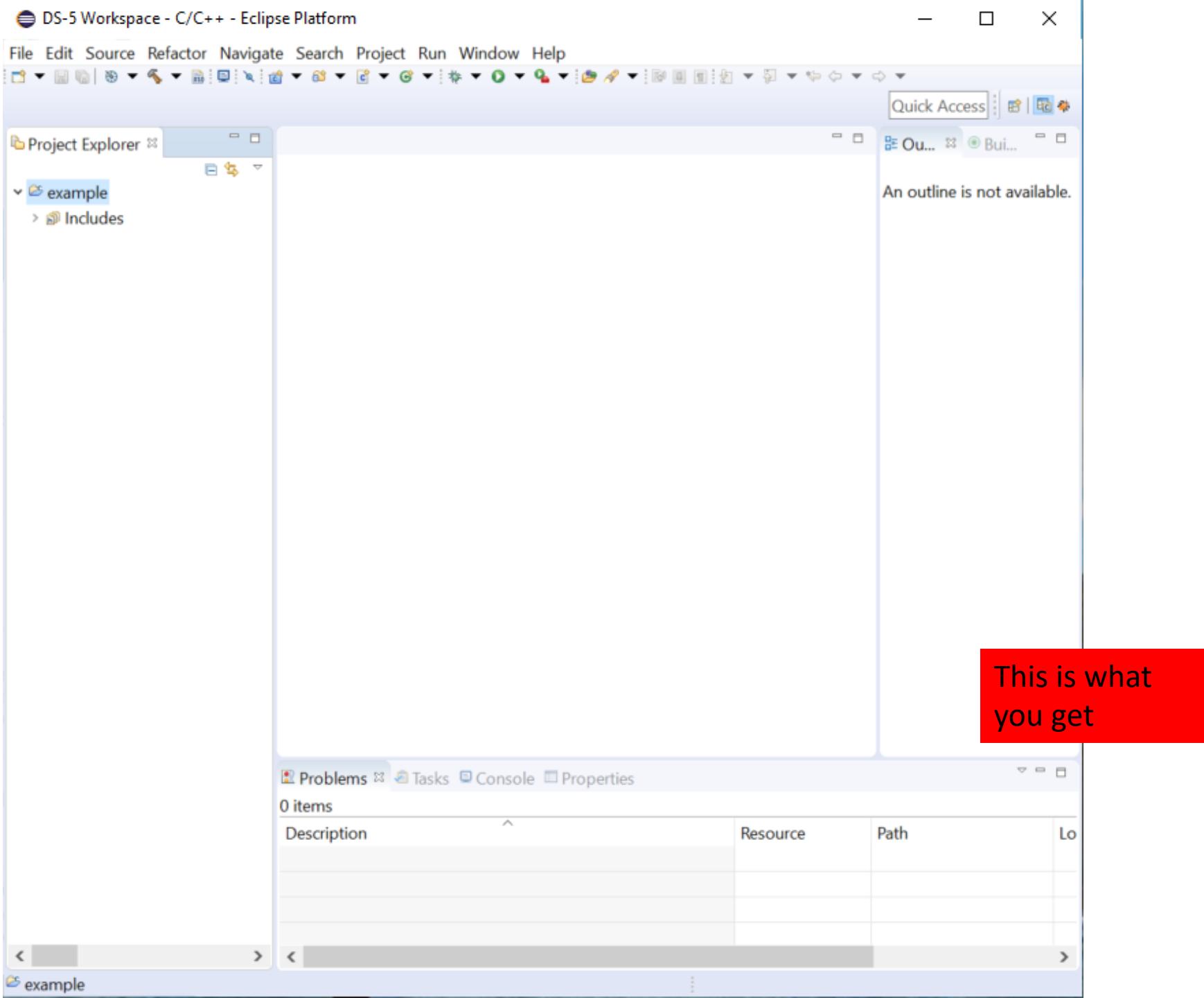
Create the project



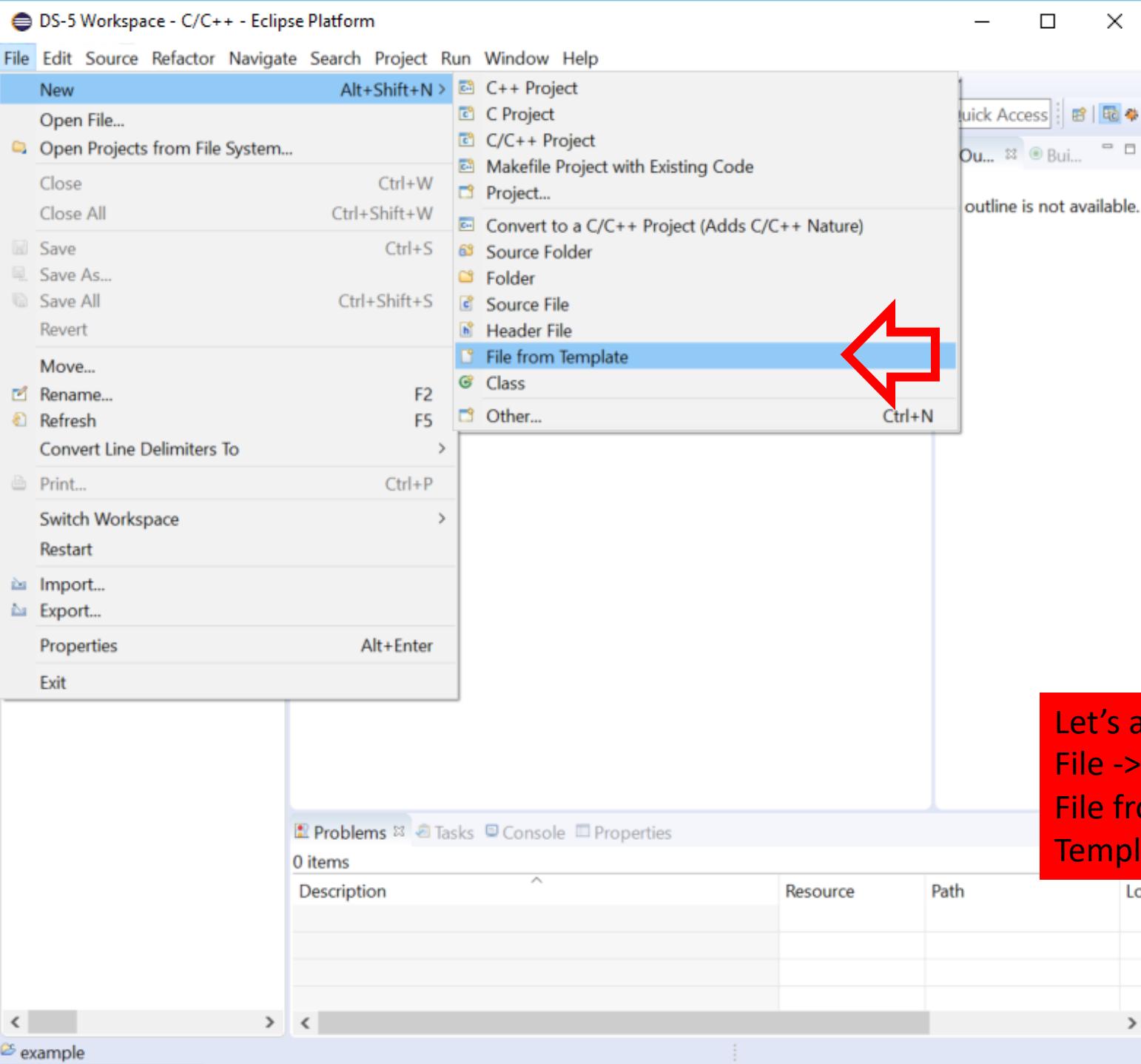


Create the project

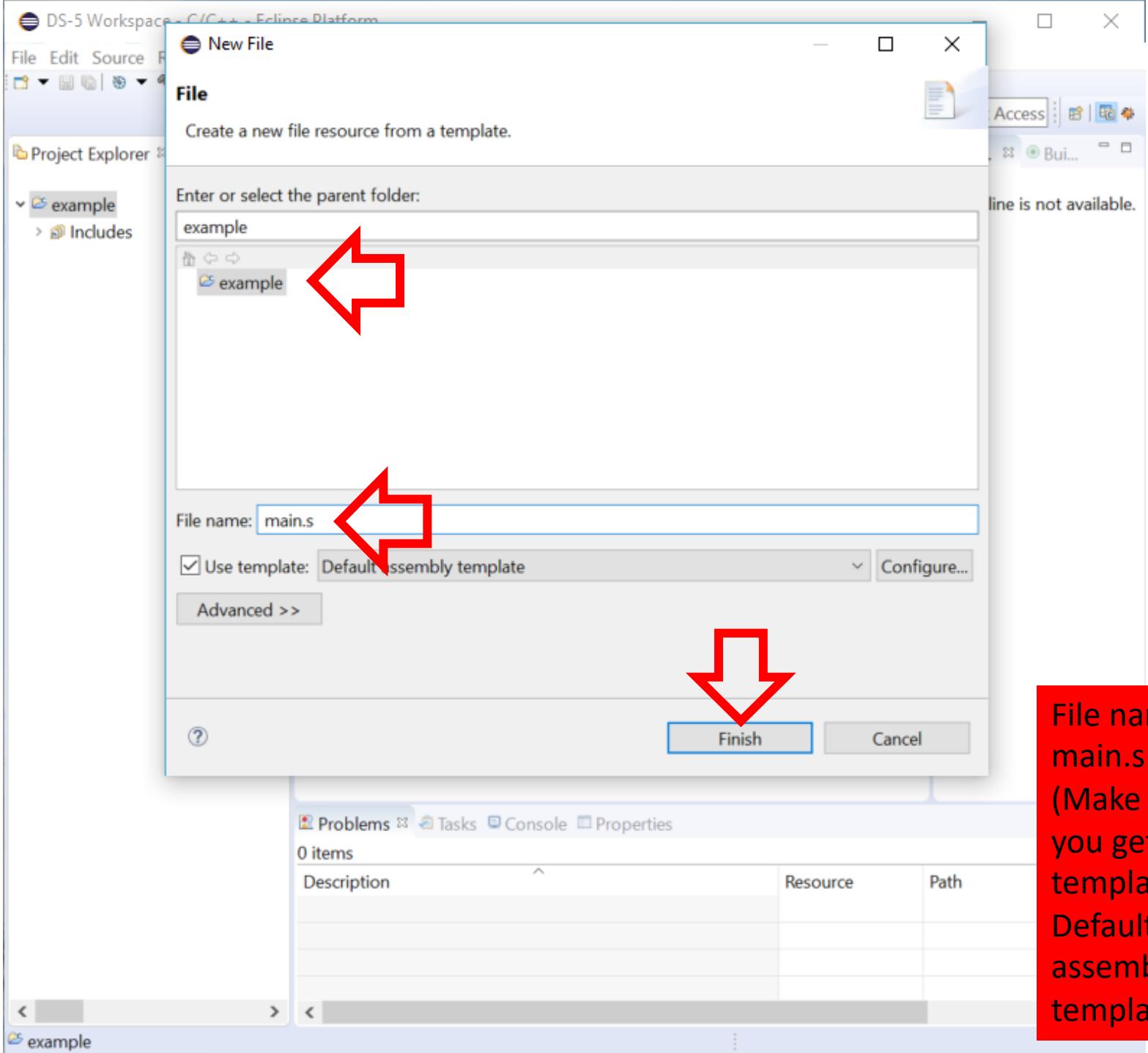
Create the project



Create the project

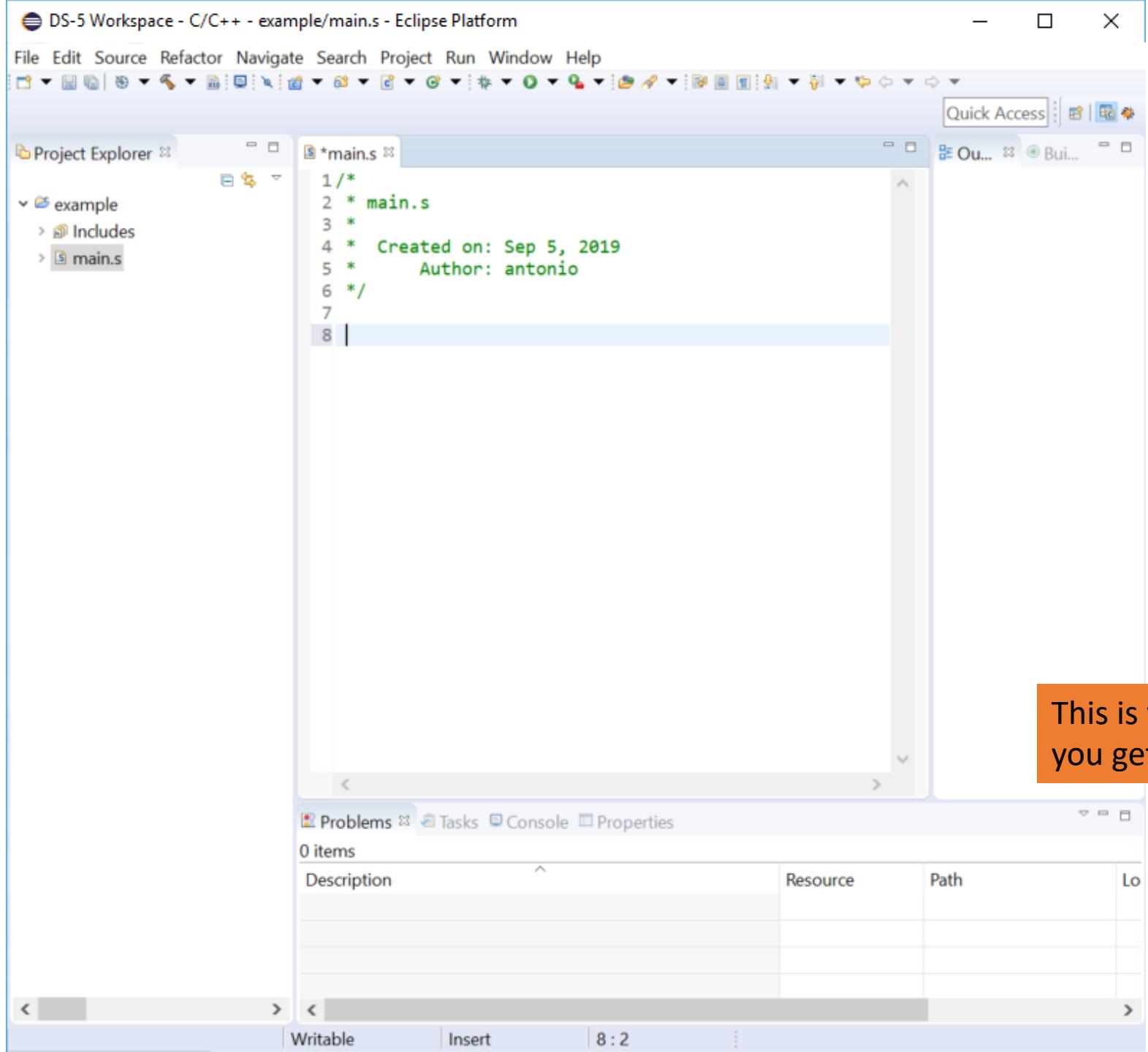


Create the project



File name:
main.s
(Make sure
you get: "Use
template:
Default
assembly
template")

Write the code



Your First Code (not Hello World!)

```
.text  
.global main  
  
main:  
    add x1, xzr, xzr /* Load value zero in x1 */  
    add x1, x1, #15   /* Add immediate value 15 to x1 */  
    br x30           /* return to the caller */  
  
.end
```

Write the code

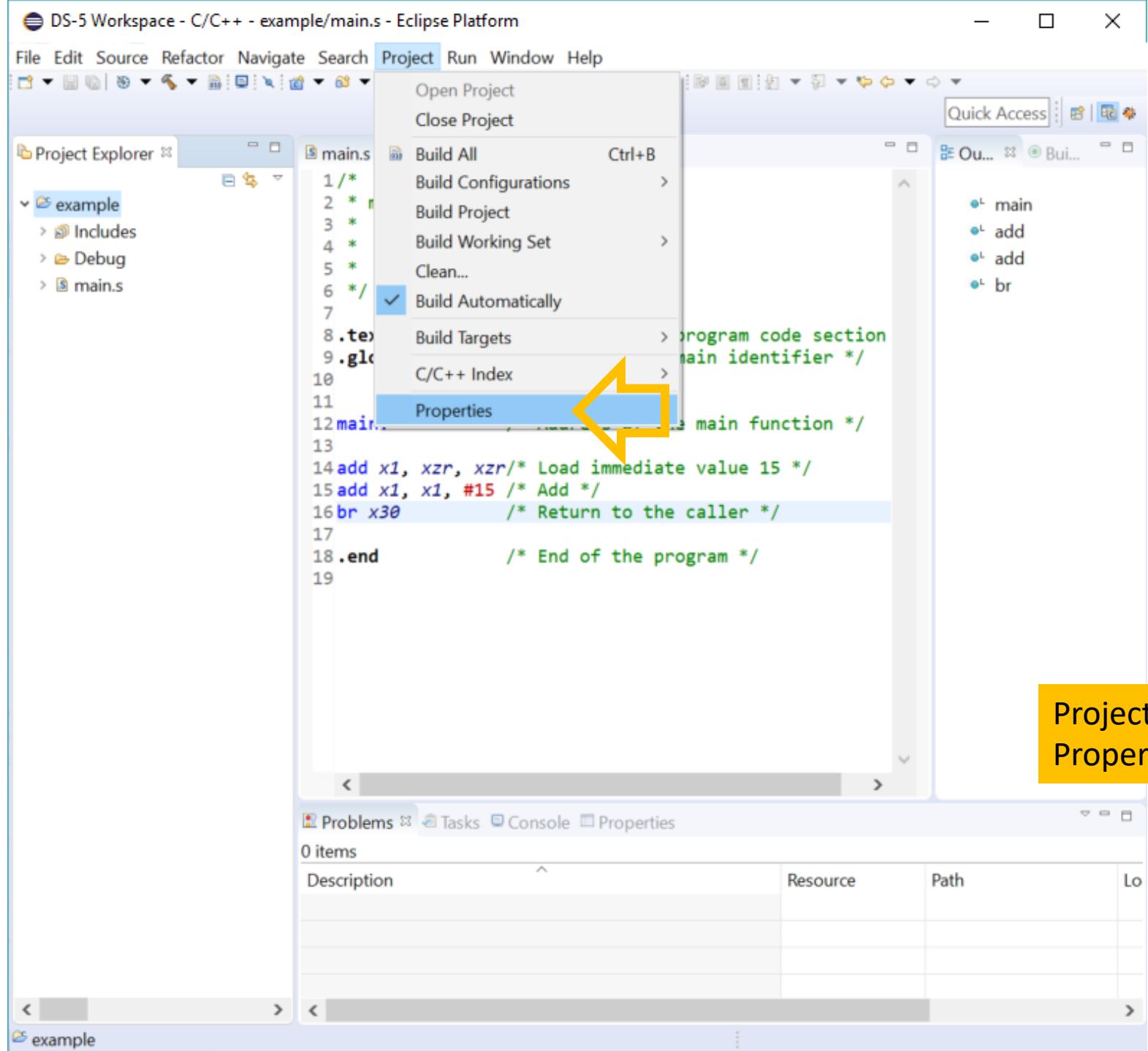
The screenshot shows the DS-5 Eclipse Platform interface. On the left, the Project Explorer view displays a project named 'example' with