# CSCE 4114/5114 Embedded Systems: Board Flashing Instructions

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#### Introduction

- To get your application flashed on your board you will need two things:
  - A bootloader application to launch your application once it is stored on the flash memory
  - Your project application

### **Bootloader:** Creating the Application

- Start off by creating a new "Application Project" in the SDK
- Name the project "*Bootloader*" or something along those lines
  - Make the OS Platform is "standalone"
  - For Board Support Package, you'll want to create a new package for the Bootloader.
- On the next page:
  - Select the "SREC SPI Bootloader" template
  - Then click on "Finish" to create the project

| New Project X  |   |
|--|---|
| Application Project<br>A project with that name already exists in the workspace.   | Mew Project – – X   |
| Project name:       Bootloader         ✓       Use default location         Location:       C\Users\tfkamuch\Desktop\labs\embedded_systems_lab.sd         Browse       Choose file system:         default       ✓         OS Platform:       standalone         ✓       Target Hardware         Hardware Platform:       base_soc_wrapper_hw_platform_0         Processor:       microblaze_0         ✓       Target Software         Language: <ul> <li>© C ○ C++</li> <li>Compiler:</li> <li>32-bit</li> <li>✓</li> <li>Board Support Package:</li> <li>O Use existing</li> <li>ArtyBot_bsp</li> <li>✓</li> </ul> | Image: Create one of the available templates to generate a fully-functioning application project.         Available Templates:         Dhrystone         Empty Application         Hello World         WWP Echo Server         Memory Tests         Peripheral Tests         SREC Solloader         SREC Spil Bootloader         SREC Spil Bootloader         Update the serial_flash_family & serial_flash_interface in xilisf library in BSP settings!         Don't forget to modify bloonfig, h to reflect the offset where your SREC image resides in non-volatile memory! |
| <br>   |   |

### **Bootloader:** Board Support Package

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- We need to make a few changes to the board support package before the Bootloader is ready:
  - Namely, we want to add support for flash memory
  - And change the flash memory family to match what's on the board
- Under "Bootloader bsp":
  - Open the "system.mss" file
  - Then select "Modify this BSP's Settings"



#### Bootloader\_bsp Board Support Package Modify this BSP's Settings Re-generate BSP Sources

#### Target Information

This Board Support Package is compiled to run on the follow Hardware Specification: C:\Users\tfkamuch\Desktop\labs\e Target Processor: microblaze\_0

#### Operating System

Board Support Package OS. Name: standalone Version: 6.1 Description: Standalone is a simple, low-level software Documentation: standalone v6 1

#### Peripheral Drivers

Drivers present in the Board Support Package.

Pmod DHB1 0 Pmod DHI Pmod\_Dual\_MAXSONAR\_0 Pmod\_Dua axi ethernetlite 0 emaclite axi\_gpio\_0 gpio axi\_gpio\_1 gpio

## **Bootloader:** Board Support Package

- In the Board Support Package Settings window:
  - Enable the "xilisf" option under supported libraries
  - A new "**xilisf**" option should appear on the left side under "*Overview > standalone > xilisf*"
  - Select the "**xilisf**" option and modify "serial flash family" value to **5**.
  - **5**, matches the Spanion flash chip on the Arty boards
- We're done with the Bootloader's BSP!

| d Support Packa   | ge Settings  |  |  |   |  |                            |
|---|--|--|--|---|--|----------------------------|
| trol various settings of y  | your Board Support Pac   | kage.  |  |   |  | 4                          |
| verview<br>standalone   | Bootloader_bsp   | 1000   | Standalono is a simple I                           | ou loud coffuero lavor litore                                 | vider access to basis a                                |                            |
| xilist<br>drivers<br>microblaze_0   | OS lype: standa<br>OS Version: 6.1 ~   | ,  | features such as caches,<br>hosted environment, su | interrupts and exceptions as<br>ch as standard input and outp | well as the basic feature<br>out, profiling, abort and | es of a<br>l exit.         |
|   | Target Hardware  |  |  |   |  |                            |
|   | Hardware Specifica   | tion: C:\Users\tfka  | much\Desktop\labs\em                               | bedded_systems_lab.sdk\bas                                    | e_soc_wrapper_hw_plat                                  | form_0                     |
|   | Processor:   | microblaze_0   |  |   |  |                            |
|   | Supported Libraries<br>Check the box nex<br>navigator on the le  | t to the libraries yo<br>ft.                                   | u want included in your                            | Board Support Package.You                                     | can configure the libra                                | y in the                   |
|   | Name   | Version  | Description  |   |  | ^                          |
|   | 🗌 xilflash   | 4.2  | Xilinx Flash library                               | for Intel/AMD CFI compliant                                   | t paral  |                            |
|   | xilisf   | 5.7  | Xilinx In-system a                                 | nd Serial Flash Library                                       |  |                            |
|   | xilmfs   | 2.2  | Xilinx Memory File System                          |   |  |                            |
|   | - vilom  | 2.0  | Power Manageme                                     | ent API Library for ZyngMP                                    |  | ~                          |
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## **Bootloader:** Memory Configuration

