SDSoC Environment Platform Development Guide

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Revision History

The following table shows the revision history for this document.

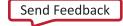
Date	Version	Revision
11/30/2016	2016.3	Initial documentation release for SDx™ IDE 2016.3, which includes both the SDSoC™ Environment and the SDAccel™ Environment. Due to this major change in tool architecture, this document has undergone substantial changes in structure and content since the previous release.



Table of Contents

Introduction

SDSoC Platforms	
Platform Directory Structure	11
Metadata Files	12
Platform Checklist	16
Hardware Platform Creation	
Vivado Design Suite Project	19
Software Platform Data Creation	
Pre-built Hardware	23
Library Header Files	24
Linux Boot Files	25
Using PetaLinux to Create Linux Boot Files	29
Standalone Boot Files	31
FreeRTOS Configuration/Version Change	32
Platform Sample Applications	
Hardware Platform Metadata Creation	
Testing the Platform Hardware Description File	47
Software Platform Metadata Creation	
Software Platform XML Metadata Reference	52
SDSoC 2016.2 Platform Migration	
Additional Resources and Legal Notices	
References	69
Please Read: Important Legal Notices	70







Introduction

The SDx™ environment is an Eclipse-based integrated development environment (IDE) for implementing heterogeneous embedded systems using Zyng®-7000 All Programmable SoCs and Zyng UltraScale+™ MPSoCs. The SDx IDE supports both the SDSoC (Software-Defined System On Chip) and SDAccel design flows on Linux and only SDSoC flows on Windows. The SDSoC system compiler generates an application-specific system-on-chip by compiling application code written in C or C++ into hardware and software that extends a target platform. The SDx IDE includes platforms for application development; other platforms are provided by Xilinx partners.

An SDSoC platform defines a base hardware and software architecture and application context, including processing system, external memory interfaces, custom input/output, and software run time - including operating system (possibly "bare metal"), boot loaders, drivers for platform peripherals and root file system. Every project you create within the SDx environment IDE targets a specific hardware platform, and you employ the tools within the SDx environment IDE to customize the platform with application-specific hardware accelerators and data motion networks. In this way, you can easily create highly tailored application-specific systems-on-chip for different base platforms, and can reuse base platforms for many different applicationspecific systems-on-chip.

This document describes how to create a custom SDSoC platform starting from a hardware system built using the Vivado® Design Suite, and a software run-time environment, including operating system kernel, boot loaders, file system, and libraries.



IMPORTANT: For additional information on using the SDSoC environment, see the SDSoC Environment User Guide (UG1027).





SDSoC Platforms

Introduction

An SDSoC platform consists of a Vivado® Design Suite hardware project, a target operating system, boot files, and optionally, software libraries that can be linked with user applications that target the platform. An SDSoC platform also includes XML metadata files that describe the hardware and software interfaces used by the SDSoC compilers to target the platform.

A platform provider designs the platform hardware using the Vivado Design Suite and IP Integrator. After the hardware has been built and verified, the platform provider executes Tcl commands within the Vivado tools to specify SDSoC platform hardware interfaces and generate the SDSoC platform hardware metadata file.

The platform creator must also provide boot loaders and target operating system required to boot the platform. A platform can optionally include software libraries to be linked into applications targeting the platform using the SDSoC compilers. If a platform supports a target Linux operating system, you can build the kernel and U-boot bootloader at the command line or using the PetaLinux tool suite. You can use the PetaLinux tools, SDx IDE or the Xilinx SDK to build platform libraries.



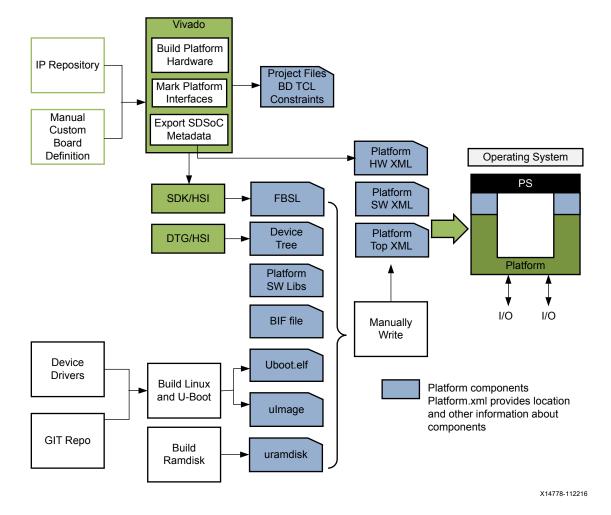


Figure 1: Primary Components of an SDSoC Platform

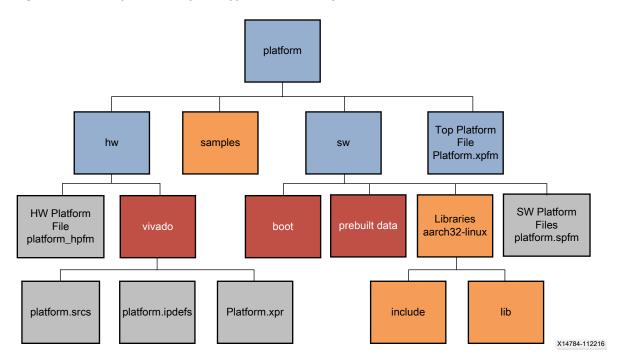
An SDSoC platform consists of the following elements:

- Metadata files
 - Platform top-level description file (<platform>.xpfm) written by hand.
 - Platform hardware description file (<platform>.hpfm) generated using Vivado tools
 - Platform software description file (<platform>.spfm) written by hand
- Vivado Design Suite project
 - Sources
 - Constraints
 - IP blocks
- · Software files
 - Library header files (optional)
 - Static libraries (optional)
 - Common boot objects (first stage boot loader, for Zynq UltraScale+ MPSoC ARM trusted firmware and power management unit firmware)
 - Linux related objects (u-boot and Linux device tree, kernel and ramdisk as discrete objects or an image.ub unified boot image)



- · Pre-built hardware files (optional)
 - Bitstream
 - Exported hardware files for SDK
 - Pre-generated port information software files
 - Pre-generated hardware and software interface files
- Platform sample applications (optional)

Figure 2: Directory Structure for a Typical SDSoC Platform



In general, only the platform provider can ensure that a platform is "correct" for use within the SDSoC environment. However, there is a zip archive file /2016.3/docs/platform_dm_test.zip which contains basic liveness tests for every datamover used by the SDSoC system compiler. Unzip platform_dm_test.zip into a work area, and from within an SDx Toolchain Terminal shell, execute the following.

```
$ make PLATFORM=<name_of_platform> axidma_simple
$ make PLATFORM=<name_of_platform> axidma_sg
$ make PLATFORM=<name_of_platform> axidma_2d
$ make PLATFORM=<name_of_platform> axififo
$ make PLATFORM=<name_of_platform> zero_copy
$ make PLATFORM=<name_of_platform> xd_adapter

<name_of_platform> could be something like zc702_axidma_simple,
zcu102_axidma_sg etc.

For example
$ make PLATFORM=zc702 axidma_simple
```

Each of these tests should build cleanly, and should be tested on the hardware platform.

A platform should provide tests for every custom interface so that users have examples of how to access these interfaces from application C/C++ code.





A platform may optionally include sample applications. By creating a samples sub-folder containing source files for one or more applications and a template.xml metadata file, users can use the SDx Environment IDE New Project Wizard to select and build any of the provided applications.

For additional information on application template creation, see Platform Sample Applications. For information on hardware platform creation and guidelines, see Hardware Platform Creation. For information on software platform components, see Software Platform Data Creation.

Platform GUI/Command Line Usage

When creating an SDSoC design, the user specifies an SDSoC platform and a system configuration that captures the software environment running on the target device, including the operating system (OS). A platform supports one or more system configurations. For example the zc702 platform (for the Zynq-7000 All Programmable SoC ZC702 Evaluation Kit board) is included in the SDx installation and offers three configurations: Linux, Standalone BSP and FreeRTOS.

The platform folder contains hardware and software platform data, with platform XML metadata that defines the supported hardware interfaces and software environments (system configurations), along with the software components they use (boot files, Linux image, header files, library files, and others).

To specify the platform and system configuration for the SDSoC Compiler command line tools sdscc or sds++, use the -sds-pf <platform> and -sds-sys-config <system_configuration> options. The <platform> can be a platform name or the path to a platform folder. If -sds-sys-config is not specified, a platform defined default system configuration is used. An example command line is shown below:

```
sdscc -sds-pf zc702 -sds-sys-config linux -c main.c
```

Command line arguments are available to display information about a platform. Use <code>-sds-pf-list</code> to list available factory platforms and <code>-sds-pf-info <platform></code> to print information about the specified platform:

```
sdscc -sds-pf-list
sdscc -sds-pf-info zc702
```

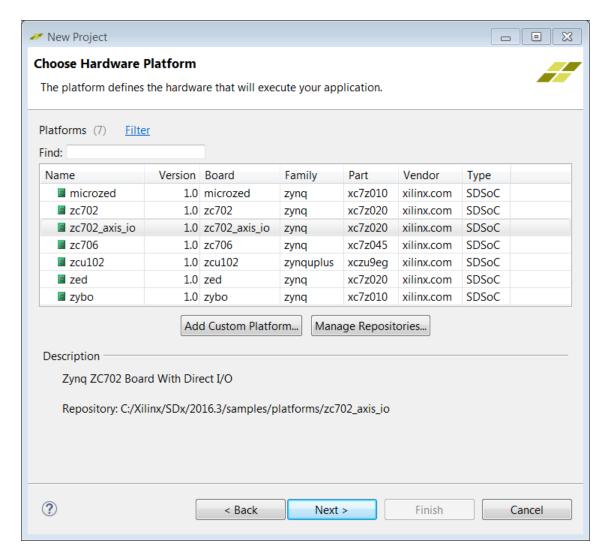
In the SDx Environment IDE, use **File > New > Xilinx SDx** to launch the New Project Wizard to create an application project. After entering a project name, the Choose Hardware Platform page appears, as shown below. Select a platform in the installation (factory platform), or click on **Add Custom Platform** to navigate to and add a platform folder.



TIP: You can also select a folder containing multiple platform folders to add multiple platforms to your repository in a single step.

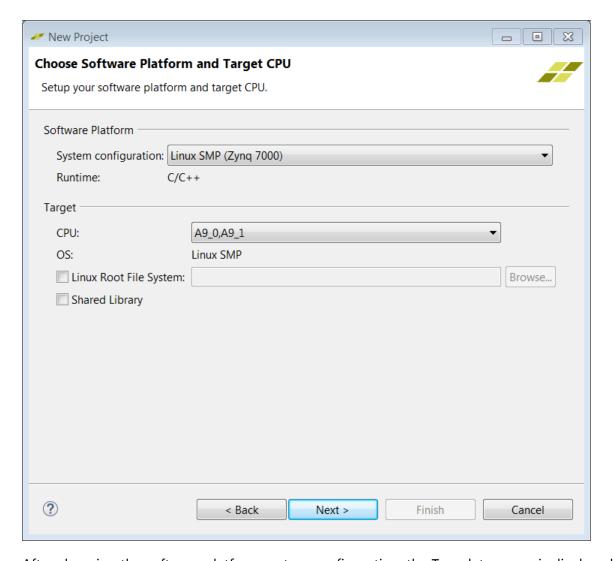
In the figure below, the **Add Custom Platform** command was used to add the zc702_axis_io platform in <SDx_install_path>/samples/platforms/zc702_axis_io. Factory platforms are found in <SDx install path>/platforms.