sub-folders 'Includes', 'Debug', and 'main.s'. The main workspace shows the assembly file 'main.s' with the following content:

```
1 /*
2 * main.s
3 *
4 * Created on: Sep 5, 2019
5 * Author: antonio
6 */
7
8 .text          /* Start of the program code section
9 .global main   /* declares the main identifier */
10
11
12 main:         /* Address of the main function */
13
14 add x1, xzr, xzr/* Load immediate value 15 */
15 add x1, x1, #15 /* Add */
16 br x30        /* Return to the caller */
17
18 .end          /* End of the program */
19
```

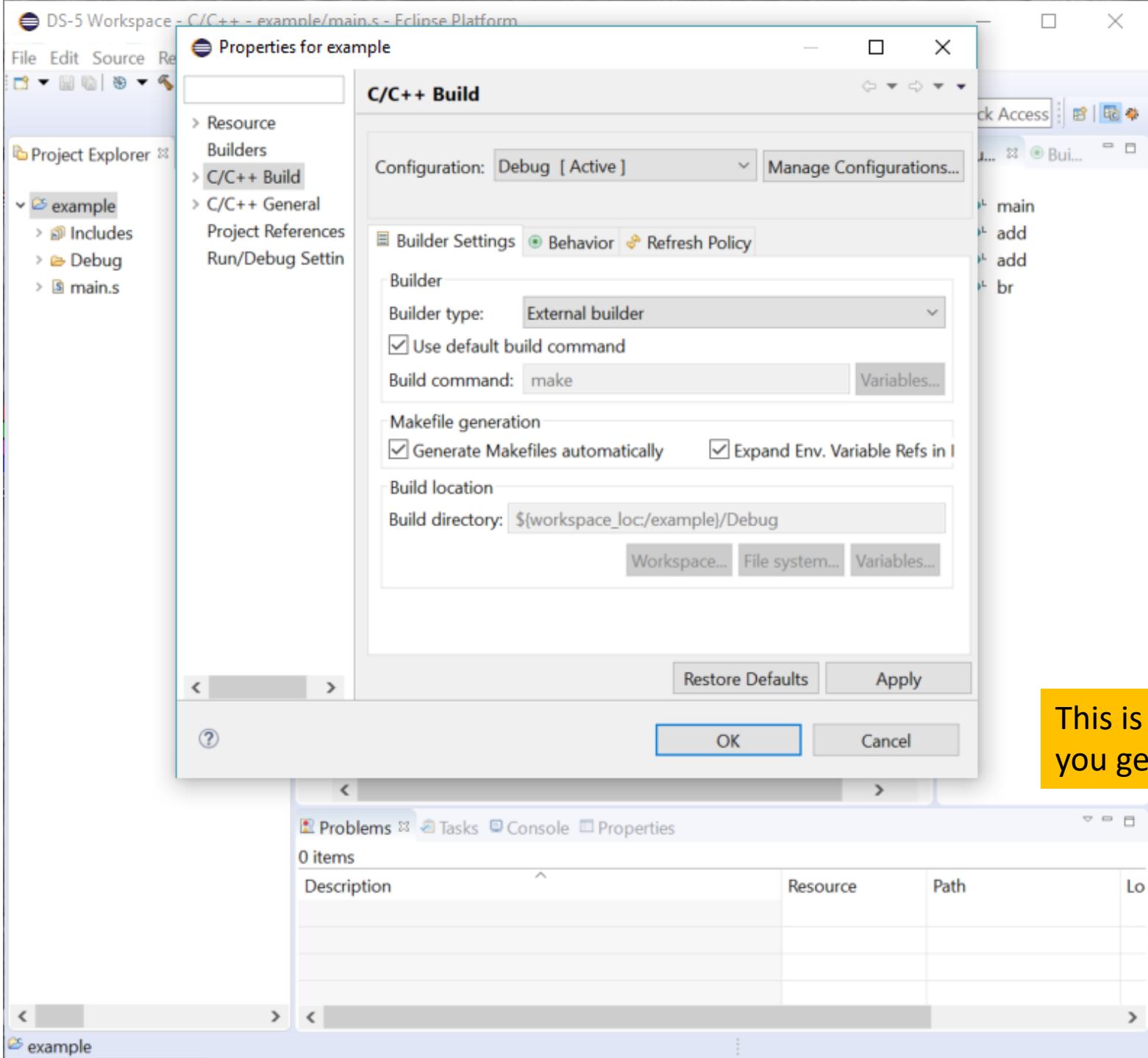
The line '16 br x30' is highlighted with a blue selection bar. To the right of the editor, the 'Quick Access' view shows symbols: 'main', 'add', 'add', and 'br'. At the bottom, the Problems view shows '0 items'.