- In the "Bootloader" project, open the "blconfig.h" file.
- Next, modify the "FLASH\_IMAGE\_BASEADDR" value to "0x00C00000"
- This will be the starting address of your project in the flash memory
- Optionally, if you want to see debug info in Putty:
  - Uncomment the "#define VERBOSE" line in "bootloader.c"
- The Bootloader is ready!



## Creating Your Project: BSP

- Start by creating your "New Application Project" for your design:
  - You can create a separate board support package for your application
- Next, make the same changes to your application's board support package to support the flash chip

| <b>ge Settings</b><br>your Board Support Pa   | ckage.   |  |   |  |   |  |
|---|--|--|---|--|---|--|
| your Board Support Pa   | ckage.   |  |   |  |   |  |
|   | -  |  |   |  | Ó   |  |
| Bootloader_bsp       OS Type:     standa       OS Version:     6.1       Target Hardware     Hardware       Hardware Specifica     Processor:       Supported Librarie     Check the box ne | Bootloader_bsp         OS Type:       standalone         Standalone       Standalone is a simple, low-level software layer. It provides access to basic processor features such as caches, interrupts and exceptions as well as the basic features of a hosted environment, such as standard input and output, profiling, abort and exit.         Target Hardware       Hardware Specification:         Hardware Specification:       C·Users\tfkamuch\Desktop\labs\embedded_systems_lab.sdk\base_soc_wrapper_hw_platform_0*         Processor:       microblaze_0   |  |   |  |   |  |
| Name<br>xilflash<br>xilisf<br>vilmfs  | eft. Version<br>4.2<br>5.7<br>2.2  | Description<br>Xilinx Flash librat<br>Xilinx In-system | ry for Intel/AMD CFI complian<br>and Serial Flash Library<br>ile System   | ıt paral   | ^   |  |
|   | 2.0  | Power Managem  | nent API Library for ZvndMP   |  | •   |  |
| :kage Settings<br><b>ackage Settings</b><br>ngs of your Board Supp  | ort Package.   |  | C   | ОК С   | ancel   |  |
| Configuration   | n for library: xilisf  |  |   |  |   |  |
| Name<br>0   | sh_family<br>sh_interface  | Value<br>5<br>1  | Default<br>1<br>1   | Type<br>integer<br>integer   | Descri<br>Indicat<br>Indicat  |  |
|   | Configuration Settings | Configuration for library: xilisf                      | OS Type:     standalone     Standalone is a simple, features such as cache hosted environment, s       OS Version:     6.1 v     features such as cache hosted environment, s       Target Hardware     Hardware Specification:     Clusers\tftkamuch\Desktop\labs\er       Hardware Specification:     Clusers\tftkamuch\Desktop\labs\er       Processor:     microblaze_0       Supported Libraries     Check the box next to the libraries you want included in you navigator on the left.       Name     Version     Description       xiliffs     5.7     Xilinx Flash libra       xiliff     5.7     Xilinx In-system       xilinfs     2.2     Xilinx Memory F       xilor     2.0     Power Managen | OS Type:     standalone     Standalone is a simple, low-level software layer. It pr<br>features such as caches, interrupts and exceptions as<br>hosted environment, such as standard input and out       Target Hardware     Hardware Specification: C:\Users\tfkamuch\Desktop\labs\embedded_systems_lab.sdk\bar<br>Processor: microblaze_0       Supported Libraries     Check the box next to the libraries you want included in your Board Support Package.You<br>navigator on the left.       Name     Version       2.0     Power Management API Library for Intel/AMD CFI compliant<br>xilinfs       2.2     Xilinx Flash library for Intel/AMD CFI compliant<br>xilinfs       2.3     Power Management API Library for ZvnoMP | OS Type:     standalone     Standalone is a simple, low-level software layer. It provides access to basic p features such as caches, interrupts and exceptions as well as the basic featur hosted environment, such as standard input and output, profiling, abort and specification:       Target Hardware |  |