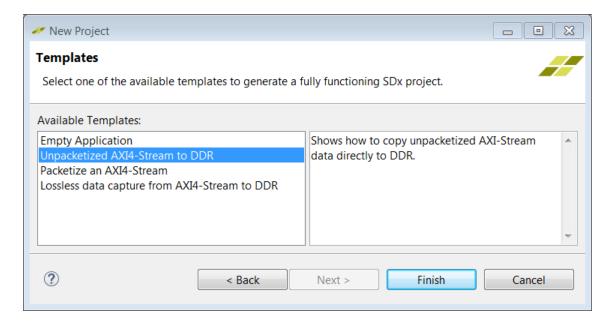
After choosing a hardware platform, the Choose Software Platform and Target CPU page is displayed, as shown in the following figure, to let you define the system configuration. The values shown in the **System configuration** dropdown list, the **CPU** dropdown list, and the **OS** text field are defined in the software platform XML metadata file (.spfm) found in <path_to_platform>/sw/<platform>.spfm. The text strings used as command line arguments are defined by sdx:name attributes in the XML file, while GUI text strings are defined by sdx:displayName attributes. See Software Platform XML Metadata Reference for information on creating these files, which are created by the platform provider.





After choosing the software platform system configuration, the Templates page is displayed as shown below. On the Templates page, you can select a platform sample application if the platform folder contains a samples folder and samples/template.xml file which describes the available template applications.





When you click **Finish** on the Templates page, the SDx Environment IDE creates the application project, copying source files from the platform folder and automatically generating a Make file. If your platform does not provide sample applications, only the Empty Application will be shown and the user can manually copy source files into the project's source folder or create source files using the source editor view.

Platform Directory Structure

The SDSoC factory platforms are found in <path_to_install>/SDx/2016.x/platforms, which contains sub-folders for each of the platforms. The zc702 platform files for the Zynq 7000 All Programmable SoC ZC702 Evaluation Kit board are shown below, details of the files are omitted:

- <path_to_install>/SDx/2016.x/platforms
 - 。zc702
 - hw
 - vivado
 - zc702.hpfm
 - SW
 - zc702.spfm
 - zc702.xpfm

The zc702.xpfm file contains references to the hardware (zc702.hpfm) and software (zc702.spfm) metadata files. All path references in the .spfm file are relative to folder containing that file.



The installation folder <path_to_install>/SDx/2016.x/samples/platforms contains additional platforms that are documented in the SDSoC Environment Tutorial: Creating a Platform from a Reference Design (UG1236). For example, the zc702_axis_io platform as shown below contains additional folders and files that are not found in the zc702 platform:

- <path_to_install>/SDx/2016.x/samples/platforms
 - ∘ zc702 axis io
 - hw
 - vivado
 - zc702_axis_io.hpfm
 - samples
 - aximm
 - pull_packet
 - stream
 - template.xml
 - src
 - SW
 - zc702_axis_io.spfm
 - readme
 - zc702_axis_io.xpfm



TIP: Aside from the basic directory structure and XML metadata file naming conventions, folder and file names of the platform are largely left to the discretion of the platform developer.

Metadata Files

The SDSoC platform includes the following XML metadata files that describe the hardware and software interfaces.

- Top-Level Platform XML File (.xpfm)
- Platform hardware description file (.hpfm)
- Platform software description file (.spfm)

Top-Level Platform XML File (.xpfm)

The top-level platform XML file is found in <path_to_platform>/<platform>.xpfm, containing references to the hardware and software XML files and the folders that contain them. To create an .xpfm file for your platform, you may copy an existing .xpfm file and change instances of the platform name.



Shown below is the file <install>/platforms/zc702/zc702.xpfm. It includes references to the hardware (.hpfm) and software (.spfm) platform XML metadata files found in <install>/platforms/zc702/hw/zc702.hpfm and <install>/platforms/zc702/sw/ zc702.spfm, respectively.



IMPORTANT: Note that the hardware and software platform data paths are relative to the top-level platform directory.

```
<?xml version="1.0" encoding="UTF-8"?>
<sdx:platform sdx:vendor="xilinx.com"</pre>
              sdx:library="sdx"
              sdx:name="zc702"
              sdx:version="1.0"
              sdx:schemaVersion="1.0"
              xmlns:sdx="http://www.xilinx.com/sdx">
  <sdx:description>Basic platform targeting the ZC702 board, which includes
1GB of DDR3,
 16MB Quad-SPI Flash and an SDIO card interface. More information is
available at
 https://www.xilinx.com/products/boards-and-kits/ek-z7-zc702-g.html
  </sdx:description>
    <!-- Support multiple DSAs for multi-FPGA platforms -->
  <sdx:hardwarePlatforms>
    <sdx:hardwarePlatform sdx:path="hw" sdx:name="zc702.hpfm"/>
  </sdx:hardwarePlatforms>
  <sdx:softwarePlatforms>
    <sdx:softwarePlatform sdx:path="sw" sdx:name="zc702.spfm"/>
  </sdx:softwarePlatforms>
</sdx:platform>
```

Hardware Platform XML File (.hpfm)

The hardware platform XML metadata file is found in

<path to platform>/hw/<platform>.hpfm, with the Vivado platform project in <path to platform>/hw/vivado. It describes the hardware interfaces in the platform used by SDSoC when creating the hardware system containing the base hardware, hardware accelerators and data motion network.

A portion of the zc702 hardware platform XML file, <install>/platforms/zc702/hw/ zc702.hpfm, is shown below with clock information, including clocks available for the data motion network and accelerators.

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<!-- zc702.hpfm -->
<xd:repository xmlns:xd="http://www.xilinx.com/xd" xd:name="zc702"</pre>
xd:library="xd"
xd:version="1.0" xd:vendor="xilinx.com">
  <xd:component xd:name="zc702" xd:library="xd" xd:version="1.0"</pre>
```



```
xd:vendor="xilinx.com"
   xd:type="platform" xd:BRAM="140" xd:DSP="220" xd:FF="106400"
xd:LUT="53200">
    <xd:platformInfo>
      <xd:deviceInfo xd:name="xc7z020clq484-1" xd:architecture="zynq"</pre>
xd:device="xc7z020"
       xd:package="clg484" xd:speedGrade="-1"/>
      <xd:registeredDevices xd:kio="0" xd:uio="0"/>
      <sdx:description>Basic platform targeting the ZC702 board, which
includes 1GB of DDR3,
      16MB Quad-SPI Flash and an SDIO card interface. More information is
available at
      https://www.xilinx.com/products/boards-and-kits/ek-z7-zc702-g.html
      </sdx:description>
      <xd:systemClocks xd:defaultClock="2">
        <xd:clock xd:name="CPU" xd:instanceRef="ps7"</pre>
xd:componentRef="processing system7"
         xd:frequency="666.666687" xd:period="1.500000"
xd:status="reserved"/>
        <xd:clock xd:name="ps7 FCLK CLK0" xd:instanceRef="ps7"</pre>
xd:componentRef="processing system7"
         xd:id="0" xd:frequency="166.666672" xd:period="6.000000"
xd:normalizedPeriod="4.000000"
        xd:status="changeable"/>
        <xd:clock xd:name="ps7 FCLK CLK1" xd:instanceRef="ps7"</pre>
xd:componentRef="processing system7"
         xd:id="1" xd:frequency="142.857132" xd:period="7.000001"
xd:normalizedPeriod="4.666667"
         xd:status="changeable"/>
        <xd:clock xd:name="ps7 FCLK CLK2" xd:instanceRef="ps7"</pre>
xd:componentRef="processing system7"
         xd:id="2" xd:frequency="100.000000" xd:period="10.000000"
xd:normalizedPeriod="6.666667"
         xd:status="changeable"/>
        <xd:clock xd:name="ps7 FCLK CLK3" xd:instanceRef="ps7"</pre>
xd:componentRef="processing system7"
         xd:id="3" xd:frequency="200.000000" xd:period="5.000000"
xd:normalizedPeriod="3.333333"
         xd:status="changeable"/>
      </xd:systemClocks>
    </xd:platformInfo>
```

For a complete discussion on the hardware platform XML file, see Hardware Platform Metadata Creation.

Software Platform XML File (.spfm)

The software platform XML file is found in <path_to_platform>/sw/<platform>.spfm. The .spfm file describes the software environments, or system configurations available for use by the platform. Each configuration has an operating system (OS) associated with it, and the user selects the system configuration when creating a design on the hardware platform.



Using the metadata in the <code>.spfm</code> file, the SDSoC tools know where to find boot files (first stage boot loader or FSBL) and Linux images used to generate an SD card image. If the platform includes optional header and library files, SDSoC automatically adds paths to the files when compiling and linking the user's application. Optional prebuilt hardware bitstreams reduce run times when building applications without hardware accelerators.

The SDx Environment IDE uses metadata in the .spfm file to create lists of system configurations, define default selections, and create labels for GUI elements in the New Project Wizard.

A portion of the zc702 software platform XML file, <install>/platforms/zc702/sw/zc702.spfm, is shown below to provide an overview of the schema, including metadata used in the command line and GUI.