This is what you get

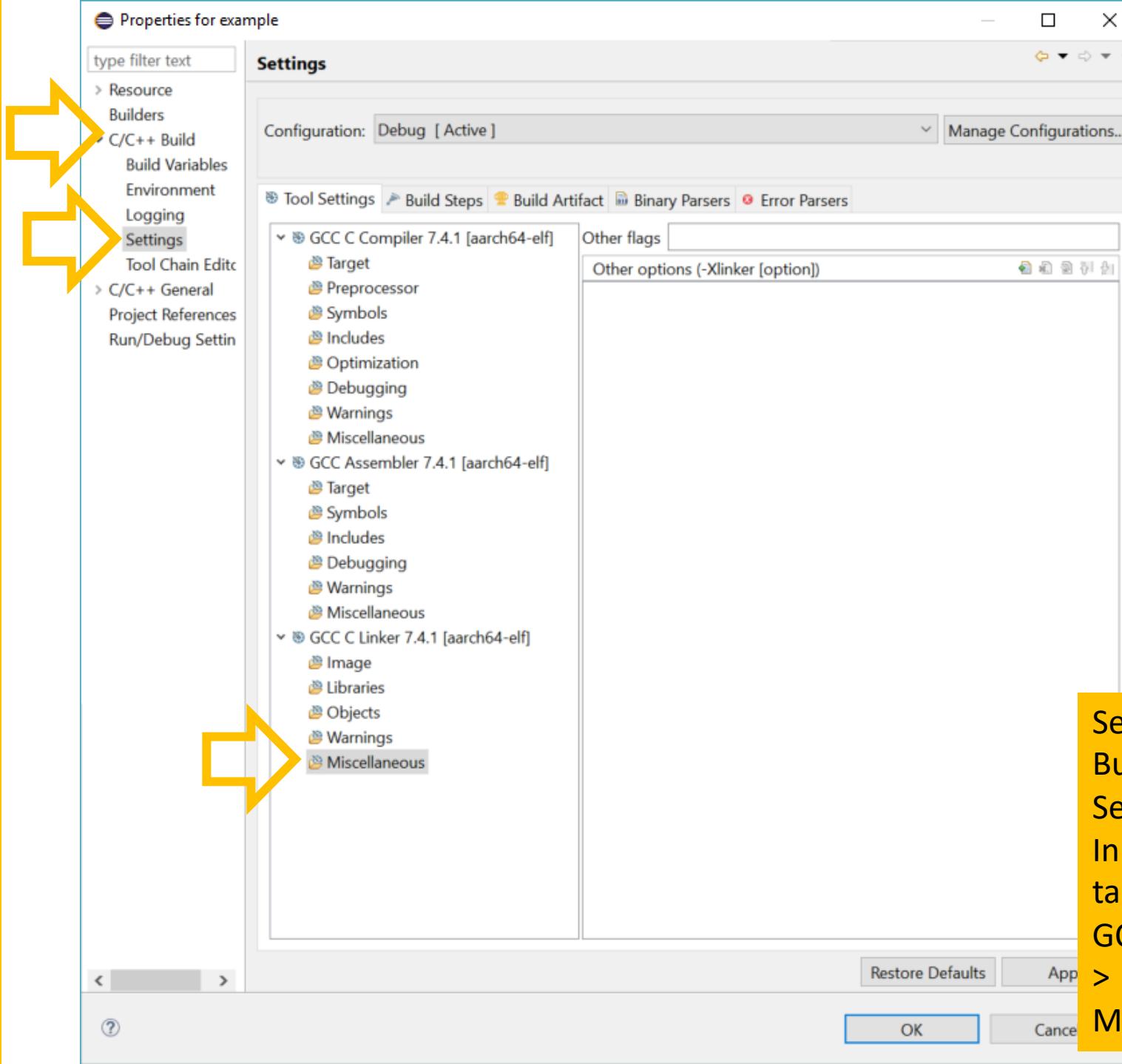
Configure (and Assemble/Link)



Configure (and Assemble/Link)

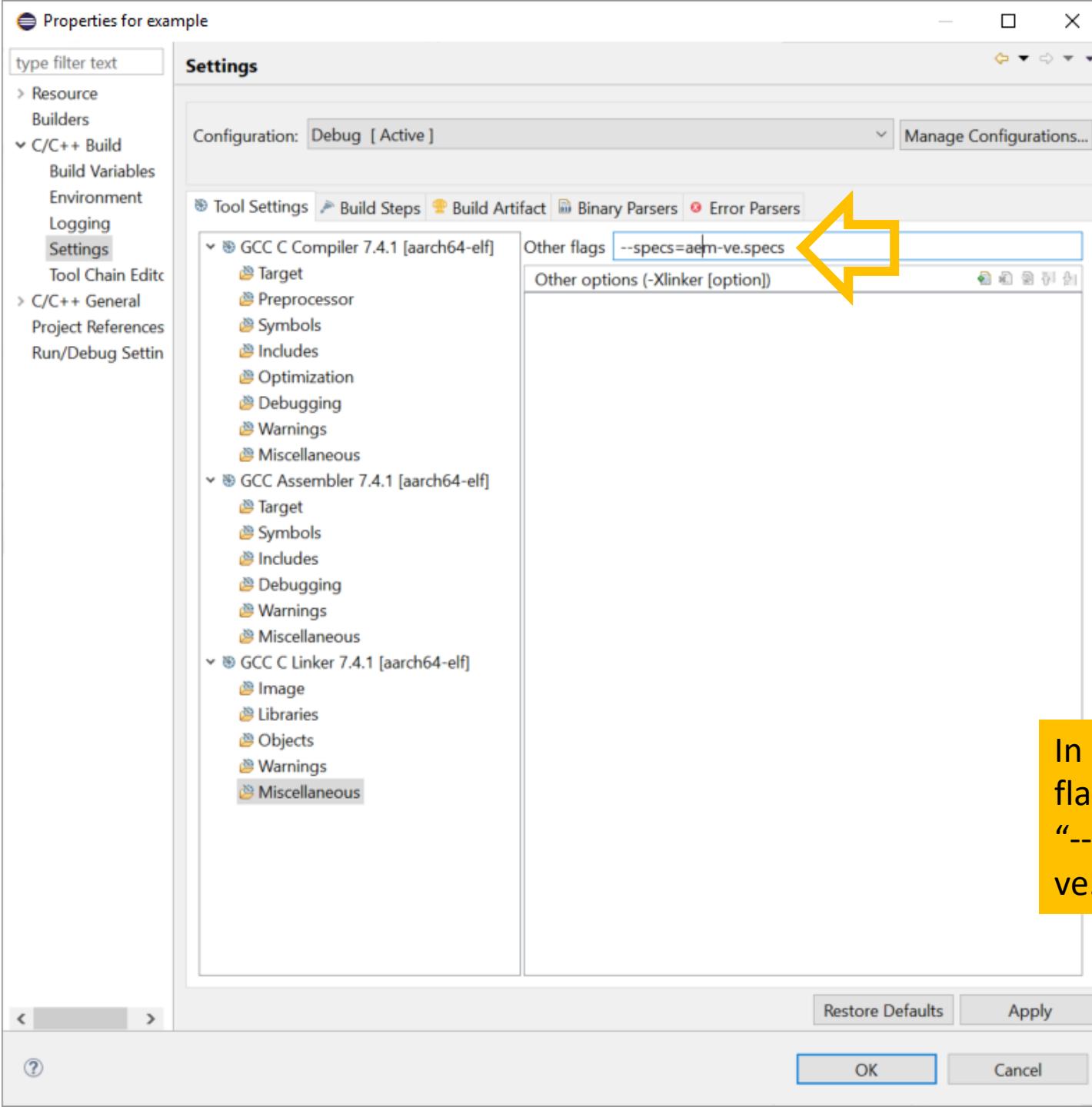


Configure (and Assemble/Link)

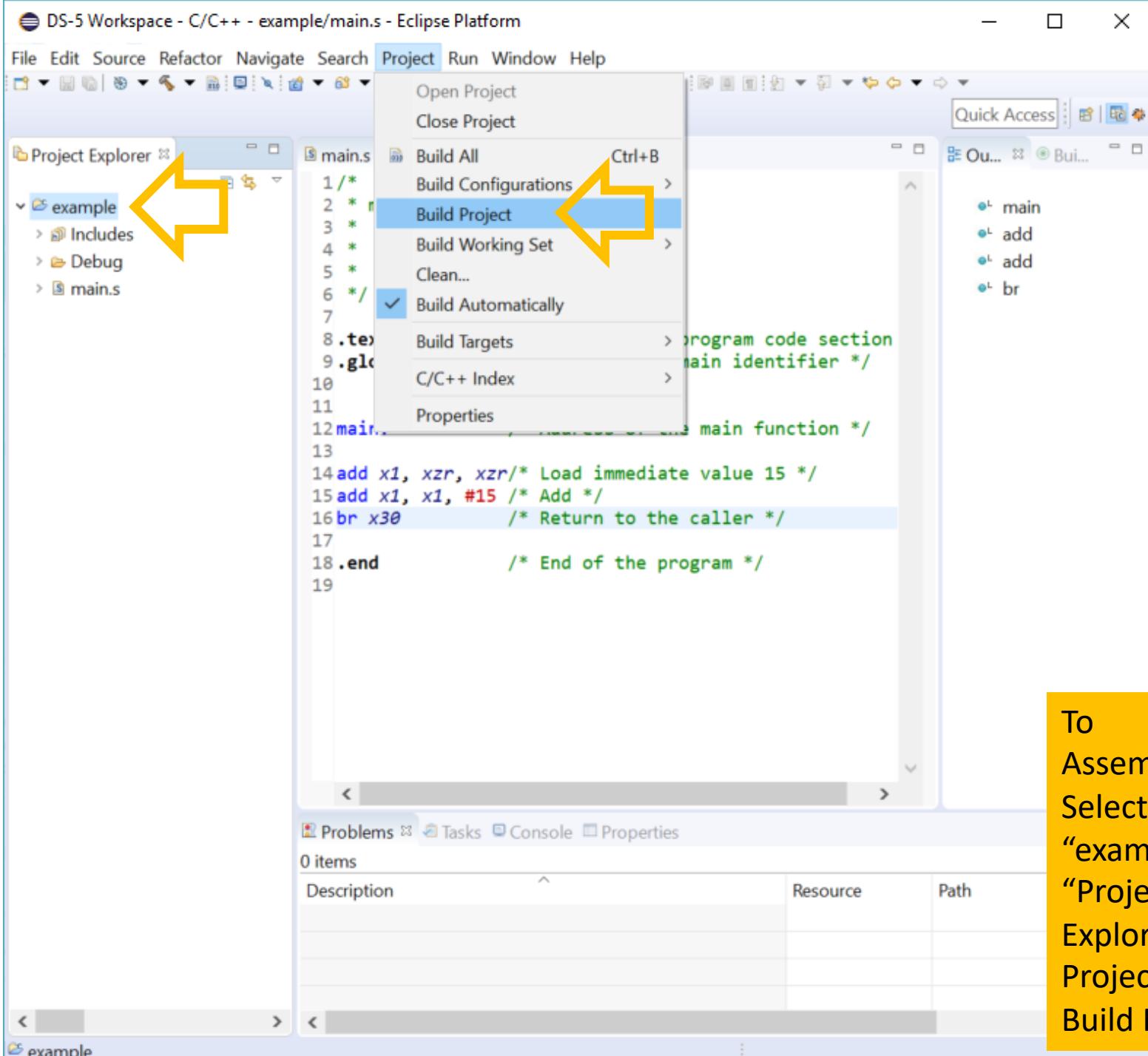


Select C/C++ Build -> Settings
In Tool Setting tab, select
GCC C Linker ->
Miscellaneous

Configure (and Assemble/Link)



Assemble/Link



To Assemble/Link
Select “example” in “Project Explorer” and Project -> Build Project