Cancel

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## Creating Your Project: Linker Script

- We want to make sure our compiled application are run from the DDR3 ram, so we need to change the linker script
- Start by right-clicking your project's folder and selecting "Generate Linker Script"
- On the right side of the generate window, change all the memory locations to "*mig\_7series\_0\_memaddr*"
- Now, move on to developing your amazing application

|   |                     |                          | 10         |                   |                         | <br>     |
|---|---------------------|--------------------------|------------|-------------------|-------------------------|----------|
| Project Explorer 🛛                            | 🖻 🕏                 |                          |            |                   |                         |          |
| > ِ ArtyBot_bsp                               |                     |                          |            |                   |                         |          |
| > ArtyBot_example0                            |                     |                          |            |                   |                         |          |
| ✓ <sup>2</sup> ArtyBot example1               |                     |                          |            |                   |                         |          |
| > 👯 Binaries                                  |                     |                          |            |                   |                         |          |
| > 🔊 Includes                                  |                     |                          |            |                   |                         |          |
| > Ca Debug                                    |                     |                          |            |                   |                         |          |
|   |                     |                          |            |                   |                         |          |
| <ul> <li>artyBotLibic</li> </ul>              |                     |                          |            |                   |                         |          |
| > le artybotcib.c                             |                     |                          |            |                   |                         |          |
| > in artybotcib.n                             |                     |                          |            |                   |                         |          |
| > .c main.c                                   |                     |                          |            |                   |                         |          |
| > C motorControl.c                            |                     |                          |            |                   |                         |          |
| > In motorControl.h                           |                     |                          |            |                   |                         |          |
| > ic pidController.c                          |                     |                          |            |                   |                         |          |
| > h pidController.h                           |                     |                          |            |                   |                         |          |
| 🐚 Iscript.ld                                  |                     |                          |            |                   |                         |          |
| Generate a linker script                      |                     |                          |            |                   |                         | ×        |
| Generate linker script                        |                     |                          |            |                   |                         | <b>6</b> |
| Control your application's memory ma          |                     |                          |            |                   |                         |          |
| r   | μ.                  |                          |            |                   |                         |          |
| Output Settings                               |                     |                          | Basic      | Advanced          |                         |          |
| Project: ArtyBot_example1                     |                     |                          | Place      | Code Sections in: | mig 7series 0 memaddr   | ~        |
| Output Script:                                | L . IIX A . D . L . |                          | Plac       | Data Sections in  | mig 7series 0 memaddr   | <br>     |
| 1\Desktop\labs\embedded_systems_              | ар.sdk\Алтувот_ex   | Cample I \src\iscript.id | owse Place |                   | mig_rseries_0_mernadal  |          |
| Modify project build settings as follow       | /s:                 |                          | Plac       | Heap and Stack in | : mig_/series_0_memaddr |          |
| Set generated script on all project but       | ld configurations   |                          | Hea        | Size:             | 1 KB                    |          |
| Hardware Memory Map                           |                     | 1                        | Stac       | c Size:           | 1 KB                    |          |
| Memory  | Base Address        | Size                     |            |                   |                         |          |
| microblaze_0_local_memory_ilmb                | 0x00000000          | 128 KB                   |            |                   |                         |          |
| mg_/selles_o_memadu                           | 0x0000000           | 230                      |            |                   |                         |          |
|   |                     |                          |            |                   |                         |          |
|   |                     |                          |            |                   |                         |          |
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|   |                     |                          |            |                   |                         |          |
| <ul> <li>Fixed Section Assignments</li> </ul> |                     |                          |            |                   |                         |          |
|   |                     |                          |            |                   |                         |          |
|   |                     |                          |            |                   |                         |          |
|   |                     |                          |            |                   |                         |          |
|   |                     |                          |            |                   |                         |          |