```
<?xml version="1.0" encoding="UTF-8"?>
<sdx:platform sdx:vendor="xilinx.com"
              sdx:library="sdx"
              sdx:name="zc702"
              sdx:version="1.0"
              sdx:schemaVersion="1.0"
              xmlns:sdx="http://www.xilinx.com/sdx">
      <sdx:description>Basic platform targeting the ZC702 board, which
includes 1GB of DDR3,
      16MB Quad-SPI Flash and an SDIO card interface. More information is
available at
      https://www.xilinx.com/products/boards-and-kits/ek-z7-zc702-g.html
      </sdx:description>
    <sdx:systemConfigurations sdx:defaultConfiguration="linux">
        <sdx:configuration sdx:name="linux"</pre>
                           sdx:displayName="Linux SMP (Zynq 7000)"
                           sdx:defaultProcessorGroup="a9 0">
            <sdx:description>Linux SMP running on Zynq
7000</sdx:description>
            <sdx:prebuilt sdx:data="prebuilt platform"/>
            <sdx:bootImages sdx:default="standard">
                <sdx:image sdx:name="standard"
                           sdx:bif="boot/linux.bif"
                           sdx:imageData="image"
                           sdx:mountPath="/mnt"
                           sdx:readme="boot/generic.readme"
                           sdx:qemuDevicetree="qemu/devicetree.dtb"
                           sdx:qemuBoot="boot/u-boot.elf"
                           sdx:qemuArguments="qemu/qemu args.txt"
                />
            </sdx:bootImages>
            <sdx:processorGroup sdx:name="a9 0"
                                sdx:displayName="A9 0,A9 1"
                                sdx:cpuType="cortex-a9">
                <sdx:os sdx:name="linux"
                       sdx:displayName="Linux SMP"
                />
            </sdx:processorGroup>
        </sdx:configuration>
```

For a complete description of the software platform XML metadata file, see Software Platform Metadata Creation.





Platform Checklist

The overview of the platform creation process in this chapter touched on hardware and software platform requirements and components, platform validation, sample application support, directory structures and the platform metadata XML files that enable SDSoC to use your custom platform.

This guide assumes familiarity with the Vivado Design Suite and its use in creating Zynq-7000 or Zynq UltraScale+ MPSoC designs, SDSoC from the perspective of a user of platforms, Xilinx software development tools such as the Xilinx Software Development Kit (SDK), and embedded software environments (Linux or bare-metal). It provides greater depth on topics that are SDSoC-specific, for example platform hardware requirements and platform metadata XML files, with general guidance or references to material that you may already be familiar with.

If you are new to the SDSoC platform creation process, read the introductions in the remaining chapters of this guide while lightly reading through the material for key concepts, and try one or more tutorials in SDSoC Environment Tutorial: Creating a Platform from a Reference Design (UG1236).

If you created SDSoC platforms in the past, the process remains largely the same. Lightly read though the chapters in this guide and the migration information in the appendix.

The checklist below summarizes tasks involved in SDSoC platform creation.

- 1. Using the Vivado Design Suite, create a Zynq-7000 or Zynq UltraScale+ MPSoC based design.
 - Refer to Hardware Platform Creation for requirements and guidelines to follow when creating the Vivado hardware project. Test the hardware design using the Vivado Design Suite tools.
- 2. For supported target operating systems, provide software components for boot and user applications.
 - SDSoC creates an SD card image for booting the OS, if applicable, using boot files included in the platform. A first stage boot loader (FSBL) is required, as well as a Boot Image File (BIF) that describes how to create a BOOT.BIN file for booting. For Linux boot, provide U-boot and a Linux image (device tree, kernel image, and root file system as discrete files or unified boot image .ub file). For bare-metal applications, create a linker script. Zynq UltraScale+ MPSoC platforms also require ARM trusted firmware (ATF) and power management unit firmware (PMUFW). In addition, create a README file and other files which need to reside on the SD card image.
 - If the platform provides libraries to link with the user's application, headers and libraries can be included as part of the platform for convenience.
 - See Software Platform Data Creation for more information.
- 3. Optionally create one or more sample applications.
 - In the platform folder, you can create a "samples" folder with a single level of subfolders, with each subfolder containing the source code for an application. The samples folder also contains a template.xml file used the SDx Environment IDE New Project Wizard when creating an application.
 - See Platform Sample Applications.



- 4. Create a platform directory with platform XML metadata files.
 - The basic platform directory structure is shown below. For folders and files not listed, their naming is flexible, otherwise use these names (replace <platform> with the name of your platform). The sample folder is optional.
 - myplatforms
 - <platform>
 - hw
 - vivado
 - <platform>.hpfm
 - SW
 - .
 - samples
 - <platform>.xpfm
 - For more information on creating the XML metadata files refer to Hardware Platform Metadata Creation and Software Platform Metadata Creation.
- 5. Validate your platform supports the SDSoC environment.
 - The Introduction of this chapter describes a platform checklist with tests for data movers used by the SDSoC system compiler. Each test should build cleanly by running make from the command line in a shell with the SDx Environment available by launching an SDx Terminal or by running a settings64 script (.bat, .sh or .csh) found in the SDx installation. The tests should also run on your platform board.
- 6. Validate project creation with your platform in the SDx Environment IDE.
 - Start the SDx Environment IDE and create an SDSoC project using the New Project
 Wizard. After specifying a project name, you are presented with a list of platforms. Click
 on Add Custom Platform to navigate to your platform folder and select it. If your platform
 includes a samples folder, you can select one of your applications, or the Empty
 application to which you can add source files. After your project is created, build it and
 run or debug the ELF file.
 - See Platform GUI/Command Line Usage for an overview of this process.



Hardware Platform Creation

Introduction

The hardware platform creation process consists of building a Vivado design and generating the hardware platform metadata XML file (.hpfm) that describes the hardware interfaces supported, including clocks, interrupts, and bus interfaces. The platform folder <path_to_platform>/hw/vivado contains the Vivado project, while the hardware platform metadata XML file is found in <path_to_platform>/hw/<platform>.hpfm.

This chapter assumes familiarity with the Vivado Design Suite and the ability to create a Vivado project for the hardware in your platform. It describes general requirements for the hardware in your platform, the Vivado project and the platform hardware folder.

The creation of the hardware platform metadata XML (.hpfm) is described in detail in Hardware Platform Metadata Creation.

Hardware Requirements

This section describes requirements on the hardware design component of an SDSoC platform. In general, nearly any design targeting the Zynq®-7000 All Programmable (AP) SoC or Zynq UltraScale+™ MPSoC device using the IP Integrator within the Vivado® Design Suite can be the basis for an SDSoC platform. The process of capturing the SDSoC hardware platform is conceptually straightforward.

- 1. Build and verify the hardware system using the Vivado Design Suite.
- 2. Create a Tcl script that uses the SDSoC Vivado TCL APIs.
- 3. Execute the Tcl script in the Vivado Tcl Console to create the hardware platform metadata XML file (.hpfm). The metadata captures platform clocks, AXI and AXI4-Stream bus interfaces, interrupts and other hardware information.

There are several rules that the platform hardware design must observe.

1. The Vivado Design Suite project name must match the hardware platform name.



TIP: If the Vivado design project contains more than one block diagram, the block diagram that has the same name as the hardware platform is the one that is used by the SDSoC Tcl script.

2. Every IP used in the platform design that is not part of the standard Vivado IP catalog must be local to the platform Vivado Design Suite project. References to external IP repository paths are not supported.



- 3. Every hardware platform design must contain a Processing System IP block from the Vivado IP catalog.
- 4. Every hardware port interface to the SDSoC platform must be an AXI, AXI4-Stream, clock, reset, or interrupt type interface only. Custom bus types or hardware interfaces must remain internal to the hardware platform.
- 5. Every platform must declare at least one general purpose AXI master port from the Processing System IP or an interconnect IP connected to such an AXI master port, that will be used by the SDSoC compilers for software control of datamover and accelerator IPs.
- 6. Every platform must declare at least one AXI slave port that will be used by the SDSoC compilers to access DDR from datamover and accelerator IPs.
- 7. To share an AXI port between the SDSoC environment and platform logic, for example S_AXI_ACP, you must export an unused AXI master or slave of an AXI Interconnect IP block connected to the corresponding AXI port, and the platform must use the ports with least significant indices.
- 8. Every platform AXI interface will be connected to a single data motion clock by the SDSoC environment.



TIP: Accelerator functions generated by the SDSoC compilers might run on a different clock that is provided by the platform.

- 9. Every platform AXI4-Stream interface requires TLAST and TKEEP sideband signals to comply with the Vivado tools data mover IP used by the SDSoC environment.
- 10. Every exported platform clock must have an accompanying Processor System Reset IP block from the Vivado IP catalog.
- 11. Platform interrupt inputs must be exported by a Concat (xlconcat) IP connected to the Processing System 7 IP IRQ_F2P port. IP blocks within a platform can use some of the sixteen available fabric interrupts, but must use the least significant bits of the IRQ_F2P port without gaps.

Vivado Design Suite Project

The SDx™ IDE uses the Vivado® Design Suite project in the <platform>/vivado directory as a starting point to build an application-specific SoC. The project must include an IP Integrator block diagram and can contain any number of source files. Although nearly any project targeting a Zynq SoC or MPSoC can be the basis for an SDSoC project, there are a few restrictions as described in Hardware Requirements.

File name and location: platforms/<platform>/hw/vivado/<platform>.xpr

Example: platforms/zc702/hw/vivado/zc702.xpr





IMPORTANT: You must place the complete Vivado Design Suite project in the same directory as the project (xpx) file. You cannot simply copy the files in a Vivado tools project; the Vivado tools manage internal states and file relationships in a way that is not preserved through a simple file copy. To properly copy the Vivado Design Suite project use the Vivado command **File**→**Archive Project** to create a zip archive. Copy and unzip this archive file into the SDSoC platform directory where the hardware platform resides.

The Vivado tool requires you to **Upgrade IP** for every new version of the Vivado Design Suite. To migrate an SDSoC hardware platform from a prior release, open the project in the new version of the Vivado tools, and upgrade the block design and all IP. Refer to this link in the Vivado Design Suite User Guide: Designing IP Subsystems Using IP Integrator (UG994) for more information on updating block design projects.

If you encounter IP Locked errors when the SDx IDE invokes the Vivado tools, it is a result of failing to properly copy the Vivado project, or failing to upgrade the IP and output products.



Software Platform Data Creation

Introduction

The software platform data creation process consists of building software components, such as libraries and header files, boot files, and others, for each supported operating system (OS) running on the Zynq®-7000 All Programmable (AP) SoC or Zynq UltraScale+™ MPSoC device, and generating a software platform metadata XML file (.spfm) that captures how the components are used and where they are located. The platform folder platform/sw contains the software components, while the software platform metadata XML file (.spfm) is found in platform/sw/<platform</pre>.spfm.

This chapter describes required and optional components of a software platform, and assumes the platform creator is able to create these components. For example, if your platform supports Linux, you will need to provide:

- Boot files first stage bootloader or FSBL; U-boot; Linux unified boot image image.ub or separate devicetree.dtb, kernel and ramdisk files; boot image file or BIF used to create BOOT.BIN boot files.
- Optional prebuilt data used by SDSoC when building applications without hardware accelerators, such as a pre-generated hardware bitstream to save time and SDSoC data files.
- Optional header and library files if the platform provides software libraries.
- Optional emulation data files, if the platform supports emulation flows using the Vivado Simulator for programmable logic and QEMU for the processing subsystem.

If your platform supports the Xilinx Standalone OS (a bare-metal board support package or BSP), the software components are similar to those for Linux, but the boot files include the FSBL and BIF files.



TIP: Zynq UltraScale+ MPSoC boot files also require ELF files for the Power Management Unit firmware (PMUFW) and ARM Trusted firmware (ATF).

Once you build the software components for a target OS, use a text or XML editor to create the software platform metadata XML file. The creation of the software platform metadata XML (.spfm) is described in Software Platform Metadata Creation.

Software Requirements

This section describes requirements for the run-time software component of an SDSoC platform.



The SDx IDE currently supports Linux, standalone (bare metal), and FreeRTOS operating systems running on the Zynq®-7000 AP SoC target, but a platform is not required to support all of them. The SDx IDE supports Linux and standalone (bare-metal) operating systems running on the Zynq UltraScale+™ MPSoC.

When platform peripherals require Linux kernel drivers, you must configure the kernel to include several SDx IDE specific drivers which are available with the linux-xlnx kernel sources in the drivers/staging/apf directory. The base platforms included with the SDx environment provide instructions in README files, for example platforms/zc702/sw/boot/generic.readme.

This linux kernel and the associated device tree are based on the 4.6 version of the linux kernel. To build the kernel:

1. Clone/pull from the master branch of the Xilinx/linux-xlnx tree at github, and check out the xilinx-v2016.3-sdsoc tag.

```
git checkout -b sdsoc_release_tag xilinx-v2016.3-sdsoc
```

2. Add the following CONFIG attributes to xilinx_zynq_defconfig and then configure the kernel.

```
CONFIG_STAGING=y
CONFIG_XILINX_APF=y
CONFIG_XILINX_DMA_APF=y
CONFIG_DMA_CMA=y
CONFIG_CMA_SIZE_MBYTES=256
CONFIG_CROSS_COMPILE="arm-linux-gnueabihf-"
CONFIG_LOCALVERSION="-xilinx-apf"
```

One way to do this is:

```
cp arch/arm/configs/xilinx_zynq_defconfig arch/arm/configs/tmp_defconfig
```

3. Edit arch/arm/configs/tmp_defconfig using a text editor and add the above config lines to the bottom of the file.