Assemble/Link

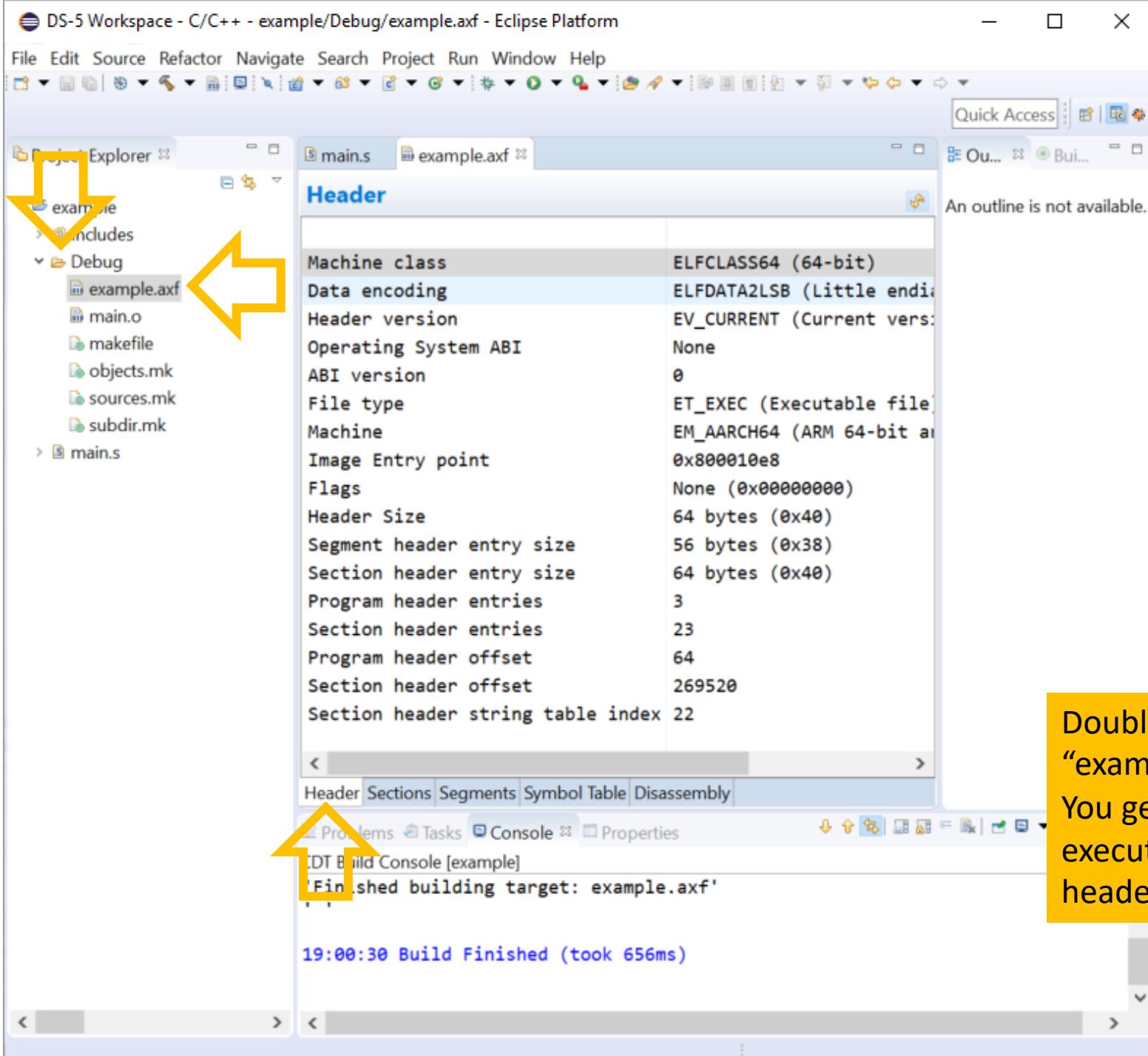
The screenshot shows the Eclipse CDT interface with the following components:

- Project Explorer:** Shows a project named "example" with subfolders "Includes", "Debug", and the source file "main.s".
- main.s Editor:** Displays the assembly code for the "main" function:

```
1 /*  
2 * main.s  
3 *  
4 * Created on: Sep 5, 2019  
5 * Author: antonio  
6 */  
7  
8 .text          /* Start of the program code section  
9 .global main   /* declares the main identifier */|  
10  
11  
12 main:         /* Address of the main function */  
13  
14 add x1, xzr, xzr/* Load immediate value 15 */  
15 add x1, x1, #15 /* Add */  
16 br x30        /* Return to the caller */  
17  
18 .end          /* End of the program */  
19
```
- Build Output:** Shows the build console output:

```
CDT Build Console [example]  
'Finished building target: example.axf'  
'  
19:00:30 Build Finished (took 656ms)
```
- Quick Access:** A sidebar on the right containing links to "main", "add", "add", and "br".
- Yellow Callout:** A yellow box in the bottom right corner contains the text "This is what you get".

Assemble/Link



Double click
“example.axf”
You get the
executable
header

Assemble/Link

DS-5 Workspace - C/C++ - example/Debug/example.axf - Eclipse Platform

File Edit Source Refactor Navigate Search Project Run Window Help

Project Explorer main.s example.axf

An outline is not available.

Sections

| Number | Name | ELF Offset | Address | Size (Bytes) | Type | Flags |
|--------|-----------|------------|---------|--------------|------|-----------|
| 1 | .note.... | 0x00... | 0x... | 36 | S... | SHF_ALLO |
| 2 | .init | 0x00... | 0x... | 52 | S... | SHF_AL... |
| 3 | .text | 0x00... | 0x... | 22836 | S... | SHF_AL... |
| 4 | .fini | 0x00... | 0x... | 52 | S... | SHF_AL... |
| 5 | .rodata | 0x00... | 0x... | 136 | S... | SHF_ALLO |
| 6 | .eh_frame | 0x00... | 0x... | 4 | S... | SHF_ALLO |
| 7 | .init_... | 0x00... | 0x... | 8 | S... | SHF_AL... |
| 8 | .fini_... | 0x00... | 0x... | 8 | S... | SHF_AL... |
| 9 | .data | 0x00... | 0x... | 12156 | S... | SHF_AL... |
| 10 | .bss | 0x00... | 0x... | 464 | S... | SHF_AL... |
| 11 | .comment | 0x00... | 0x... | 116 | S... | SHF_ME... |
| 12 | .debug... | 0x00... | 0x... | 1424 | S... | |
| 13 | .debug... | 0x00... | 0x... | 71272 | S... | |
| 14 | .debug... | 0x00... | 0x... | 14467 | S... | |
| 15 | .debug... | 0x00... | 0x... | 20011 | S... | |
| 16 | .debug... | 0x00... | 0x... | 4696 | S... | |
| 17 | .debug... | 0x00... | 0x... | 8389 | S... | SHF_ME... |
| 18 | .debug... | 0x00... | 0x... | 28708 | S... | |

Header Sections Segments Symbol Table Disassembly

Problems Tasks Console Properties

CDT Build Console [example]
'Finished building target: example.axf'
'

19:00:30 Build Finished (took 656ms)

You get the executable sections

Assemble/Link

DS-5 Workspace - C/C++ - example/Debug/example.axf - Eclipse Platform

File Edit Source Refactor Navigate Search Project Run Window Help

Project Explorer main.s example.axf

Segments

| Number | Type | Virtual Address | Physical Address | Memory Size (Bytes) | File Size |
|--------|------|-----------------|------------------|---------------------|-----------|
| 0 | P... | 0x00000... | 0x0000000... | 27124 (0x69F4) | 27124 |
| 1 | P... | 0x00000... | 0x0000000... | 14168 (0x3758) | 13700 |
| 2 | P... | 0x00000... | 0x0000000... | 36 (0x24) | 36 (0: |

An outline is not available.

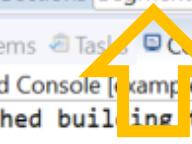
Header Sections Segments Symbol Table Disassembly

Problems Tasks Console Properties

CDT Build Console [example]
'Finished building target: example.axf'
19:00:30 Build Finished (took 656ms)

Quick Access

You get the executable segments



Assemble/Link

DS-5 Workspace - C/C++ - example/Debug/example.axf - Eclipse Platform

File Edit Source Refactor Navigate Search Project Run Window Help

Project Explorer main.s example.axf Symbol Table

An outline is not available.

| Number | Address | Name |
|--------|--------------------|---------------------------|
| 247 | 0x0000000080003BA0 | __register_exitproc |
| 248 | 0x0000000080019FC0 | __malloc_current_mallinfo |
| 249 | 0x0000000080006440 | _close_r |
| 250 | 0x0000000080005EA8 | _sfp |
| 251 | 0x0000000080019750 | __malloc_av_ |
| 252 | 0x0000000080005FE8 | _sinit_lock_release |
| 253 | 0x00000000800061B0 | _sread |
| 254 | 0x0000000080004B88 | __malloc_lock |
| 255 | 0x00000000800067F8 | _fflush_r |
| 256 | 0x0000000080019F7C | _bss_start |
| 257 | 0x0000000080003940 | memset |
| 258 | 0x0000000080001218 | main |
| 259 | 0x0000000080005938 | _link |
| 260 | 0x0000000080019FF0 | __malloc_max_total_mem |
| 261 | 0x00000000800062C0 | _sclose |
| 262 | 0x0000000080006580 | fclose |
| 263 | 0x0000000080004348 | __malloc_r |
| 264 | 0x0000000080006020 | fwalk |

Header Sections Segments Symbol Table Disassembly

Properties

CDT Build Console [example]
'Finished building target: example.axf'
19:00:30 Build Finished (took 656ms)

Quick Access

Ou... Bui...

Double click "example.axf"
You get the executable symbol table

Assemble/Link

DS-5 Workspace - C/C++ - example/Debug/example.axf - Eclipse Platform

File Edit Source Refactor Navigate Search Project Run Window Help

Project Explorer main.s example.axf

Disassembly

| | 0x00000000800011F0: | DCD | 0x8001A150 |
|------|---------------------|-----|----------------|
| | 0x00000000800011F4: | DCD | 0x00000000 |
| | 0x00000000800011F8: | DCD | 0x80003868 |
| | 0x00000000800011FC: | DCD | 0x00000000 |
| | 0x0000000080001200: | DCD | 0x80017028 |
| | 0x0000000080001204: | DCD | 0x00000000 |
| | 0x0000000080001208: | DCD | 0x80017030 |
| | 0x000000008000120C: | DCD | 0x00000000 |
| | 0x0000000080001210: | DCD | 0x000000FF |
| | 0x0000000080001214: | DCD | 0x00000000 |
| main | 0x0000000080001218: | ADD | x1, xzr, xzr |
| | 0x000000008000121C: | ADD | x1, x1, #0xf |
| | 0x0000000080001220: | BR | x30 |
| | 0x0000000080001224: | DCI | 0x00000000 ; ? |
| | 0x0000000080001228: | DCI | 0x00000000 ; ? |
| | 0x000000008000122C: | DCI | 0x00000000 ; ? |
| | 0x0000000080001230: | DCI | 0x00000000 ; ? |
| | 0x0000000080001234: | DCI | 0x00000000 ; ? |
| | 0x0000000080001238: | DCI | 0x00000000 ; ? |
| | 0x000000008000123C: | DCI | 0x00000000 ; ? |
| | 0x0000000080001240: | DCI | 0x00000000 ; ? |
| | 0x0000000080001244: | DCI | 0x00000000 ; ? |
| | 0x0000000080001248: | DCI | 0x00000000 ; ? |

Header Sections Segments Symbol Table Disassembly

Problems Tasks Console Properties

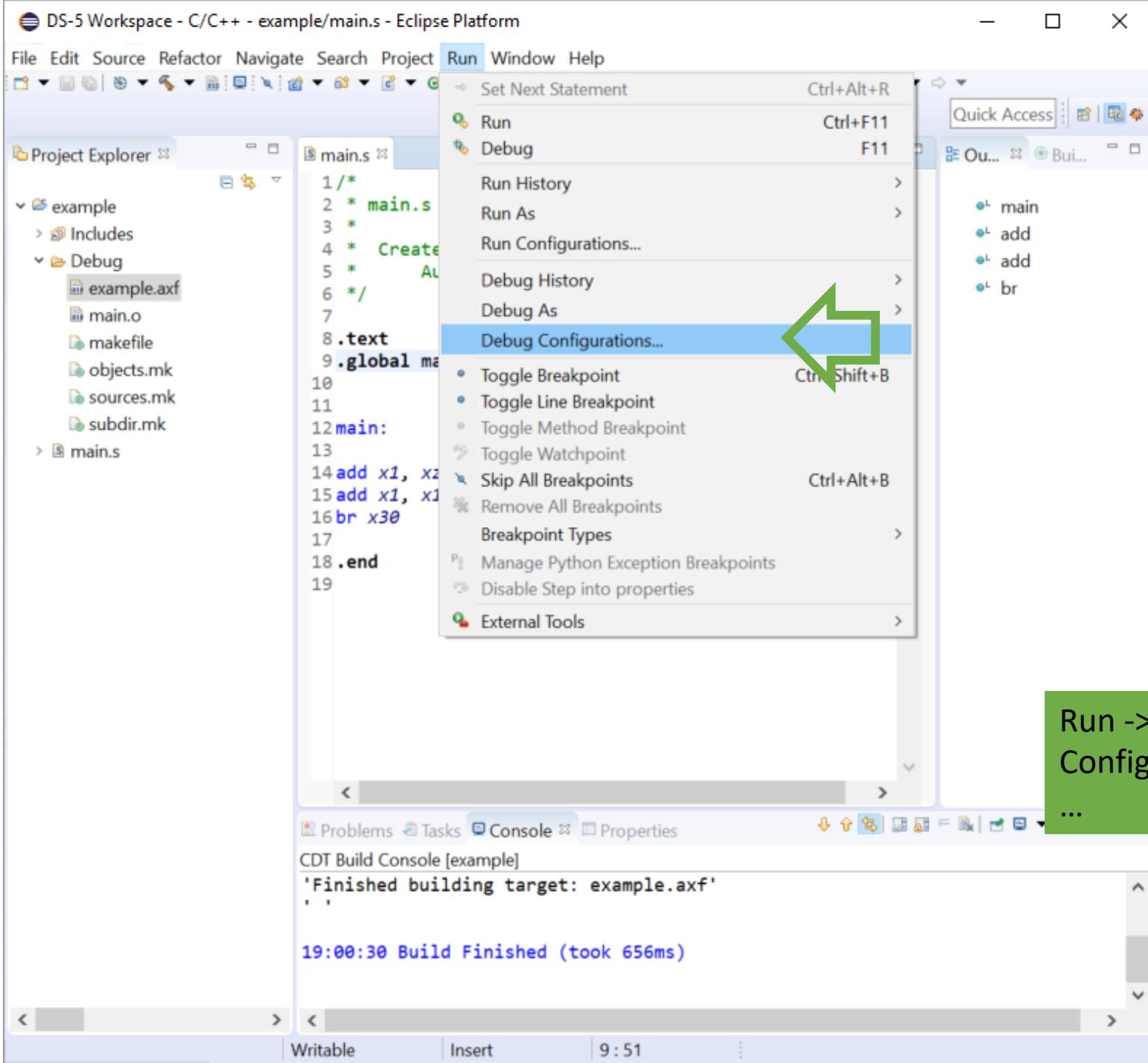
CDT Build Console [example]
'Finished building target: example.axf'
19:00:30 Build Finished (took 656ms)

Quick Access

An outline is not available.