## SPI Flashing: Generating Bitstream

- First, we generate a bitstream that we'll later use to flash the SPI memory.
- Open the "Program FPGA" utility
- Then change the "ELF/MEM File to Initialize Block RAM" option to "Bootloader.elf"
- Refer to example image for path to elf file
- Now, click "Program"

| SOK Program FPGA      | Program FPGA        |  |             |          |  |  |
|-----------------------|---------------------|--|-------------|----------|--|--|
| Program FPGA          |                     |  |             | <b></b>  |  |  |
| Specify the bitstream | n and the ELF files | that reside in BRAM memory   |             | ц́но (   |  |  |
| -Hardware Configura   | tion                |  |             |          |  |  |
| Hardware Platform:    | base_soc_wrapp      | er_hw_platform_0 v   |             |          |  |  |
| Connection:           | Local               | ~  | New         |          |  |  |
| Device:               | Auto Detect         |  | Select      |          |  |  |
| Bitstream:            | base_soc_wrapp      | per.bit  | Search      | Browse   |  |  |
| Partial Bitstream     |                     |  |             |          |  |  |
| BMM/MMI File:         | base_soc_wrapp      | ver.mmi  | Search      | Browse   |  |  |
| Software Configurat   | ion                 |  |             |          |  |  |
| Processor             |                     | ELF/MEM File to Initialize in Block RAM  |             |          |  |  |
| microblaze_0          |                     | $\label{eq:c:Users} C: \label{eq:users} C: \l$ | ebug\Bootlo | ader.elf |  |  |
|                       |                     |  |             |          |  |  |
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| <                     |                     |  |             | >        |  |  |
| (2)                   |                     | Progra   | n           | Cancel   |  |  |
|                       |                     | Program  |             | ancer    |  |  |

## SPI Flashing: Your project

- Now let's get your project on the board
- Open the "Program Flash Memory" utility
- Set the "Image File" to your project's compiled elf file
- Set the "Offset" to "Ox00C00000"
- For flash type, refer to example image
- Check all the checkboxes in the bottom section
- Now, click "Program" to begin flashing the board

| SDK                  |  | ×      |  |  |  |
|----------------------|--|--------|--|--|--|
| Program Flash Memory |  |        |  |  |  |
| Program Flash Mer    | mory via In-system Programmer.   |        |  |  |  |
| Hardware Platform:   | base_soc_wrapper_hw_platform_0   | ~      |  |  |  |
| Connection:          | Local ~  | New    |  |  |  |
| Device:              | Auto Detect  | Select |  |  |  |
| Image File:          | $\fbox{\label{thm:constraint} C:\label{thm:constraint} C:\label{thm:constraint} C:\label{thm:constraint} Users\tfkamuch\Desktop\label{thm:constraint} label{thm:constraint} example 1.elf} \label{thm:constraint} C:\label{thm:constraint} Users\tfkamuch\Desktop\label{thm:constraint} label{thm:constraint} label{thm:constraint} label{thm:constraint} label{thm:constraint} \label{thm:constraint} \label{thm:constraint} C:\label{thm:constraint} Users\tfkamuch\Desktop\label{thm:constraint} label{thm:constraint} lab$ | Browse |  |  |  |
| Offset:              | 0x00C00000   |        |  |  |  |
| Flash Type           | s25f1128sxxxxx0-spi-x1_x2_x4   | ~      |  |  |  |
| FSBL File:           |  | Browse |  |  |  |
| Convert ELF to be    | potloadable SREC format and program  |        |  |  |  |
| Blank check after    | erase  |        |  |  |  |
| ✓ Verify after flash |  |        |  |  |  |
| ?                    | Program Car  | ncel   |  |  |  |

## SPI Flashing: Bootloader

- Almost there! Now we need to flash Bootloader
- Open the "**Program Flash Memory**" utility again
- This time, change "Image File" to "base\_soc\_wrapper\_hw\_platform\_0\d ownload.bit"
- Set the "Offset" to "OxO"
- Finally, click "Program"
- We're done! Your bot should be ready to drive solo.