```
make ARCH=arm tmp_defconfig
```

4. Build the kernel using:

```
make ARCH=arm UIMAGE_LOADADDR=0x8000 uImage
```

By default, the SDSoC system compiler generates an SD card image for booting the platform.

For creating a standalone platform, you must first build the hardware component using the IP Integrator feature of the Vivado Design Suite, and run the hardware export command (write_hwdef) to create the hardware handoff file. Using this newly generated hardware handoff file, use the SDx environment IDE to create a hardware platform project. From this project, you can create a new board support project. The system.mss file, as well as the linker script can now be delivered as part of the platform. Details of this process can be found in the SDSoC Environment Tutorial: Creating a Platform from a Reference Design (UG1236). The platform can include the libraries and header files using the procedure defined in Software Platform XML File (.spfm) and Software Platform Metadata Creation.



Pre-built Hardware

A platform can optionally include pre-built configurations to be used directly when you do not specify any hardware functions in an application. In this case, you do not need to wait for a hardware compile of the platform itself to create a bitstream and other required files.

The pre-built hardware should reside in a subdirectory of the platform software directory. Data in the subdirectory is pointed to by the <sdx:prebuilt> element of the <sdx:configuration> for the corresponding pre-built hardware. Refer to Software Platform XML Metadata Reference for more information.

For a given <sdx:prebuilt sdx:data="prebuilt_platform_path"/> in a platform xml, the location is:

```
<path to platform>/sw/prebuilt platform path
```

The path is relative to the software platform folder. For example, the element:

```
<sdx:prebuilt sdx:data="prebuilt data"/>
```

Indicates the prebuilt hardware bitstream and generated files are found in <path_to_platform>/sw/prebuilt_data. The prebuilt_data folder for the zc702 platform contains bitstream.bit, zc702.hdf, partitions.xml, apsys_0.xml, portinfo.c and portinfo.h files.

Pre-built hardware files are automatically used by the SDx environment when an application has no hardware functions using the usual flag:

```
-sds-pf zc702
```

To force a full Vivado tools bitstream and SD card image compile, use the following sdscc option:

```
-rebuild-hardware
```

Files used to populate the platforms/<platform>/sw/prebuilt_data folder are found in the sds folder after creating the application ELF and bitstream.

- · bitstream.bit
 - File found in sds/p0/ipi/<platform>.runs/impl 1/bitstream.bit
- <platform>.hdf
 - o Files found in sds/p0/ipi/<platform>.sdk
- partitions.xml, apsys_0.xml
 - Files found in sds/.llvm
- portinfo.c, portinfo.h
 - Files found in sds/swstubs





Library Header Files

If the platform requires application code to #include platform-specific header files, these should reside in a subdirectory of the platform directory pointed to by the sdx:includePaths attribute for the corresponding OS in the platform software description file.

For a given sdx:includePaths="<relative_include_path>" in a platform software description file, the location is:

```
<platform root directory>/<relative_include_path>
```

Example:

For sdx:includePaths="aarch32-linux/include":

```
<sdx_root>/samples/platforms/zc702_axis_io/sw/aarch32-linux/include/
zc702 axis io.h
```

To use the header file in application code, use the following line:

```
#include "zc702_axis_io.h"
```

Use the colon (:) character to separate multiple include paths. For example

```
sdx:includePaths="<relative_include_path1>:<relative_include_path2>"
```

in a platform software description file defines a list of two include paths

```
<platform_root_directory>/<relative_include_path1>
<platform root directory>/<relative include path2>
```



RECOMMENDED: If header files are not put in the standard area, users need to point to them using the -I switch in the SDSoC environment compile command. We recommend putting the files in the standard location as described in the platform XML file.

Static Libraries

If the platform requires users to link against static libraries provided in the platform, these should reside in a subdirectory of the platform directory pointed to by the sdx:libraryPaths attribute for the corresponding OS in the platform software description file.

For a given sdx:libraryPaths="<relative_lib_path>" in a platform software description file, the location is:

```
<platform root>/sw/<relative lib path>
```

Example:





For sdx:libraryPaths="aarch32-linux/lib":

```
<sdx_root>/samples/platforms/zc702_axis_io/sw/aarch32-linux/lib/
libzc702_axis_io.a
```

To use the library file, use the following linker switch:

```
-lzc702_axis_io
```

Use the colon: character to separate multiple library paths. For example,

```
sdx:libraryPaths="<relative_lib_path1>:<relative_lib_path2>"
```

in a platform software description defines a list of two library paths

```
<platform_root>/sw/<relative_lib_path1>
<platform_root>/sw/<relative_lib_path2>
```



RECOMMENDED: If static libraries are not put in the standard area, every application needs to point to them using the -L option to the sdscc link command. Xilinx recommend putting the files in the standard location as described in the platform software description file.

Linux Boot Files

The SDx™ IDE can create an SD card image to boot the Linux operating system on the board. After booting completes, a Linux prompt is available for executing the compiled applications. For this, the SDx IDE requires several objects as part of the platform including:

- First Stage Boot Loader (FSBL)
- U-Boot
- Device Tree (optional)
- Linux Image
- Ramdisk Image (optional)

The SDx IDE permits the use of Linux images packaged in two forms:

- 1. As separate components consisting of a kernel image, ramdisk image, and device tree as separate files.
- 2. As a "unified boot" image, which consists of the three previously mentioned components packed into a single file, entitled image.ub.

For this reason, a Linux Image is mandatory, but a Ramdisk Image and Device Tree are optional, depending on how the <code>image.ub</code> gets packed. Refer to the *PetaLinux Tools Documentation Reference Guide* (UG1144) for more information.



TIP: Additionally, a hatrdware platform that targets a Zynq UltraScale+™ MPSoC device requires PMU firmware, and ARM trusted firmware, which must subsequently be packed into BOOT.BIN.



The SDx environment uses the Xilinx® bootgen utility program to combine the FSBL, PMU-FW, ARM trusted firmware, u-boot files with the bitstream into a BOOT.BIN file in a folder called sd_card, along with the required kernel image files, and the optional ramdisk/device-tree. The end-user copies the contents of this folder into the root of an SD card to boot the platform.



TIP: For detailed instructions on how to build the boot files, refer to the Xilinx Wiki at http://wiki.xilinx.com. Under the heading of Zynq AP SoC & Zynq UltraScale+ MPSoC (ZU+) you will find links to topics like Building U-Boot, Building the Linux Kernel, and other topics..

First Stage Boot Loader (FSBL)

The first stage boot loader (FSBL) is responsible for loading the bitstream and configuring the Zynq® architecture Processing System (PS) at boot time.

When the platform project is open in Vivado® Design Suite, click the **File→Export→Export Hardware** menu option.

Create a new software project **File→New→Application Project** with the name fsbl as you would using the Xilinx SDK.

Using the exported Hardware Platform, select the Zynq FSBL application from the list. This creates an FSBL executable.

For more detailed information, see the SDK Help System.

Once you generate the FSBL, you must copy it into a standard location for the SDx environment flow.

Example:

```
samples/platforms/zc702_axis_io/sw/boot/fsbl.elf
```

For the SDx system compiler to use an FSBL, a BIF file must point to it, as defined by the sdx:bif attribute of the<sdx:image> element. Refer to the Software Platform XML Metadata Reference for more information on the sdx:bif attribute. The file must reside in the cpath to platform>/sw/boot/fsbl.elf folder.



TIP: The BIF file for a Zyng AP SoC is very different from the BIF file for the Zyng UltraScale+ MPSoC device.

The following is an example boot.bif file for the Zynq®-7000 All Programmable (AP) SoC:



The following is an example boot.bif file for the Zynq UltraScale+™ MPSoC device:

```
/* linux */
the_ROM_image:
{
    [fsbl_config] a53_x64
    [bootloader]<boot/fsbl.elf>
    [pmufw_image]<boot/pmufw.elf>
    [destination_device=pl] <bitstream>
    [destination_cpu=a53-0, exception_level=el-3, trustzone] <boot/bl31.elf>
    [destination_cpu=a53-0, exception_level=el-2] <boot/u-boot.elf>
}
```

U-Boot

U-Boot is an open source boot loader. Follow the Building U-Boot instructions at wiki.xilinx.com to download U-Boot and configure it for your platform. If you use PetaLinux to create Linux boot files, it will configure and create U-boot for you.

For the SDx system compiler to use a U-Boot, a BIF file must point to it, as defined by the sdx:bif attribute of the<sdx:image> element. Refer to the Software Platform XML Metadata Reference for more information on the sdx:bif attribute.

Example: samples/platforms/zc702 axis io/sw/boot/u-boot.elf

Device Tree

The Device Tree is a data structure for describing hardware so that the details do not have to be hard coded in the operating system. This data structure is passed to the operating system at boot time. Use Xilinx SDK to generate the device tree for the platform. For detailed instructions on how to build the device-tree refer to the Build the Device Tree Compiler link on the Xilinx Wiki at wiki.xilinx.com to download the device tree generator support files, and install them for use with Xilinx SDK. There is one device tree per platform.

A small change is required to a device tree in order to make use of SDx:SDSoC in a booted linux system. You must manually add the following text at the bottom of the top-most device tree file:

```
/{
xlnk {
  compatible = "xlnx,xlnk-1.0";
  };
};
```





💢 IMPORTANT: Note, SDK will NOT automatically generate this change. You must manually add this to the top-level device tree file.

If PetaLinux is used to create Linux boot files, the device tree is included in the unified boot image file image.ub, rather than as a separate file.

Whether you provide an image.ub file, or separate Linux boot files (device tree, kernel, ramdisk), you will need to define the sdx:imageData attribute of the <sdx:image> element to specify the platform folder that contains these files:

sdx:imageData=image

Location: samples/platforms/zc702 axis io/sw/image

Linux Image

A Linux image is required to boot the hardware platform. Xilinx provides single platformindependent pre-built Linux image that works with all the SDSoC platforms supplied by Xilinx.

However, if you want to configure Linux for your own platform, follow the instructions at wiki.xilinx.com to download and build the Linux kernel. Make sure you enable the SDx IDE APF drivers, and the Contiguous Memory Allocator (CMA) when configuring Linux for your platform.

If PetaLinux is used to create Linux boot files, the Linux kernel image is included in the unified boot image file, image.ub, rather than as a separate file.

Whether you provide an image.ub file, or separate Linux boot files (device tree, kernel, ramdisk), you will need to define the sdx:imageData attribute of the <sdx:image> element to specify the platform folder that contains these files. For sdx:imageData="image" the location of the image.ub file would be <path to platform>/sw/image/image.ub.

Sample xml description:

sdx:imageData="image"

Location: samples/platforms/zc702 axis io/sw/image

Ramdisk Image

A ramdisk image is required to boot. A single ramdisk image is included as part of the SDx environment IDE installation. If you need to modify it, or create a new ramdisk, follow the instructions at wiki.xilinx.com.

If PetaLinux is used to create Linux boot files, the ramdisk is included in the unified boot image file, image.ub, rather than as a separate file.

Whether you provide an image.ub file, or separate Linux boot files (device tree, kernel, ramdisk), you will need to define the sdx:imageData attribute of the <sdx:image> element to specify the platform folder that contains these files.



Sample xml description:

```
sdx:imageData="image"
```

Location: samples/platforms/zc702 axis io/sw/image

Using PetaLinux to Create Linux Boot Files

PetaLinux can generate the Linux boot files for an SDSoC platform using the process documented in *PetaLinux Tools Documentation: Workflow Tutorial* (UG1156). The overall workflow for SDSoC platforms is the same, and the basic steps are outlined below. If you are familiar with the PetaLinux tools, you should be able to complete these steps for Zynq-7000 or Zynq-UltraScale+ MPSoC designs.

Before starting, you should complete the following:

- Set up your shell environment with PetaLinux 2016.3 tools in your PATH environment variable.
- Clone/pull from the master branch of the Xilinx/linux-xlnx tree at github, and check out the Xilinx-v2016.3_sdx tag:

```
git checkout -b sdx_release_tag xilinx-v2016.3-sdsoc
```

- Create and cd into a working directory.
- Create a new PetaLinux project targeting a BSP that corresponds to the type of board you are targetting:

```
petalinux-create -t project <path to project> -s <path to base BSP>
```

• Obtain a copy of the hardware handoff file (.hdf) from the Vivado project for your hardware platform.

The steps below include basic setup, loading the hardware handoff file, kernel configuration, root file system configuration, and building the Linux image. The steps include the actions to perform, or the PetaLinux command to run, with arguments. Once the build completes, your working directory contains a unified boot image file (image.ub) that includes the devicetree, kernel and ramdisk. The basic setup is the procedure used to configure the linux images packaged in all base platforms shipped with SDSoC platforms.

When using the <code>petalinux-config</code> command, a text-based user interface appears with a hierarchical menu system. The steps present a hierarchy of commands and the settings to use. Selections with the same indentation are at the same level of hierarchy. For example, the <code>petalinx-config -c kernel</code> step asks you to select Device Drivers from the top-level menu, select Generic Driver Options, go down one level to apply settings, go back up to Staging drivers, and apply settings to its sub-menu items.

To build the PetaLinux image, use the following steps:

- 1. Set up the working directory by running the following commands:
 - mkdir components/linux-kernel/
 - ln -s <path_to_linux_checkout> components/linux-kernel/sdsoc



2. Configure the hardware description:

- petalinux-config --get-hw-description=<PATH TO HDF>
- Apply the settings in the configuration menu as shown below:

```
linux Components Selection
    kernel [sdsoc]

Kernel Bootargs
    generate boot args automatically [OFF]
    <Zynq> user set kernel bootargs [console=ttyPS0,115200
earlyprintk quiet]
    <MPSoC> user set kernel bootargs
[earlycon=cdns,mmio,0xFF000000,115200n8 console=ttyPS0,115200 quiet]
```

3. Configure the kernel:

- petalinux-config -c kernel
- Apply the settings in the configuration menu as shown below:

```
Device Drivers

Generic Driver Options

<Zynq only> Size in Mega Bytes [256]

<MPSoC only> Size in Mega Bytes [1024]

Staging drivers [ON]

Xilinx APF Accelerator driver [ON]

Xilinx APF DMA engines support [ON]
```

4. Configure the root file system:

- petalinux-config -c rootfs
- Apply the settings in the configuration menu as shown below:

```
Filesystem Packages

base

gcc-runtime-xilinx
libstdc++6 [ON]

tcf-agent

tcf-agent-lic [ON]

tcf-agent [ON]

console/network
dropbear

dropbear-openssh-sftp-server [OFF]

Apps

<everything> [OFF]
```

5. Update the device tree:

• Append the text below to the end of subsystems/linux/configs/system-top.dts:

```
/{
      xlnk {
         compatible = "xlnx, xlnk-1.0";
    };
};
```



6. Update the U-boot configuration:

Append the text below to the end of subsystems/linux/configs/u-boot/platform-top.h:

```
#undef CONFIG_PREBOOT
#define CONFIG_PREBOOT "echo U-BOOT for ${hostname};setenv preboot;
echo"
```

7. Build the PetaLinux image:

• petalinux-build

After the PetaLinux build completes, the images/linux/ directory contains an image.ub file and a u-boot.elf file.



TIP: For Zynq UltraScale+ MPSoC platforms, this directory also contains b131.elf, which is a required ARM trusted firmware file necessary for booting the platform, and a pre-compiled power management unit firmware file, pmufw.elf, in pre-built/linux/images/.

Standalone Boot Files

If no OS is required, you can create a boot image that automatically executes a generated executable.

First Stage Boot Loader (FSBL)

The first stage boot loader (FSBL) is responsible for loading the bitstream and configuring the Zyng® architecture Processing System (PS) at boot time.

When the platform project is open in Vivado® Design Suite, click the **File→Export→Export Hardware** menu option.

Create a new software project **File→New→Application Project** with the name fsbl as you would using the Xilinx SDK.

Using the exported Hardware Platform, select the Zynq FSBL application from the list. This creates an FSBL executable.

For more detailed information, see the SDK Help System.

Once you generate the FSBL, you must copy it into a standard location for the SDx environment flow.

Example:

 ${\tt samples/platforms/zc702_axis_io/sw/boot/fsbl.elf}$



For the SDx system compiler to use an FSBL, a BIF file must point to it, as defined by the sdx:bif attribute of the<sdx:image> element. Refer to the Software Platform XML Metadata Reference for more information on the sdx:bif attribute. The file must reside in the path to platform>/sw/boot/fsbl.elf folder.



TIP: The BIF file for a Zynq AP SoC is very different from the BIF file for the Zynq UltraScale+ MPSoC device.

The following is an example boot.bif file for the Zyng®-7000 All Programmable (AP) SoC:

The following is an example boot.bif file for the Zyng UltraScale+™ MPSoC device:

```
/* linux */
the_ROM_image:
{
    [fsbl_config] a53_x64
    [bootloader] < boot/fsbl.elf >
    [pmufw_image] < boot/pmufw.elf >
    [destination_device=pl] < bitstream >
    [destination_cpu=a53-0, exception_level=el-3, trustzone] < boot/bl31.elf >
    [destination_cpu=a53-0, exception_level=el-2] < boot/u-boot.elf >
}
```

Executable

For the SDx environment to use an executable in a boot image, a BIF file must point to it.

The SDx environment automatically inserts the generated bitstream and ELF files.

FreeRTOS Configuration/Version Change

The SDx™ IDE FreeRTOS support uses a pre-built library using the default FreeRTOSConfig.h file included with the v8.2.3 software distribution, along with a predefined linker script.



To change the FreeRTOS v8.2.3 configuration or its linker script, or use a different version of FreeRTOS, follow the steps below:

- 1. Copy the folder <path to install>/SDx/<version>/platforms/zc702 to a local folder.
- 2. To just modify the default linker script, modify the file <path_to_your_platform>/zc702/sw/freertos/lscript.ld.
- 3. To change the FreeRTOS configuration (FreeRTOSConfig.h) or version:
 - a. Build a FeeRTOS library as libfreertos.a.
 - b. Add include files to the folder <path_to_your_platform>/zc702/sw/freertos/include.
 - c. Add the library libfreertos.a to <path_to_your_platform>/zc702/sw/freertos/
 li.
 - d. Change the paths in <path_to_your_platform>/zc702/zc702.spfm for the section
 containing the line ("sdx:os sdx_name="freertos"

```
(sdx:includePaths="/aarch32-none/include and
sdx:libraryPaths="/aarch-32-none/lib/freertos").
```

- 4. In your makefile, change the SDSoC platform option from -sds-pf zc702 to -sds-pf <path to your platform>/zc702.
- 5. Rebuild the library:

The SDx IDE folder <path_to_install>/SDx/2016.x/tps/FreeRTOS includes the source files used to build the pre-configured FreeRTOS v8.2.3 library libfreertos.a, along with a simple makefile and an SDSoC_readme.txt file. See the SDSoC_readme.txt file for additional requirements and instructions.

- a. Open a command shell.
- b. Run the SDx IDE <path_to_install>/SDx/2016.x/settings64-SDx script to set up the environment to run command line tools (including the ARM GNU toolchain for the Zynq®-7000 AP SoC).
- c. Copy the folder to a local folder.
- d. Modify FreeRTOSConfig.h.
- e. Run the make command.

If you are not using FreeRTOS v8.2.3, see the notes in the <code>sdsoc_readme.txt</code> file describing how the source was derived from the official software distribution. After uncompressing the ZIP file, a very small number of changes were made (incorporate <code>memcpy</code>, <code>memset</code> and <code>memcmp</code> from the demo application <code>main.c</code> into a library source file and change include file references from <code>Task.h</code> to <code>task.h</code>) but the folder structure is the same as the original. If the folder structure is preserved, the makefile created to build the preconfigured FreeRTOS v8.2.3 library can be used.



Platform Sample Applications

A platform can optionally include sample application templates to demonstrate the usage of the platform. Sample applications must reside in the samples directory of a platform:

```
<platform install>/samples.
```

The file that describes the applications to SDx is called template.xml and it resides inside the samples directory. The template.xml file uses a very simple format. Here is an example for the zc702_led sample platform found in $\scalebox{SDx_install>/samples/platforms/zc702_led/samples/template.xml.}$

```
<?xml version="1.0" encoding="UTF-8"?>
<manifest:Manifest xmi:version="2.0"</pre>
                   xmlns:xmi="http://www.omg.org/XMI"
                   xmlns:manifest="http://www.xilinx.com/manifest">
 <template location="arraycopy" name="Array copy"</pre>
            description="Simple test application">
    <supports>
      <and>
        <os name="Linux"/>
      </and>
    </supports>
    <accelerator name="arraycopy" location="arraycopy.cpp"/>
  <template location="arraycopy sa" name="Array copy"</pre>
            description="Simple test application">
    <supports>
      <and>
        <os name="Standalone"/>
      </and>
    </supports>
    <accelerator name="arraycopy" location="arraycopy.cpp"/>
  </template>
</manifest:Manifest>
```

The first line defines the template file format as XML, and is mandatory:

```
<?xml version="1.0" encoding="UTF-8"?>
```



The <manifest: Manifest> XML element is required as a container for all application templates defined in the template file:

<template> element

Each application template is defined inside a <template> element, and there can be multiple <template> tags defined within the <manifest> element. The <template> element can have multiple attributes as shown in the following table:

Table 1: Attributes of the Template Element

Attribute	Description	
location	Relative path to the template application	
name	Application name displayed in the SDSoC environment	
description	Application description displayed in the SDSoC environment	

Example:

```
<template location="myapp" name="My App" description="Sample application">
```

The <template> element can also contain multiple nested elements that define different aspects of the application.

Table 2: Template Sub-Elements

Element	Description
<supports></supports>	Boolean function that defines the matching template.
<includepaths></includepaths>	Paths relative to the application to be added to the compiler as -I flags.
librarypaths>	Paths relative to the application to be added to the linker as -L flags.
libraries>	Platform libraries to be linked against using linker -1 flags.
<exclude></exclude>	Directories or files to exclude from copying into the SDSoC project.
<system></system>	Application project settings for the system, for example the data motion clock.
<accelerator></accelerator>	Application project settings for specifying a function target for hardware.
<compiler></compiler>	Application project settings defining compiler options.
ker>	Application project settings defining linker options.



<supports> element

The <supports> element defines an Operating System match for the selected SDx platform. The <os> elements must be enclosed in <and> and <or> elements to define a boolean function.

The following example defines an application that can be selected when either of Linux, Standalone or FreeRTOS are selected as an Operating System:

<includepaths> element

The <includepaths> element defines the set of paths relative to the application that are to be passed to the compiler using -I flags. Each <path> element has a location attribute.

The following example results in SDx adding the flags -I"../src/myinclude" -I"../src/dir/include" to the compiler:

```
<includepaths>
  <path location="myinclude"/>
  <path location="dir/include"/>
  </includepaths>
```

<librarypaths> element

The librarypaths> element defines the set of paths relative to the application that are to be passed to the linker using -L flags. Each <path> element has a location attribute.

The following example results in SDSoC adding the flags -L"../src/mylibrary" -L"../src/dir/lib" to the linker:

```
librarypaths>
  <path location="mylibrary"/>
   <path location="dir/lib"/>
  </librarypaths>
```



libraries> element

The libraries> element defines the set of libraries that are to be passed to the linker -I flags. Each element has a name attribute.

The following example results in SDx adding the flags -lmylib2 -lmylib2 to the linker:

```
<libraries>
  lib name="mylib1"/>
  name="mylib2"/>
  </libraries>
```

<exclude> element

The <exclude> element defines a set of directories and files to be excluded from being copied when SDSoC creates the new project.

The following example will result in SDx not making a copy of directories MyDir and MyOtherDir when creating the new project. It will also not make a copy of files MyFile.txt and MyOtherFile.txt. This allows you to have files or directories in the application directory that are not needed to build the application.

```
<exclude>
  <directory name="MyDir"/>
  <directory name="MyOtherDir"/>
  <file name="MyFile.txt"/>
  <file name="MyOtherFile.txt:/>
</exclude>
```

<system> element

The optional <system> element defines application project settings for the system when
creating a new project. The dmclkid attribute defines the data motion clock ID. If the <system>
element is not specified, the data motion clock uses the default clock ID.

The following example will result in SDx setting the data motion clock ID to 2 instead of the default clock ID when creating the new project.

```
<system dmclkid="2"/>
```



<accelerator> element

The optional <accelerator> element defines application project settings for a function targeted for hardware when creating a new project. The name attribute defines the name of the function and the location attribute defines the path to the source file containing the function (the path is relative to the folder in the platform containing the application source files). The name and location are required attributes of the <accelerator> element. The optional attribute clkid specifies the accelerator clock to use instead of the default. The optional sub-element <hlsfiles> specifies the name of a source file (path relative to the folder in the platform containing application source files) containing code called by the accelerator and the accelerator is found in a different file. The SDx environment normally infers <hlsfiles> information for an application and this sub-element does not need to be specified unless the default behavior needs to be overridden.

The following example will result in SDx specifying two functions to move to hardware func1 and func2 when creating the new project.