Double click "example.axf"
You get the executable disassembly

Configure (and Debug)



Configure (and Debug)

Debug Configurations

Create, manage, and run configurations

Create, edit or choose a configuration to launch a DS-5 debugging session.

Configure launch settings from this dialog:

- Press the 'New' button to create a configuration of the selected type.
- Press the 'Duplicate' button to copy the selected configuration.
- Press the 'Delete' button to remove the selected configuration.
- Press the 'Filter' button to configure filtering options.
- Edit or view an existing configuration by selecting it.

Configure launch perspective settings from the '[Perspectives](#)' preference page.

DS-5 Debugger

Java Applet

Java Application

JUnit

Jython run

Jython unittest

Launch Group

PyDev Django

PyDev Google App Run

Python Run

Python unittest

Remote Java Application

Filter matched 18 of 18 items

Double click on “DS-5 Debugger”



Debug

Close

Configure (and Debug)

Debug Configurations

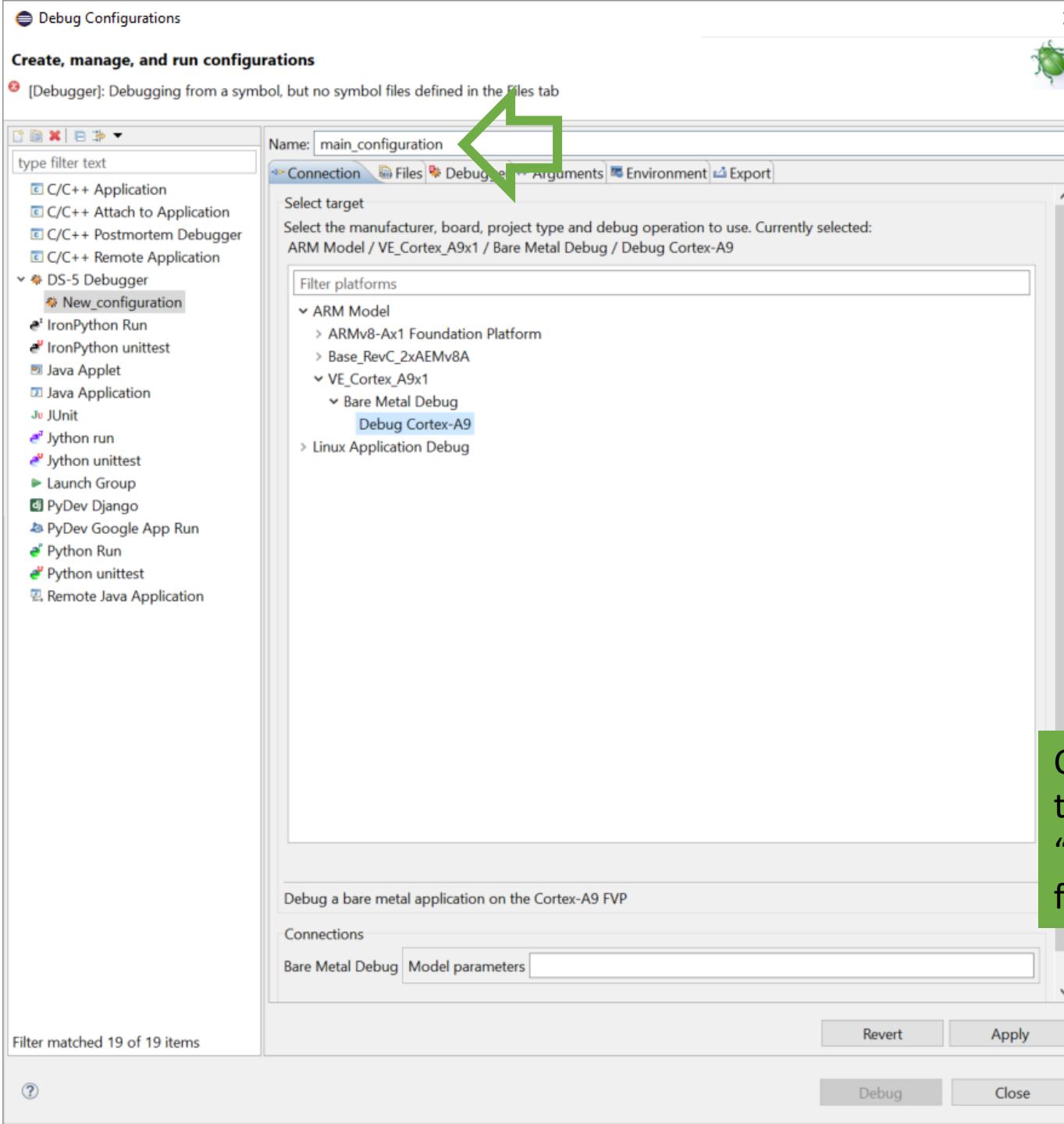
Create, manage, and run configurations

[Debugger]: Debugging from a symbol, but no symbol files defined in the Files tab

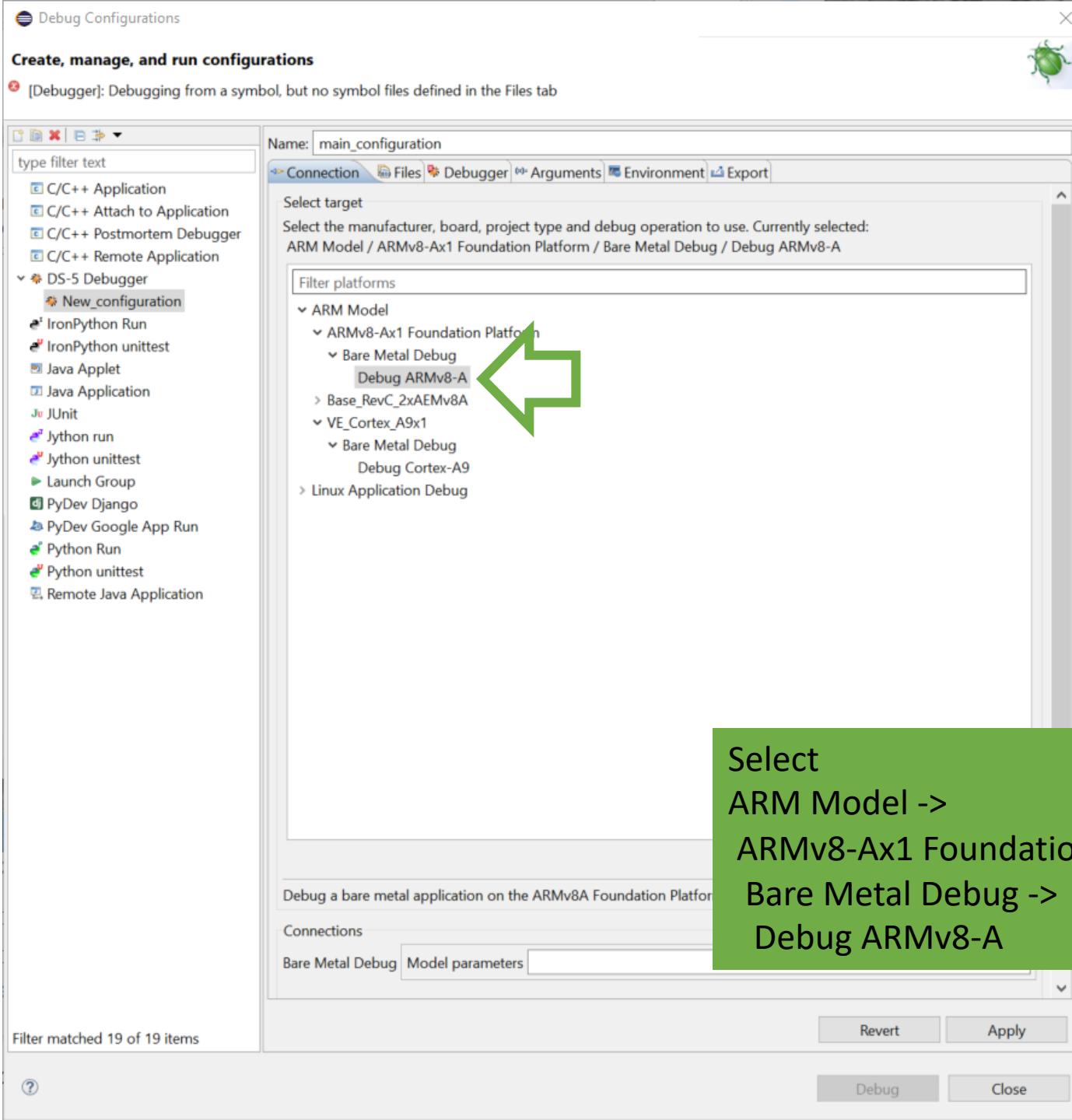
The screenshot shows the 'Debug Configurations' dialog in Eclipse. On the left is a tree view of configuration types, with 'DS-5 Debugger' expanded and 'New_configuration' selected. The main area is titled 'Name: New_configuration' and contains tabs for Connection, Files, Debugger (selected), Arguments, Environment, and Export. Under 'Select target', it says 'ARM Model / VE_Cortex_A9x1 / Bare Metal Debug / Debug Cortex-A9'. A 'Filter platforms' dropdown shows 'ARM Model' expanded, with 'VE_Cortex_A9x1' and 'Bare Metal Debug' selected, and 'Debug Cortex-A9' highlighted. Below this is a note: 'Debug a bare metal application on the Cortex-A9 FVP'. At the bottom are 'Connections' (Bare Metal Debug selected), 'Model parameters' (empty), and buttons for Revert, Apply, Debug, and Close.

This is what you get (need to make changes)

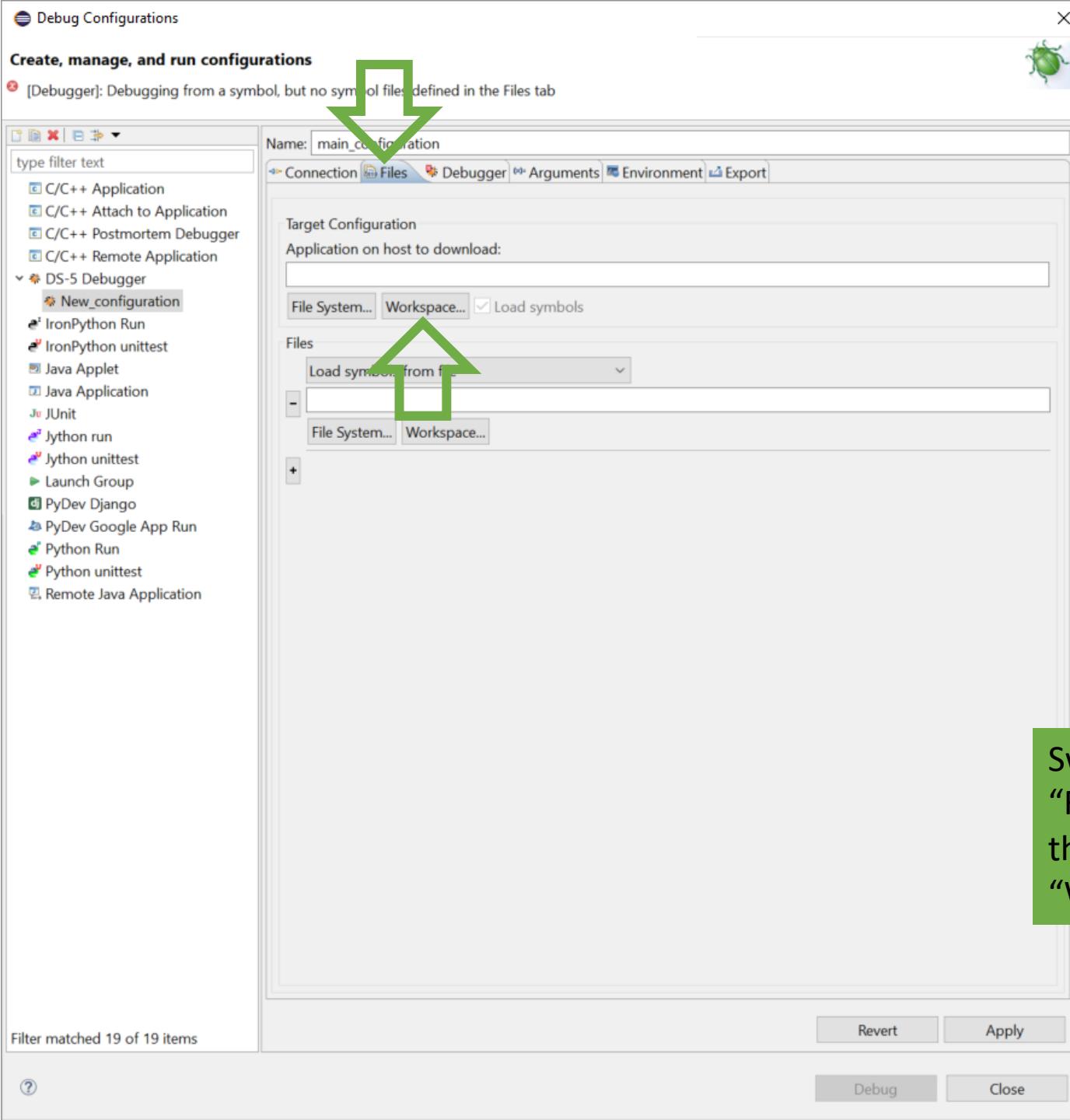
Configure (and Debug)



Configure (and Debug)

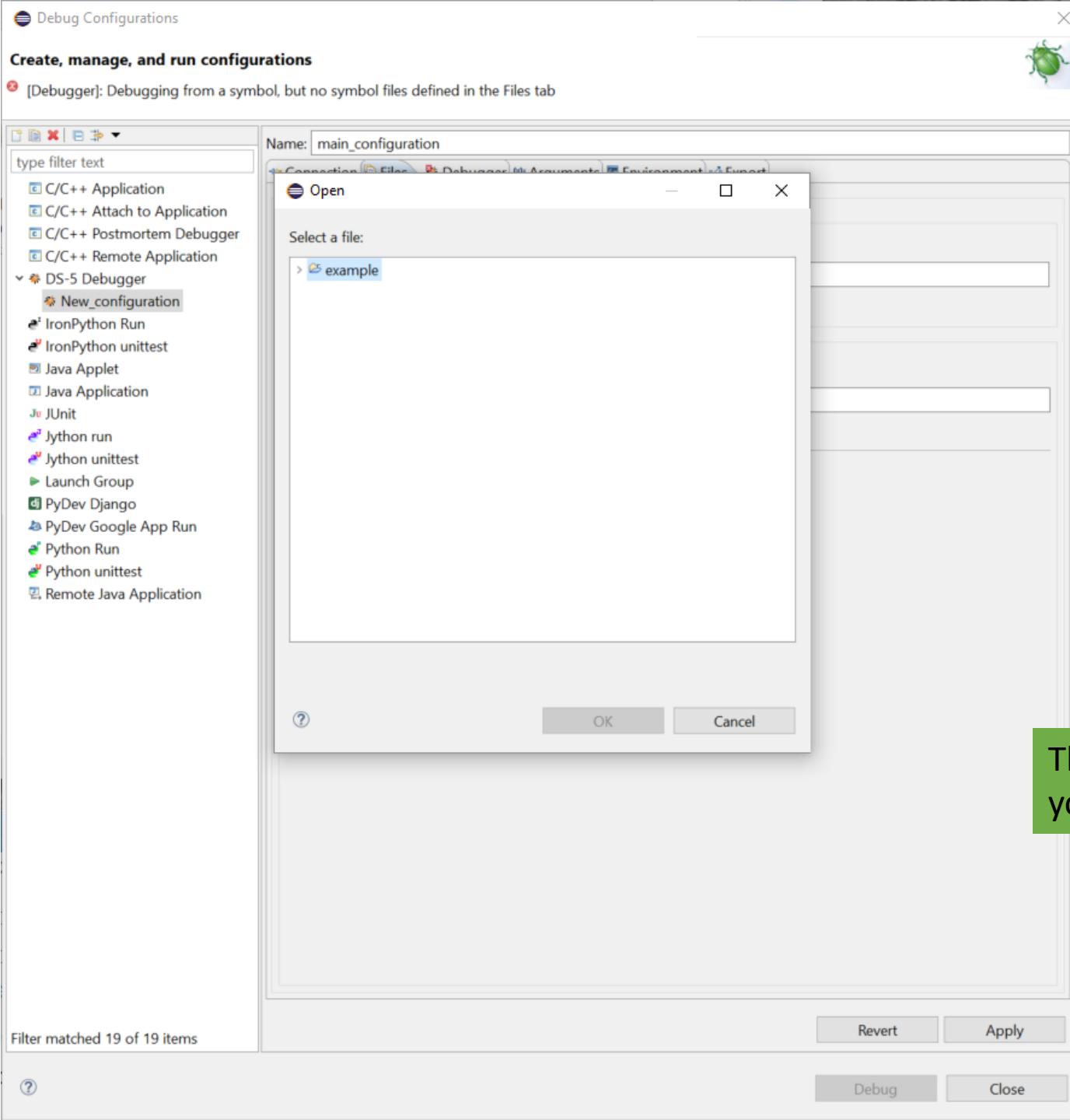


Configure (and Debug)



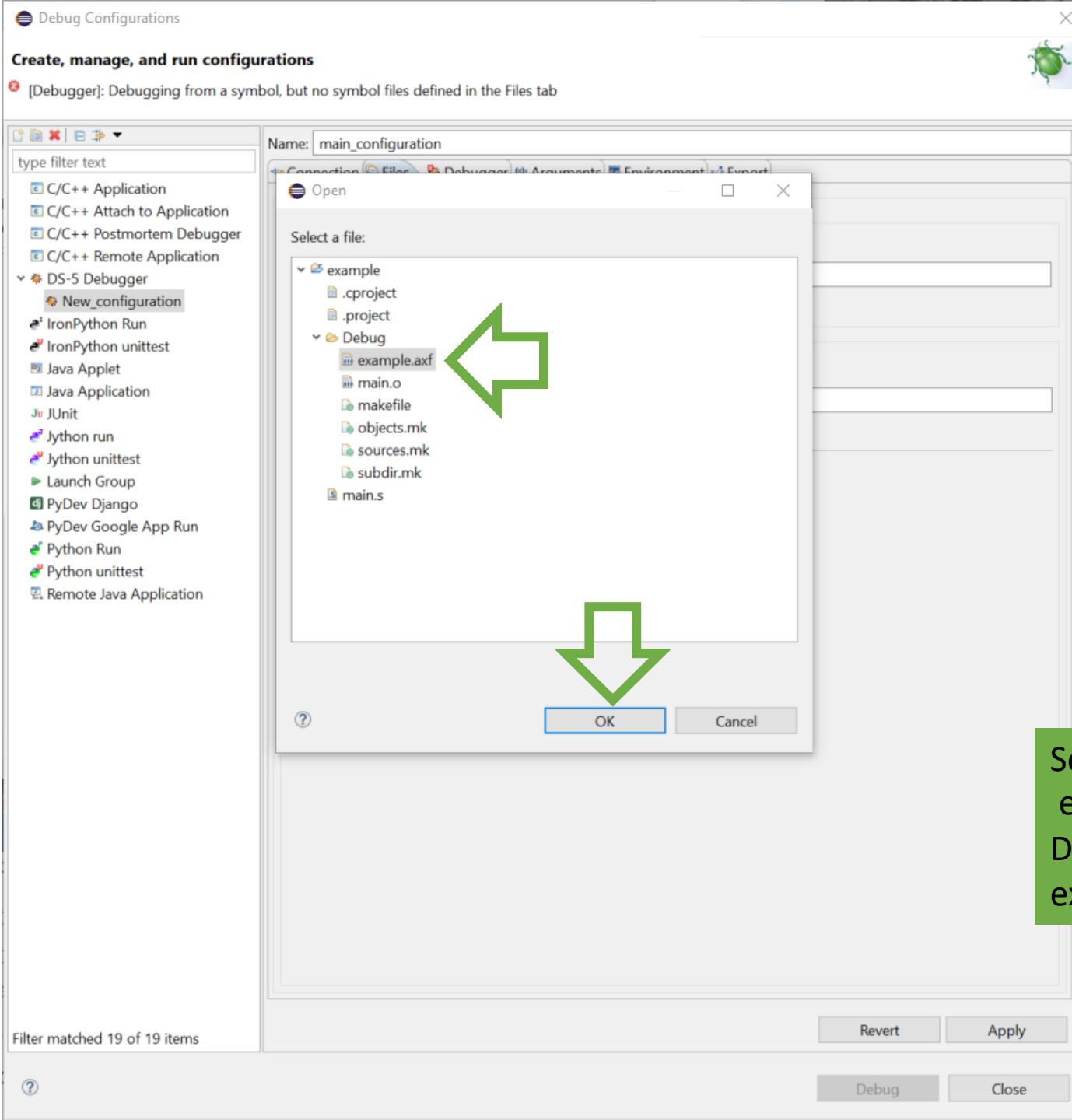
Switch to the
“Files” tab,
then click
“Workspace...”

Configure (and Debug)



This is what
you get

Configure (and Debug)



Select
example ->
Debug ->
example.axf

Configure (and Debug)

Debug Configurations

Create, manage, and run configurations

Create, edit or choose a configuration to launch a DS-5 debugging session.