```
<accelerator name="func1" location="func1.cpp"/>
<accelerator name="func2" location="func2.cpp" clkid="2">
    <hlsfiles name="func2_helper_a.cpp/>
    <hlsfiles name="func2_helper_b.cpp/>
    </accelerator>
```

<compiler> element

The optional <compiler> element defines application project settings for the compiler when creating a new project. The inferredOptions attribute defines compiler options required to build the application and appears in the SDx Environment C/C++ Build Settings dialog as compiler Inferred Options under Software Platform.

The following example will result in SDSoC adding the compiler option -D MYAPPMACRO when creating the new project.

```
<compiler inferredOptions="-D MYAPPMACRO"/>
```

<linker> element

The optional linker> element defines application project settings for the linker when creating a new project. The inferredOptions attribute defines linker options required to build the application and appears in the SDx Environment C/C++ Build Settings dialog as linker Miscellaneous options.

The following example will result in SDx adding the linker option -poll-mode 1 when creating the new project.



```
<linker inferredOptions="-poll-mode 1"/>
```

Complete Example of template.xml

The following is a complete example of a template.xml file:

```
<?xml version="1.0" encoding="UTF-8"?>
<manifest:Manifest xmi:version="2.0"</pre>
                   xmlns:xmi="http://www.omg.org/XMI"
                   xmlns:manifest="http://www.xilinx.com/
manifest">
  <template location="myapp" name="My App"
           description="Sample application">
    <supports>
      <and>
        <or>
          <os name="Linux"/>
          <os name="Standalone"/>
          <os name="FreeRTOS"/>
        </or>
      </and>
    </supports>
    <accelerator name="myaccel" location="myaccel.cpp"/>
    <includepaths>
      <path location="myinclude"/>
      <path location="dir/include"/>
    </includepaths>
    libraries>
      <lib name="mylib1"/>
      <lib name="mylib2"/>
    </libraries>
    <exclude>
      <directory name="MyDir"/>
      <directory name="MyOtherDir"/>
      <file name="MyFile.txt"/>
      <file name="MyOtherFile.txt:/>
    </exclude>
  </template>
  <!-- Multiple template elements allowed -->
</manifest:Manifest>
```



Hardware Platform Metadata Creation

Introduction

Every SDSoC platform includes a hardware platform metadata XML file, <platform>.hpfm, containing information about its hardware interfaces. SDSoC uses this information when creating the hardware system for your design, adding the data motion network and hardware accelerators along with the required connections for clocks, data and control signals. This chapter describes the steps used to create the .hpfm file, the hardware platform Tcl API, and the Vivado commands used to load and run the Tcl script, Finally, an example of a complete hardware platform Tcl script is presented.

The .hpfm file is found in the folder <path_to_platform>/hw. For example, the hardware platform metadata XML file for the Zynq 7000 ZC702 Evaluation Kit board is found in <SDx_install>/platforms/zc702/hw/zc702.hpfm. An example Zynq UltraScale+ MPSoC hardware platform file can be found at <SDx_install>/platforms/zcu102/hw/zcu102.hpfm.

After you complete a hardware platform design project in the Vivado Design Suite, you can create a Tcl script that will generate the hardware platform description file from the Vivado project using the SDSoC Vivado Tcl commands as described in the following section. With your Vivado project loaded, execute the Tcl file commands to write out the <platform>.hpfm file.



SDSoC Vivado Tcl Commands

This section describes the Vivado® IP Integrator Tcl commands that specify the hardware interface of an SDSoC™ platform, which includes clock information and clock, reset, interrupt, AXI, and AXI4-Stream type interfaces. Once you have built and verified your hardware system within the Vivado Design Suite, the process of creating an SDSoC platform hardware description file consists of the following steps.

1. Load the SDSoC Vivado Tcl API by executing the following command in the Vivado Design Suite Tcl console.

```
source -notrace <sdx install path>/scripts/vivado/sdsoc pfm.tcl
```

- 2. Execute Tcl APIs in Vivado to accomplish the following steps:
 - a. Declare the hardware platform name.
 - b. Define a brief description of the platform.
 - c. Declare the platform clock ports.
 - d. Declare the platform AXI bus interfaces.
 - e. Declare the platform AXI4-Stream bus interfaces.
 - f. Declare the available platform interrupts.
 - q. Write the hardware platform description metadata file.

Defining the Hardware Platform Name and Description

The following describes the TCL API to be used within a block diagram in the Vivado IP Integrator feature.

• To create a new hardware platform file, set the name and description, use:

```
sdsoc::create_pfm <platform>.hpfm

Arguments:
    <platform> - platform name

Returns:
```

new platform handle



• To set the platform name and description:

Example:

Declaring Clocks

You can export any clock source with the platform, but for each clock you must also export synchronized reset signals using a Processor System Reset IP block in the platform. To declare clocks, use:

```
sdsoc::pfm_clock <pfm_handle> <port> <instance> <id> <is_default>
<prec_sys_reset>
```

Arguments:

Argument	Description
pfm_handle	pfm handle
port	Clock port name
instance	Instance name of the block that contains the port
id	Clock id (user-defined, must be a unique non-negative integer)
is_default	True if this is the default clock, false otherwise
proc_sys_reset	Corresponding proc_sys_reset block instance for synchronized reset signals

Every platform must declare one default clock for the SDSoC environment to use when no explicit clock has been specified. A clock is the default clock when the "is_default" argument is set to true.

Examples:

sdsoc::pfm_clock	<pre>\$pfm FCLK_CLK0 ps7 0 false proc_sys_reset_0</pre>
sdsoc::pfm_clock	<pre>\$pfm FCLK_CLK1 ps7 1 false proc_sys_reset_1</pre>
sdsoc::pfm_clock	<pre>\$pfm FCLK_CLK2 ps7 2 true proc_sys_reset_2</pre>
sdsoc::pfm_clock	<pre>\$pfm FCLK_CLK3 ps7 3 false proc_sys_reset_3</pre>



Declaring AXI Ports

To declare AXI ports, use:

```
sdsoc::pfm_axi_port <pfm> <axi_port> <instance> <memport>
```

Arguments:

Argument	Description
pfm	pfm handle
port	AXI port name
instance	Instance name of the block that contains the port
memport	Corresponding memory interface port type. Values:
	M_AXI_GP – A general-purpose AXI master port
	• s_AXI_HP – A high-performance AXI slave port
	s_AXI_ACP - An accelerator coherent slave port
	MIG – An AXI slave connected to a MIG memory controller

Examples:

Example for an AXI interconnect:

Exporting AXI interconnect master and slave ports involves several requirements.

- 1. All ports on the interconnect used within the platform must precede in index order any declared platform interfaces.
- 2. There can be no gaps in the port indexing.
- 3. The maximum number of master IDs for the S_AXI_ACP port is eight, so on an connected AXI interconnect, available ports to declare must be one of {S00_AXI, S01_AXI, ..., S07_AXI}. Do not declare any ports that are used within the platform itself. Declaring as many as possible will allow sds++ to avoid cascaded axi_interconnects in generated user systems.
- 4. The maximum number of master IDs for an S_AXI_HP or MIG port is sixteen, so on an connected AXI interconnect, available ports to declare must be one of {S00_AXI, S01_AXI, ..., S15_AXI}. Do not declare any ports that are used within the platform itself. Declaring as many as possible will allow sds++ to avoid cascaded axi_interconnects in generated user systems.



5. The maximum number of master ports declared on an interconnect connected to an M_AXI_GP port is sixty-four, so on an connected AXI interconnect, available ports to declare must be one of {M00_AXI, M01_AXI, ..., M63_AXI}. Do not declare any ports that are used within the platform itself. Declaring as many as possible will allow sds++ to avoid cascaded axi_interconnects in generated user systems.

As an example, the zc702_acp_pfm.tcl file includes the following declarations for interconnect ports connected to M_AXI_GP0 and S_AXI_ACP.

```
for {set i 1} {$i < 64} {incr i} {
   sdsoc::pfm_axi_port $pfm M[format %02d $i]_AXI axi_ic_gp0 M_AXI_GP
}
for {set i 1} {$i < 8} {incr i} {
   sdsoc::pfm_axi_port $pfm S[format %02d $i]_AXI axi_ic_acp S_AXI_ACP
}</pre>
```

Declaring AXI4-Stream Ports

To declare AXI4-Stream ports, use:

```
sdsoc::pfm_axis_port <pfm> <axis_port> <instance> <type>
```

Arguments:

Argument	Description
pfm	pfm handle
port	AXI4-Stream port name
instance	Instance name of the block that contains the port
type	Interface type (values: M_AXIS, S_AXIS)

Examples:

```
sdsoc::pfm_axis_port     $pfm S_AXIS axis2io S_AXIS
sdsoc::pfm_axis_port     $pfm M_AXIS io2axis M_AXIS
```

Declaring Interrupt Ports

Interrupts must be connected to the platform Processing System 7 IP block through an IP integrator Concat block (xlconcat). If any IP within the platform includes interrupts, these must occupy the least significant bits of the Concat block without gaps.



To declare interrupt ports, use:

```
sdsoc::pfm_irq <pfm> <port> <instance>
```

Arguments:

Argument	Description
pfm	pfm handle
port	irq port name
instance	Instance name of the concat block that contains the port

Example:

```
for {set i 0} {$i < 16} {incr i} {
   sdsoc::pfm_irq    $pfm In$i xlconcat
}</pre>
```

Declaring IO Devices

If you use the Linux UIO framework, you must declare the devices. To declare an instance to be a Linux IO platform device, use:

```
sdsoc::pfm_iodev <pfm> <port> <instance> <type>
```

Arguments:

Argument	Description
pfm	pfm handle
port	I/O port name
instance	Instance name of the block that contains the UIO
type	I/O device type (e.g., UIO, KIO)

Example:

Writing the Hardware Platform Description File

After using the above Tcl API commands to describe your platform, use the following to write the hardware platform description file:

```
sdsoc::generate_hw_pfm <pfm_handle>
```

Example:

sdsoc::generate_hw_pfm \$pfm



This command will write the file specified in the sdsoc::create pfm command.

Complete Example

All platforms included in the SDSoC release include the Tcl script used to generate the corresponding hardware description file. The Tcl script is located inside the hw/vivado directory and is called <platform>_pfm.tcl.

The following is a complete example of the usage of the Tcl API to generate a ZC702 platform



Testing the Platform Hardware Description File

The SDx Environment includes an XML Schema for validating your platform hardware description file. For example, to validate your platform hardware description XML file in an SDx terminal, use this command:

```
sds-pf-check <platform>.hpfm
```

After putting the hardware platform description file (<platform>.hpfm) and software platform description file (<platform>.spfm) in the platform directory, you can verify that the SDx IDE can read the files correctly by executing the following command, which lists all the available platforms:

```
> sdscc -sds-pf-list
```

If you see the platform you have created in the displayed list, then the SDx IDE has found it. To display more information about your platform, use the following command:

```
> sdscc -sds-pf-info <platform_name>
```



Software Platform Metadata Creation

Introduction

Each hardware platform you develop requires a software platform metadata file, <platform>.spfm, that contains information about supported software environments, referred to as system configurations. The software platform metadata file can be found in <path_to_platform_folder>/sw/<platform>.spfm. You must manually create the .spfm file using a text or XML editor. You can create a new SPFM file by editing an existing file, and modifying it to suit your hardware platform.

When building user applications, the SDSoC compiler needs to know any include paths and library paths located in the platform, and also needs to locate files required to build SD card images. The SDx environment IDE requires this information to populate GUI elements for selecting the system configuration. For example, the ZC702 platform included in the SDx environment installation supports system configurations for Linux, Standalone OS, and FreeRTOS OS, that target the Xilinx Zynq-7000 All Programmable SoC ZC702 Evaluation Kit board.

This chapter walks you through the contents of the ZC702 software platform metadata XML file, zc702.spfm, with annotations that describe elements of the file. A metadata reference section follows that presents each of the XML elements and attributes, and describes their use.

Example ZC702.spfm File

The zc702.spfm software platform XML file for the ZC702 platform is displayed below for reference. The complete file can be found in the SDx environment installation $$$\langle \text{SDx_install_path}\rangle / \text{platforms/zc702/sw/zc702.spfm}. Each of the system configurations and their metadata are described and annotated. Where paths are specified, they are relative to the folder containing the .spfm file ($\path_to_platform>/sw$) unless otherwise noted.$

As shown below, the zc702.spfm begins with the sdx:platform tag.

The sdx:description should summarize the features of the hardware platform, and can be displayed by the SDSoC environment.



The zc702.spfm contains three System Configurations in the sdx:systemConfigurations section, each described by a sdx:configuration section.



TIP: You only need to specify one if that is all your platform supports.

The sdx:systemConfigurations designates one of the sdx:configuration sections as the default to use by the SDx environment New Project Wizard, or as an sdscc/sds++ -sds-sysconfig option when none is specified (sdx:defaultConfiguration).

The sdx:configuration includes a name used as the sdscc/sds++-sds-sys-config option value (sdx:name), a string used in the SDx Environment IDE New Project Wizard System Configuration dropdown menus (sdx:displayName), and mouse over text for the System Configuration (sdx:description).

The sdx:defaultProcessorGroup defines the default Target CPU in the New Project Wizard dropdown menu, and as the sdscc/sds++ -sds-proc option value if not specified.

The sdx:prebuilt element defines a folder with a prebuilt bitstream that represents the hardware platform implemented without any accelerators. The sdx:prebuilt attribute sdx:data specifies the path to the folder, relative to the .spfm file, containing the prebuilt bitstream and project files used when SDSoC builds applications containing no hardware accelerators. The sdx:prebuilt entity is optional, but eliminates time spent building the bitstream when specified.

The sdx:prebuilt platform data is the same for all system configurations of a platform, since it represents the hardware platform implemented without accelerators, and the hardware is the same regardless of the OS that runs on it, as long as the platform supports the OS.



TIP: For the zc702, sdx:prebuilt is defined separately for each system configuration, but they all point to the same folder.

The sdx:bootImages metadata contains one or more sdx:image sections used by SDSoC when creating SD card images.



While sdx:default specifies the default image creation metadata, in this initial release only one sdx:image section is supported. The sdx:image must specify a .bif file used with the "bootgen" tool to create the SD card image (sdx:bif specifies the path to the .bif file relative to the "sw" folder).

The sdx:imageData attribute specifies a folder containing boot files to copy to the SD card root folder – since the System Configuration is for Linux, the image folder includes the kernel, ramdisk and device tree (as separate files or a .ub unified boot file).

The sdx:gemu* values are optional and used for SDSoC emulation flows.

The sdx:mountPath is the path to the SD card in the Linux file system once the system boots.

The sdx:processorGroup includes a name used as the sdscc/sds++ -sds-sys-proc option value (sdx:name), a string used in the SDx Environment IDE New Project Wizard Target CPU dropdown menus (sdx:displayName), and mouse over text for the Target CPU (sdx:description).

The sdx:cpuType is cortex-a9 for Zynq, and cortex-a53 or cortex-r5 for Zynq UltraScale+.

The sdx:os includes a name and a string used in the SDx Environment IDE New Project Wizard OS label (sdx:displayName).

The sdx:crossCompilerType specifies whether to use the Linux or baremetal Linaro ARM cross-compiler and the sdx:toolConfig specifies an SDSoC file containing settings used to build the user application (include paths, library paths, compiler options, linker options, etc).

The standalone system configuration metadata is similar to the metadata for the Linux configuration. The processor instance name (sdx:cpuInstance) is required to build the standalone BSP libxil.a. There are no additional boot files copied to the SD card, so sdx:imageData is not used in this configuration. The configuration also requires a linker script (sdx:ldscript). The emulation flow does not require U-boot (sdx:qemuBoot), but it does require a device tree (sdx:Devicetree) for QEMU to register devices.



```
<sdx:configuration sdx:name="standalone"</pre>
                           sdx:displayName="Standalone OS (Zynq
7000)"
          sdx:defaultProcessorGroup="a9 0">
            <sdx:description>Standalone OS running on Zyng
7000</sdx:description>
            <sdx:prebuilt sdx:data="prebuilt platform"/>
            <sdx:bootImages sdx:default="standard">
                <sdx:image sdx:name="standard"
          sdx:bif="boot/standalone.bif"
          sdx:readme="boot/generic.readme"
          sdx:qemuDevicetree="qemu/devicetree.dtb"
          sdx:qemuArguments="qemu/qemu args.txt" />
            </sdx:bootImages>
            <sdx:processorGroup sdx:name="a9 0"
sdx:displayName="A9 0"
          sdx:cpuInstance="ps7 cortexa9 0"
          sdx:cpuType="cortex-a9">
                <sdx:os sdx:name="standalone"
                        sdx:displayName="Standalone
OS"
          sdx:ldscript="aarch32-none/lscript.ld"
            </sdx:processorGroup>
          </sdx:configuration>
```

The FreeRTOS System Configuration metadata is also similar to the metadata for the Linux configuration. The processor instance name (sdx:cpuInstance) is required to build the standalone BSP libxil.a (FreeRTOS is code is additive to the standalone BSP, implementing a task scheduler and other functions). There are no additional boot files copied to the SD card, so sdx:imageData is not used in this configuration. The configuration also requires a linker script (sdx:ldscript). The emulation flow is not implemented for FreeRTOS running on the zc702 platform.

Include paths (sdx:includePaths), library paths (sdx:libraryPaths) and a library (sdx:libraryNames) are defined, with the leading slash character '/' indicating the path is relative to the SDSoC installation, for example <install>/aarch32-none/include/freertos. If there were no leading slash character '/', the path is relative to the "sw" folder.



Software Platform XML Metadata Reference

An SDSoC software platform XML file (.spfm) defines one or more system configurations. When building an SDSoC application, the user specifies the system configuration that defines a software runtime environment for a target operating system (OS), and metadata used by the SDSoC system compilers to generate application-specific systems-on-chip built upon the hardware platform. The information includes:

- Optional prebuilt platform data, for example bitstream and files normally generated by SDSoC, which minimizes SDSoC build times when a design contains no accelerators.
- SD card image data files, for example bootloaders, boot files for Linux (kernel, ramdisk, devicetree) and the Boot Image File (BIF) template used with by SDSoC with the bootgen utility to create the images.
- Compile and link software files and settings for a targeted processor:
 - Optional include files and libraries required by platform software applications.
 - Linker scripts.
 - Optional BSP configuration files and repositories.
 - Target device information.

The informal software platform XML schema is shown below, although not all elements or attributes are required:



```
<sdx:prebuilt sdx:data="prebuilt platform path"/>
             <sdx:bootImages sdx:default="default name">
                <sdx:image sdx:name="name"
                           sdx:bif="path to bif file"
                           sdx:imageData="path to_image_data"
                           sdx:extraData="path to more image data"
                           sdx:mountPath="sd card mount path"
                           sdx:readme="path to readme file"
                           sdx:qemuDevicetree="path qemu devicetree"
                           sdx:gemuBoot="path gemu uboot"
                           sdx:qemuArguments="path arguments file" />
            </sdx:bootImages>
            <sdx:processorGroup
sdx:name="name"
          sdx:displayName="GUI name"
                                sdx:cpuType="cpu type"
                                sdx:cpuInstance="instance name">
                <sdx:os sdx:name="os name"
                        sdx:displayName="GUI name"
                        sdx:includePaths="path to include folder"
                        sdx:libraryPaths="path_to_library folder"
                        sdx:libraryNames="list of library names"
                        sdx:ldscript="path to linker script"
                        sdx:bspConfig="path_to_mss_file"
                        sdx:bspRepo="path to bsp repository"
                        sdx:compilerOptions="compiler options"
                        sdx:linkerOptions="linker options"
            </sdx:processorGroup>
          </sdx:configuration>
           <sdx:configuration sdx:name="name"
sdx:displayName="GUI name"
          sdx:defaultProcessorGroup="default name">
        </sdx:configuration>
          </sdx:systemConfigurations></sdx:platform>
```

The first line of the file defines the format of the file to be XML and is mandatory:

```
<?xml version="1.0" encoding="UTF-8"?>
```

<sdx:platform>

The <sdx:platform> XML element is required as a container for all software platform information. It has the following attributes:

```
<sdx:platform sdx:vendor="xilinx.com"
sdx:library="sdx"
sdx:name="platform_name"
sdx:version="1.0"</pre>
```



```
sdx:schemaVersion="1.0"
xmlns:sdx="http://www.xilinx.com/sdx">
```

Table 3: Attributes of <sdx:platform>

Attribute	Description
sdx:vendor	Vendor information
sdx:library	Library name space
sdx:name	Platform name
sdx:version	Platform version
sdx:schemaVersion	Platform schema version
xmlns:sdx	XML namespace is sdx

<sdx:description>

The <sdx:description> element describes the software platform and may be used when SDSoC displays summary information.

```
<sdx:description>software_platform_description </sdx:description>
```

<sdx:systemConfigurations>

The <sdx:systemConfigurations> XML element is required as a container for all system configurations.

The <sdx:systemConfigurations> element specifies the name of the default sdx:configuration to use as the selection in the SDx environment IDE New Project Wizard drop-down list of system configurations, or when the SDSoC compiler tool sdscc/sds++ command line does not include the -sds-sys-config <system_configuration_name> option.

```
<sdx:systemConfigurations sdx:defaultConfiguration="default_name">
```

The <sdx:configuration> element defines a System Configuration and includes the following attributes:

```
<sdx:configuration sdx:name="name"
sdx:displayName="GUI_name"
sdx:defaultProcessorGroup="default_name">
```

Table 4: Attributes of <sdx:configuration>

Attribute	Description
sdx:name	System Configuration name, used in the sdscc/sds++ command
	line option -sds-sys-config <system_configuration_name>.</system_configuration_name>



Attribute	Description
sdx:displayName	System Configuration name, used in the SDx Environment IDE New Project Wizard selection menus. This is typically a longer, more descriptive name than sdx:name.
sdx:defaultProcessorGroup	Default processor group name, specifies the default sdx:processorGroup to use as the selection in the SDx Environment IDE New Project Wizard drop-down list of Target CPUs, or when the sdscc/sds++ command line does not include the –sds-proc <pre>processor_group_name</pre> > option.

The <sdx:configuration> element can also contain multiple XML sub-elements:

Table 5: Sub-elements of <sdx:configuration>

Element	Description
<sdx:description></sdx:description>	Description of the System Configuration
<sdx:prebuilt></sdx:prebuilt>	Prebuilt data for the platform, for example bitstream and other generated files
<sdx:bootimages></sdx:bootimages>	Boot image creation data required to create an SD card image
<sdx:processorgroup></sdx:processorgroup>	Processor and OS-specific software data and files used to build user applications

<sdx:description> Element

The sdx:description element contains a description of the System Configuration. This is used in the SDx Environment IDE New Project Wizard when a more detailed description is required, for example mouse over the name in a list of system configurations, or when sdscc/sds++ -sds-pf-list or -sds-pf-info options are used to print information about a platform

```
<sdx:description>configuration_description
</sdx:description>
```

<sdx:prebuilt> Element

The <sdx:prebuilt> element specifies pre-generated data for the platform used with the system configuration when building user applications that contain no accelerators. This optional element can be used to reduce build times, since you do not need to wait for a hardware compile of the platform itself to create a bitstream and other required files.

The <sdx:prebuilt> element contains a single attribute sdx:data which specifies the path to a folder containing pre-generated files.