Name: main_configuration

Connection Files Debugger Arguments Environment Export

Target Configuration

Application on host to download:
\${workspace_loc:/example/Debug/example.axf}

Load symbols

Files

Load symbols from file

-

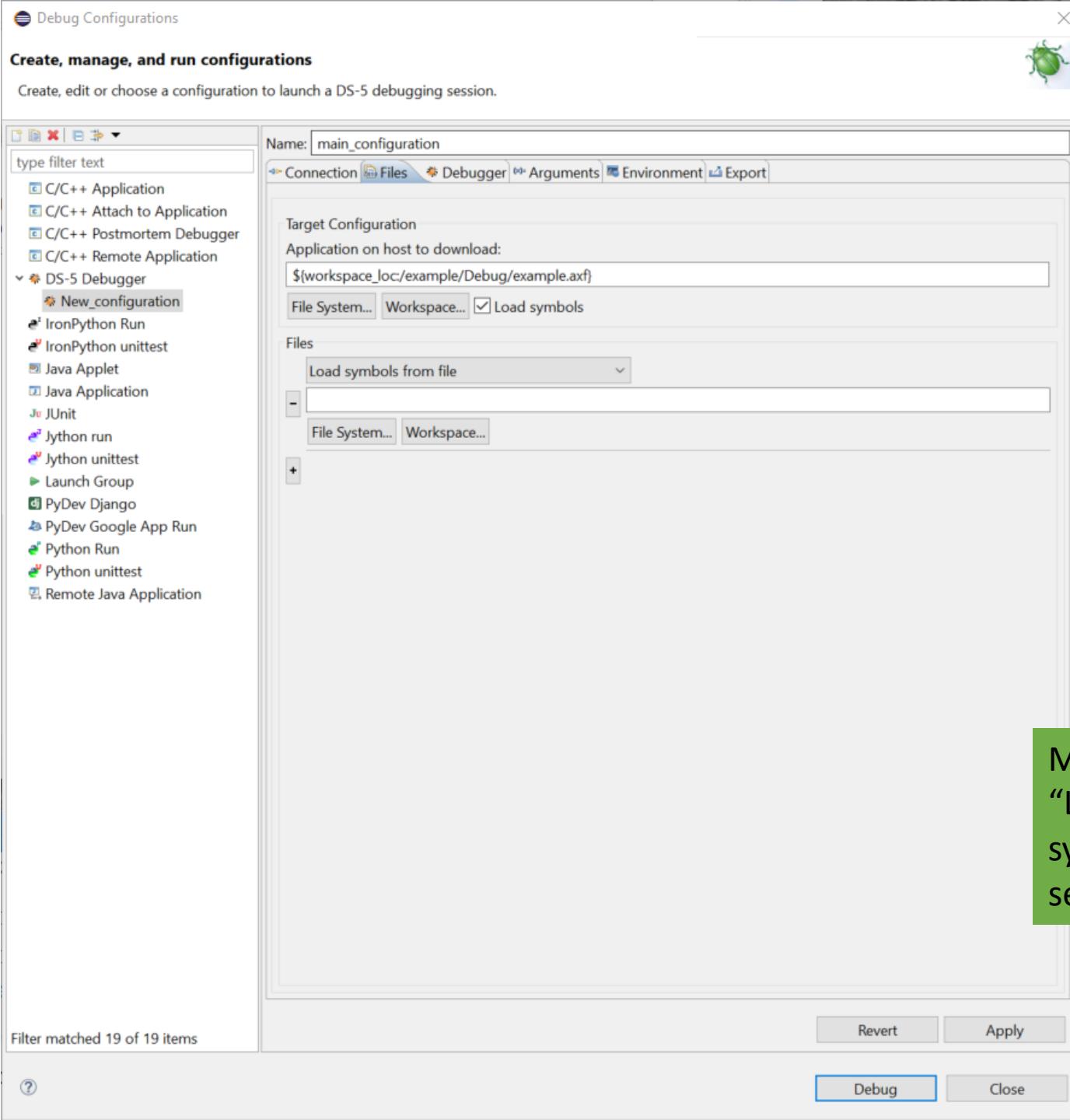
+

Filter matched 19 of 19 items

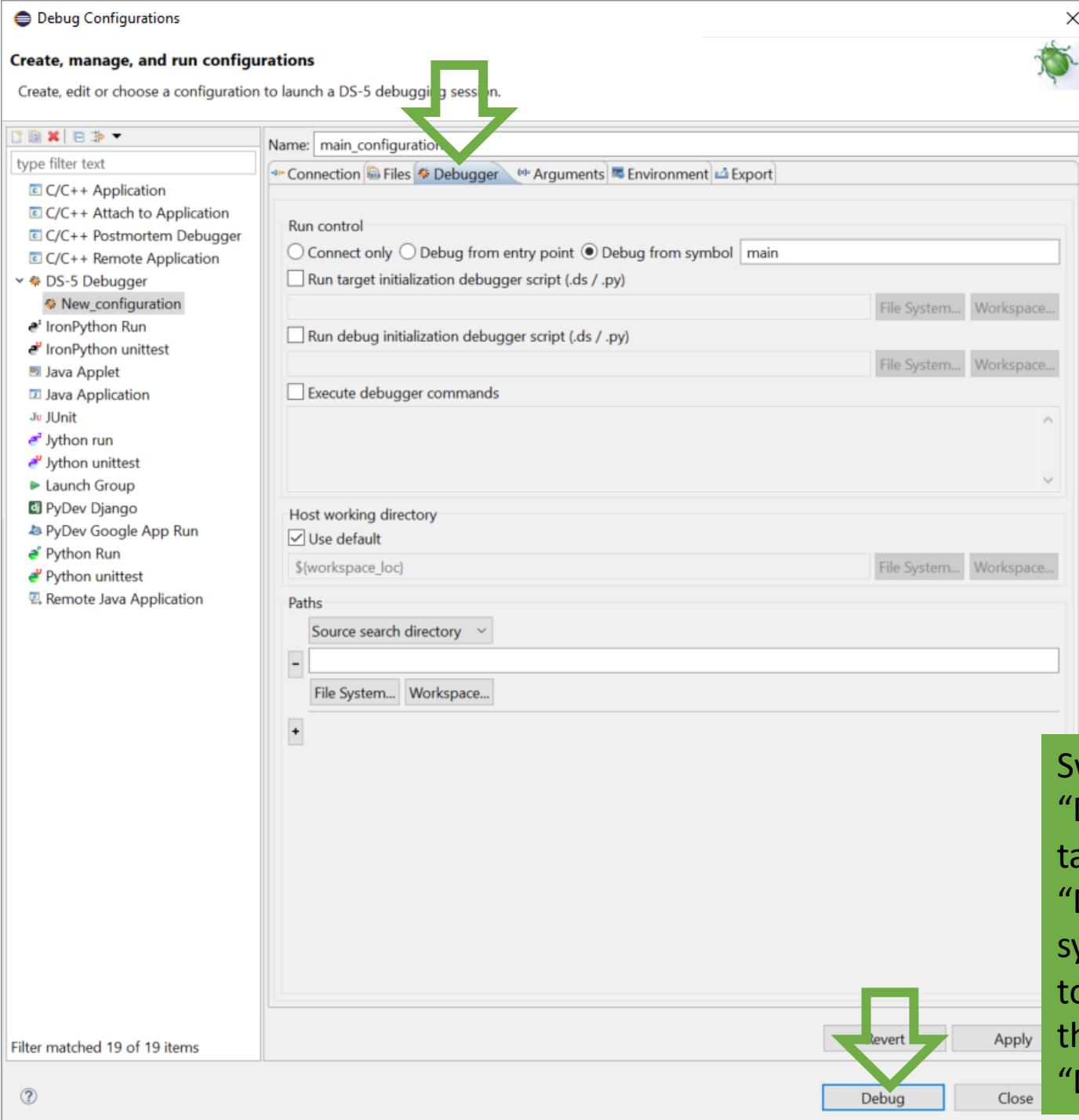
Revert Apply

Debug Close

Make sure
“Load
symbols” is
selected



Configure (and Debug)



Switch to
“Debugger”
tab, make sure
“Debug from
symbol” is set
to “main”,
then click
“Debug”



Project Explorer

- example
- Includes
- Debug
 - example.axf
 - main.o
 - makefile
 - objects.m
 - sources.m
 - subdir.mk
- main.s

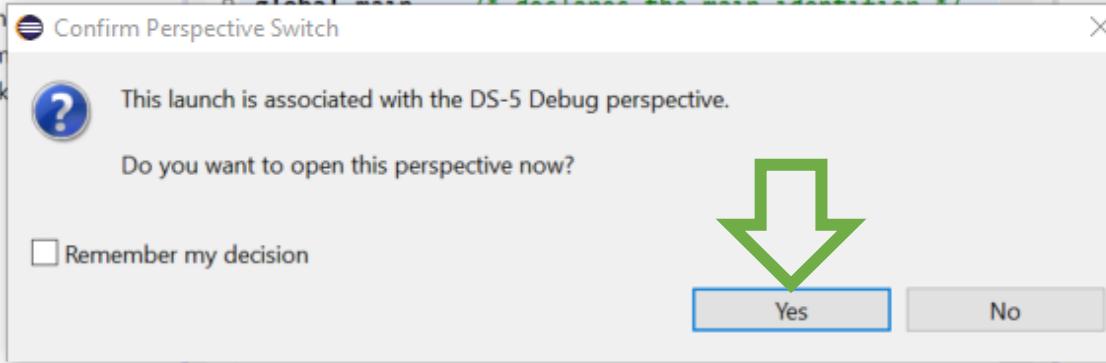
main.s

```
1 /*  
2 * main.s  
3 *  
4 * Created on: Sep 5, 2019  
5 * Author: antonio  
6 */  
7  
8 .text      /* Start of the program code section  
9 _global_main /* declares the main identifier */
```

Quick Access

Ou... Bui...

- main
- add
- add
- br



This is what
you get,
Click "Yes"

Problems Tasks Console Properties

CDT Build Console [example]

```
'Finished building target: example.axf'  
''
```

19:00:30 Build Finished (took 656ms)

Debug

DS-5 Workspace - DS-5 Debug - example/main.s - Eclipse Platform

File Edit Navigate Search Project Run Window Help

Debu... Proj... Remo... Commands History Scripts

main_configuration connected
ARMv8-A #1 stopped on breakpoint

Status: connected

main.s

```
1 /*
2 * main.s
3 *
4 * Created on: Sep 5, 2019
5 * Author: antonio
6 */
7
8 .text          /* Start of the program code section */
9 .global main   /* declares the main identifier */
10
11 main:         /* Address of the main function */
12
13 *14 add x1, xzr, xzr/* Load immediate value 15 */
14 add x1, x1, #15 /* Add */
15 br x30        /* Return to the caller */
16
17 .end           /* End of the program */
18
19
```

Commands

Starting target with image C:\Users\antonio\Documents\ARM\Workshop\DS-5\example\main.s
Running from entry point
wait
Execution stopped in EL3h mode at breakpoint
In main.s
EL3:0x000000080001218 14,0 add x1,
Deleted temporary breakpoint: 1

Command: Press (Ctrl+Space) for Content Assist Submit

Locals 0 variables
Local variables 0 of 11 variables
Globals 0 of 11 variables

Add Variable Browse...

D... M... S... E... O...

<Next Instrct 100

| Address | Opcc |
|-----------------------|-------|
| EL3:0x000000080001214 | 0000 |
| EL3:0x000000080001218 | 881F |
| EL3:0x00000008000121C | 9100 |
| EL3:0x000000080001220 | D61F0 |
| EL3:0x000000080001224 | 0000C |
| EL3:0x000000080001228 | 0000D |
| EL3:0x00000008000122C | 0000E |
| EL3:0x000000080001230 | 0000F |
| EL3:0x000000080001234 | 0000G |

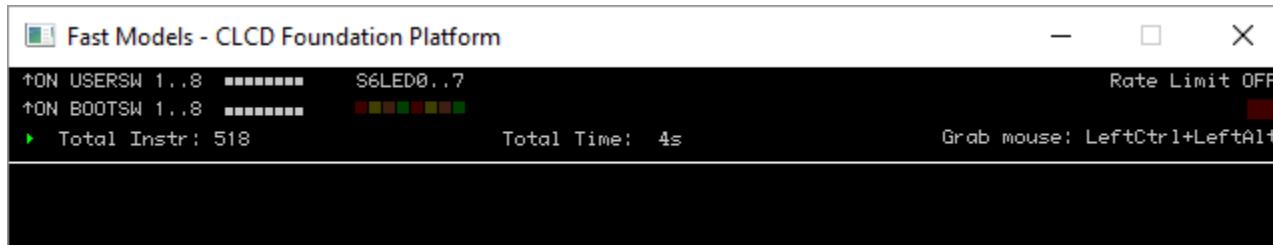
This is what you get

App... Target... Error...

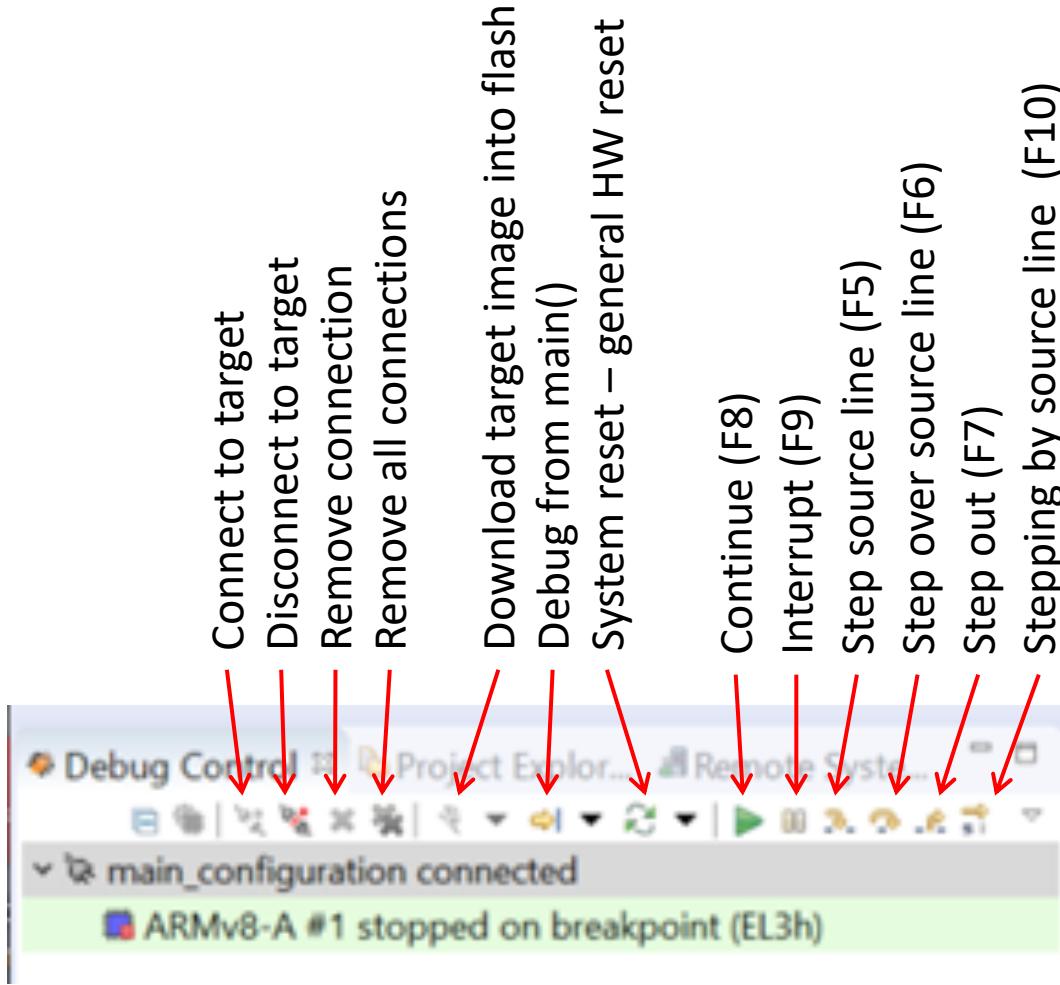
Info: Foundation_AEMv8A: CADI
CADI server is reported on po

Fast Models (the ARM Emulator)

- You need an emulator to run ARM on x86
 - x86 machine doesn't understand ARM machine code
- It will pop-up somewhere in you Desktop
 - Outside the DS-5 IDE



Controlling the Debugger



The Debugger

Debug

The screenshot shows the DS-5 Eclipse Platform interface for debugging an ARMv8-A target. The main window is divided into several sections:

- Source Code:** The leftmost section displays the C source code for "main.s". It includes comments like "Start of the program code section" and "End of the program". A large black arrow points from the text "Your Source Code" to this area.
- Registers:** The top right section shows the "Register Windows" for the AArch64 core. It lists registers X0 through X5 with their current values set to 0x0000000000000000. A large black arrow points from the text "Registers" to this table.
- Disassembly:** The bottom right section shows the "Disassembly" window. It lists instructions starting at address EL3:0x0000000080001214, including an ADD instruction at address EL3:0x0000000080001218 with operands x1, xzr, xzr. A large black arrow points from the text "Disassembly Code" to this window.
- Control Windows:** The top center section contains the "Debug Control" window, which shows the command history and the current configuration: "main_configuration connected" and "ARMv8-A #1 stopped on breakpoint (EL3h)". A large black arrow points from the text "Debug Ctrl Windows" to this window.
- Registers:** The middle right section shows the "Registers" tab of the Registers window, listing all 699 registers with their sizes and access types (R/W).
- Memory:** The bottom center section shows the "Memory" tab of the Registers window.
- Events:** The bottom right section shows the "Events" tab of the Registers window.
- Outline:** The bottom right section shows the "Outline" tab of the Registers window.
- App Console:** The bottom right section shows the "App Console" output, which includes messages about listening for serial connections and starting the CADI server.

Annotations in the image:

- Current instruction:** A dashed arrow points from the text "Current instruction" to the ADD instruction in the Disassembly window.
- Registers:** A large black arrow points from the text "Registers" to the Registers table in the top right.
- Disassembly Code:** A large black arrow points from the text "Disassembly Code" to the Disassembly window.
- Debug Ctrl Windows:** A large black arrow points from the text "Debug Ctrl Windows" to the Debug Control window.

Step Source Line #1

DS-5 Workspace - DS-5 Debug - example/main.s - Eclipse Platform

File Edit Navigate Search Project Run Window Help

Debug Control Project Explor... Remote System

main_configuration connected
ARMv8-A #1 stopped on stepi (EL3h)

Execution stopped in EL3h mode at breakpoint ^
In main.s
EL3:0x000000080001218 14,0 add x1, xzr
Deleted temporary breakpoint: 1
wait
step
Execution stopped in EL3h mode at EL3:0x00000008000121C 15,0 add x1, x1,
X0 0x0000000000000000
X1 0x0000000000000000
X2 0x0000000080017028
X3 0x00000000FEFFFFF0
X4 0x00000000FEFFFFE0
X5 0x0000000000000000

Status: connected

main.s

```
1/*
2 * main.s
3 *
4 * Created on: Sep 5, 2019
5 * Author: antonio
6 */
7
8.text      /* Start of the program code section */
9.global main /* declares the main identifier */
10
11
12main:     /* Address of the main function */
13
14add x1, xzr, xzr/* Load immediate value 15 */
15add x1, x1, #15 /* Add */
16br x30        /* Return to the caller */
17
18.end       /* End of the program */
19
```

Disassembly

| Address | Opcode | Disassembly |
|-----------------------|----------|------------------------------|
| EL3:0x000000080001214 | 00000000 | DCD 0x00000000 |
| EL3:0x000000080001218 | 8B1F03E1 | main ADD x1,xzr,xzr |
| EL3:0x00000008000121C | 01091C28 | ADD x1,x1,#0xf |
| EL3:0x000000080001220 | D61F03C0 | BR x30 |
| EL3:0x000000080001224 | 00000000 | DCI 0x00000000 ; ? Undefined |
| EL3:0x000000080001228 | 00000000 | DCI 0x00000000 ; ? Undefined |
| EL3:0x00000008000122C | 00000000 | DCI 0x00000000 ; ? Undefined |
| EL3:0x000000080001230 | 00000000 | DCI 0x00000000 ; ? Undefined |

App Console Target Console Error Log

terminal_3: Listening for serial connection on port 5003
CADI server started listening to port 7000

Info: Foundation_AEMv8A: CADI Debug Server started for ARM Models...
CADI server is reported on port 7000

main_configuration connected (ARM Model - ARMv8-Ax1 Foundation Platform)



Step Source Line #2

DS-5 Workspace - DS-5 Debug - example/main.s - Eclipse Platform

File Edit Navigate Search Project Run Window Help

Debug Control Project Explor... Remote System

main_configuration connected
ARMv8-A #1 stopped on stepi (EL3h)

Commands History Scripts

wait
step
Execution stopped in EL3h mode at EL3:0x000
EL3:0x00000008000121C 15,0 add x1, x1,
wait
step
Execution stopped in EL3h mode at EL3:0x000
EL3:0x000000080001220 16,0 br x30

Status: connected

main.s

```
1 /*  
2 * main.s  
3 *  
4 * Created on: Sep 5, 2019  
5 * Author: antonio  
6 */  
7  
8 .text      /* Start of the program code section */  
9 .global main /* declares the main identifier */  
10  
11  
12 main:    /* Address of the main function */  
13  
14 add x1, xzr, xzr/* Load immediate value 15 */  
15 add x1, x1, #15 /* Add */  
16 br x30     /* Return to the caller */  
17  
18 .end      /* End of the program */  
19
```

Variables Breakpoints Registers Expressions Functions

Register Set: All registers

| Name | Value | Size | Access |
|---------|----------------------|------|--------|
| AArch64 | 699 of 699 registers | | |
| Core | 64 of 64 registers | | |
| X0 | 0x0000000000000000 | 64 | R/W |
| X1 | 0x000000000000000f | 64 | R/W |
| X2 | 0x0000000080017028 | 64 | R/W |
| X3 | 0x00000000FEFFFFF0 | 64 | R/W |
| X4 | 0x00000000FEFFFFE0 | 64 | R/W |
| X5 | 0x0000000000000000 | 64 | R/W |

Disassembly

| Address | Opcod | Disassembly |
|-----------------------|----------|------------------------------|
| EL3:0x000000080001218 | 8B1F03E1 | ADD x1,xzr,xzr |
| EL3:0x00000008000121C | 91003C21 | ADD x1,x1,#0xf |
| EL3:0x000000080001220 | 051F03C0 | BR x30 |
| EL3:0x000000080001224 | 00000000 | DCI 0x00000000 ; ? Undefined |
| EL3:0x000000080001228 | 00000000 | DCI 0x00000000 ; ? Undefined |
| EL3:0x00000008000122C | 00000000 | DCI 0x00000000 ; ? Undefined |
| EL3:0x000000080001230 | 00000000 | DCI 0x00000000 ; ? Undefined |
| EL3:0x000000080001234 | 00000000 | DCI 0x00000000 ; ? Undefined |
| EL3:0x000000080001238 | 00000000 | DCI 0x00000000 ; ? Undefined |

App Console Target Console Error Log

terminal_3: Listening for serial connection on port 5003
CADI server started listening to port 7000

Info: Foundation_AEMv8A: CADI Debug Server started for ARM Models...
CADI server is reported on port 7000



Step Source Line #3 (out of program)

Debug

DS-5 Workspace - DS-5 Debug - Source Not Found - Eclipse Platform

File Edit Navigate Search Project Run Window Help

Quick Access

Debug Control Project Explor... Remote Syste...

main_configuration connected

ARMv8-A #1 stopped on stepi (EL3h)

Execution stopped in EL3h mode at EL3:0x000000080001220 16,0 br x30
wait
step

Execution stopped in EL3h mode at EL3:0x0000000800011D8 221,0 B e

Status: connected

main.s crt0.S

Source Not Found

The Source File /home/tcwg-buildslave/workspace/tcwg-make-release_1/snapshots/newlib.git~linaro-local~linaro-newlib-2_5_0/libgloss/aarch64/crt0.S was not found. If this source is available you can view it by configuring a path substitution.

Set Path Substitution

Commands History Scripts

Variables Breakpoints Registers Expressions Functions

Register Set: All registers

| Name | Value | Size | Access |
|------|--------------------|------|--------|
| X0 | 0x0000000000000000 | 64 | R/W |
| X1 | 0x000000000000000F | 64 | R/W |
| X2 | 0x0000000080017028 | 64 | R/W |
| X3 | 0x00000000FEFFFFF0 | 64 | R/W |
| X4 | 0x00000000FEFFFFE0 | 64 | R/W |
| X5 | 0x0000000000000000 | 64 | R/W |

Disassembly

| Address | Opcde | Disassembly |
|------------------------|----------|----------------------|
| EL3:0x00000000800011D0 | 9100009F | MOV sp,x4 |
| EL3:0x00000000800011D4 | 94000011 | BL main ; 0x80001218 |
| EL3:0x00000000800011D8 | 400095 | B exit ; 0x80003830 |
| EL3:0x00000000800011DC | D65F03C0 | RET |
| EL3:0x00000000800011E0 | 80017008 | DDC 0x80017008 |
| EL3:0x00000000800011E4 | 00000000 | DDC 0x00000000 |
| EL3:0x00000000800011E8 | 80019F7C | DDC 0x80019F7C |
| EL3:0x00000000800011EC | 00000000 | DDC 0x00000000 |
| EL3:0x00000000800011F0 | 8001A150 | DDC 0x8001A150 |

App Console Target Console Error Log

terminal_3: Listening for serial connection on port 5003
CADI server started listening to port 7000

Info: Foundation_AEMv8A: CADI Debug Server started for ARM Models...
CADI server is reported on port 7000

main_configuration connected (ARM Model - ARMv8-Ax1 Foundation Platform)

Additional Material

Reference Material from ARM

- **Part 1 - Introduction to ARMv8 Architecture and DS-5**
 - https://www.youtube.com/watch?v=_tXWrHD8shs
- **Part 2 - Install and Setup DS-5**
 - <https://www.youtube.com/watch?v=vnycl5JV0B8>
- **Part 3 - Create a Project for ARMv8 Model**
 - <https://www.youtube.com/watch?v=xNHIAHJ2ceY>
- **DS-5 Tutorials**
 - <https://developer.arm.com/tools-and-software/embedded/legacy-tools/ds-5-development-studio/resources/tutorials>
- **DS-5 Getting Started Tutorial**
 - <https://developer.arm.com/tools-and-software/embedded/legacy-tools/ds-5-development-studio/resources/tutorials/getting-started-with-ds-5-development-studio>

Other Links

- How to create a ASM project (not ARM!)
 - <http://www.lirmm.fr/~bosio/HLEE503/TP/TP0.pdf>
- How to create a C + ASM project (ARM)
 - <https://bitbucket.org/HarryBroeders/legv8/wiki/Home>
 - <http://math.hws.edu/eck/cs220/f18/lab4/index.html>
 - Check “First-time Setup”
- **Please note you must create ASM only projects**