```
<sdx:prebuilt sdx:data="prebuilt_platform_path"/>
```

The path is relative to the software platform folder. For example, the element:

```
<sdx:prebuilt sdx:data="prebuilt_data"/>
```

Indicates the prebuilt hardware bitstream and generated files are found in <path_to_platform>/sw/prebuilt_data (the folder name can be defined by the platform provider).



Pre-built hardware files are automatically used by the SDSoC compiler when an application has no hardware functions specified in the SDx Environment IDE in the SDx Project Settings view or in the sdscc/sds++ command line using the platform, system configuration and processor flags:

```
-sds-pf zc702 -sds-sys-config linux -sds-proc a9_0
```

To force a full Vivado tools bitstream and SD card image compile, use the following sdscc option:

```
-rebuild-hardware
```

Files used to populate the <path_to_platform>/sw/prebuilt_data are found in the _sds project folder after creating the application ELF and bitstream:

- bitstream.bit : found in _sds/p0/ipi/<platform>.runs/impl_1/bitstream.bit
- <platform>.hdf : found in _sds/p0/ipi/<platform>.sdk
- apsys_0.xml and partitions.xml : found in _sds/.llvm
- portinfo.c and portinfo.h : found in _sds/swstubs

If the <sdx:prebuilt> element is not defined, SDSoC will generate the bitstream for applications without hardware accelerators. Examples can be found in factory platforms in <install>/platforms/<sw/prebuilt_data.

<sdx:bootImages> Element

The <sdx:bootImages> element is a container for one or more <sdx:image> elements, each of which includes attributes used to create an SD card image. The attribute sdx:default specifies the name of the default <sdx:image> to use.



TIP: In the 2016.3 release each <sdx:bootImages> element only contains a single <sdx:image> element.

```
<sdx:bootImages sdx:default="default_name">
    <sdx:image sdx:name="name"
    sdx:bif="path_to_bif_file"
    sdx:imageData="path_to_image_data"
    sdx:extraData="path_to_more_image_data"
    sdx:mountPath="sd_card_mount_path"
    sdx:readme="path_to_readme_file"
    sdx:qemuDevicetree="path_qemu_devicetree"
    sdx:qemuBoot="path_qemu_uboot"
    sdx:qemuArguments="path_arguments_file"
    />
    </sdx:bootImages>
```

The <sdx:image> element contains attributes used when SDSoC creates SD card boot images.

Table 6: Attributes of <sdx:image>

Attribute	Description
sdx:name	Image name
sdx:bif	Path to Boot Image File (BIF) used to create the SD card
sdx:imageData	Path to a folder containing boot files to copy to the SD card



Attribute	Description
sdx:extraData	Path to a folder containing additional files to copy to the SD card
sdx:mountPath	SD card mount path for Linux running on the target
sdx:readme	Readme file for the SD card
sdx:qemuDevicetree	Path to QEMU devicetree file (SDSoC emulation flows)
sdx:qemuBoot	Path to QEMU U-boot executable (SDSoC emulation flows)
sdx:qemuArguments	Path to QEMU arguments file (SDSoC emulation flows)

sdx:name Attribute

The sdx:name attribute is required and specifies the name of the <sdx:image> element.

sdx:bif Attribute

The sdx:bif attribute is required and specifies the path to a Boot Image File (BIF) relative to the software platform folder where the BIF file must exist. For example, the attribute:

```
sdx:bif="boot/linux.bif"
```

resolves to the path <path_to_platform>/sw/boot/linux.bif, where <path_to_platform>/sw is the folder containing the <platform>.spf file and both of these values are attributes specified in the file <path to platform>.xpfm file.

An example platform BIF file template for a Linux target has the following contents:

During system generation, the SDSoC system compiler reads this template and inserts application-specific file names to generate the BIF file. This file is passed to the bootgen utility to create the boot image.

```
/* linux */
the_ROM_image:
{
[bootloader]<path_to_platform>/boot/fsbl.elf
<path_to_generated_bitstream>/<project_name>.elf.bit
<path_to_platform>/boot/u-boot.elf
}
```

An example standalone.bif file has the following contents:



```
<elf>
}
```

During system generation, the SDSoC system compiler reads this template and inserts application-specific file names to generate the BIF file. This file is passed to the bootgen utility to create the boot image.

sdx:imageData Attribute

The sdx:imageData attribute is required for Linux images and specifies a folder containing boot files to copy to the SD card image whose path is relative to the software platform folder. For example, the attribute:

```
sdx:imageData="image"
```

resolves to the path <path_to_platform>/sw/image, where <path_to_platform>/sw is the folder containing the <platform>.spfm file.

The folder typically contains Linux boot files, and SDSoC copies all folders and files found in the folder to the root of the SD card. If you are using a unified boot image file (.ub) containing a kernel image, device tree and root file system, the folder typically contains an <code>image.ub</code> file. If you use separate <code>image.ub</code>, <code>devicetree.dtb</code> and <code>ramdisk.image.gz</code> files, the folder contains those files.

sdx:extraData Attribute

The sdx:extraData attribute is optional. It specifies a folder containing additional files to copy to the SD card folder whose path is relative to the software platform folder. For example, the attribute:

```
sdx:extraData="sdfiles"
```

resolves to the path <path_to_platform>/sw/sdfiles, where <path_to_platform>/sw is the folder containing the <platform>.spfm file.

The sdx:extraData attribute is optional and allows you isolate non-boot SD card files from the boot files specified by sdx:imageData.

sdx:mountPath Attribute

The sdx:mountPath attribute is optional. It specifies the SD card mount path, which defaults to /mnt if not specified.

sdx:readme Attribute



The sdx:readme attribute is optional. It specifies a readme file copied to the root of the SD card and whose path is relative to the software platform folder. For example, the attribute:

```
sdx:readme="linux/readme.txt"
```

resolves to the path <path_to_platform>/sw/linux/readme.txt, where <path to platform>/sw is the folder containing the <platform>.spfm file.

An example README file:

```
-= SD card boot image =-
Platform: <platform>
Application: <elf>

1. Copy the contents of this directory to an SD card
2. Set boot mode to SD
    Revision C and earlier boards:
        Jumper J22 1-2
        Jumper J25 1-2
    Revision D and newer boards:
        DIP switch SW16 positions 3 and 4 set to 1
3. Insert SD card and turn board on
```

If the sdx:readme attribute is used, SDSoC prepends build information to the start of the file before writing it to the SD card. If build information is not required to be inserted into the README file, the README file can be added to a folder defined by the sdx:imageData or sdx:extraData attributes and the sdx:readme attribute can be omitted.

sdx:qemuDevicetree, sdx:qemuBoot, and sdx:qemuArguments Attributes

The sdx:qemuDevicetree, sdx:qemuBoot and sdx:qemuArguments attributes define the path to the device tree, U-boot executable and QEMU arguments files used in SDSoC emulation flows, where the user application executes on QEMU and interacts with programmable logic running in the Vivado simulator. The paths to these files are relative to the software platform folder, where <path_to_platform>/sw is the folder containing the <platform>.spfm file.

The sdx: qemuDevicetree attribute is required whether the operating system (OS) running on the target is Linux or baremetal. The device tree is used by QEMU to enable device support.

The sdx:qemuBoot attribute is required when Linux is running on the target, but not for baremetal software. It points to the U-boot executable used to create Linux SD card boot images.

The sdx: qemuArguments attribute is required for all target OS which support emulation flows.

For an example of QEMU software platform files and support, see the folder <install>/platforms/zc702/sw/qemu.



TIP: Platform support for emulation is optional and these attributes are not required if your platform does not support emulation.

<sdx:processorGroup> Element



The <sdx:processorGroup> element defines compile and link software files and settings for a targeted processor such as:

- Target device information.
- Optional include files and libraries required by platform software applications.
- · Linker scripts.
- Optional BSP configuration files and repositories.

The <sdx:processorGroup> element includes the following attributes:

```
<sdx:processorGroup sdx:name="name"
sdx:displayName="GUI_name"
sdx:cpuType="cpu_type"
sdx:cpuInstance="instance_name">
```

Table 7: Attributes of <sdx:processorGroup>

Attribute	Description
sdx:name	Processor Group name, used in the sdscc/sds++ command line option - sds-proc <pre>csds-proc <pre>csystem_configuration_name</pre> option. Use one of the following names depending on the target processor: a9_0, a53_0 or r5_0.</pre>
sdx:displayName	Processor Group name, used in the GUI Target CPU selection menus. This is typically a longer, more descriptive name than sdx:name.
sdx:cpuType	The target CPU type: cortex-a9, cortex-a53 or cortex-r5.
sdx:cpuInstance	The CPU instance name, for example ps7_cortexa9_0, psu_cortexa53_0, or psu_cortexr5_0. This is optional when running the Linux OS on the target, but required for the Standalone OS (used in BSP generation).

The <sdx:processorGroup> element contains a single sub-element <sdx:os>, which optionally contains paths to file and folders, settings and other data used to build the user application for the target operating system.

The <sdx:os> element contains the following attributes:

```
<sdx:os sdx:name="os_name"
sdx:displayName="GUI_name"
sdx:includePaths="path_to_include_folder"
sdx:libraryPaths="path_to_library_folder"
sdx:libraryNames="list_of_library_names"
sdx:ldscript="path_to_linker_script"
sdx:bspConfig="path_to_mss_file"
sdx:bspRepo="path_to_bsp_repository"
sdx:compilerOptions="compiler_options"
sdx:linkerOptions="linker_options"
/>
</sdx:processorGroup>
```

Table 8: Attributes of <sdx:os>

Attribute	Description
sdx:name	Operating system name: linux, standalone or freertos



Attribute	Description
sdx:displayName	Operating system name, used in the GUI OS labels. This is typically a longer, more descriptive name than sdx:name.
sdx:includePaths	Directory paths containing platform include files
sdx:libraryPaths	Directory paths containing platform library files
sdx:libraryNames	Platform library names required to link user applications
sdx:ldscript	Linker script used to link the user application
sdx:bspConfig	Configuration file for building the standalone BSP (.mss)
sdx:bspRepo	Software repository used to build the standalone BSP
sdx:compilerOptions	Options required to compile applications using the platform
sdx:linkerOptions	Options required to link applications using the platform

sdx:name Attribute

The sdx:name attribute specifies the operating system running on the processor. Valid values are linux, standalone or freertos, if supported by the platform.

sdx:displayName Attribute

The sdx:displayName attribute is a descriptive name for the operating system, used in the SDx environment IDE as a label in the New Project Wizard in the Choose Software Platform and Target CPU page.

sdx:includePaths Attribute

The sdx:includePaths attribute is optional. It specifies the path to any platform software include folders that must be added when compiling user source files. Separate multiple include paths with a colon character ':'. The include folder is located in the software platform folder. When specified, the SDSoC Compiler tool sdscc/sds++ automatically adds the –I option during compilation. For example, the attribute:

sdx:includePaths="aarch32-none/include"

resolves to the path <path_to_platform>/sw/aarch32-none/include, where <path_to_platform>/sw is the folder containing the <platform>.spfm file. When compiling source files, sdscc/sds++ adds the option "-I <path_to_platform>/sw/aarch32-none/include".

When the SDSoC Compiler tool sdscc/sds++ compiles source files, the include path search order is:

- user include paths
- platform include paths
- SDSoC installation include paths
- Vivado HLS include paths (if required)

sdx:libraryPaths Attribute



The sdx:libraryPaths attribute is optional. It specifies the path to any platform software library folders that must be added when linking the user application ELF. Separate multiple library paths with a colon character ':'. The library folder is located in the software platform folder and contains libraries used to link applications. When specified, the SDSoC Compiler tool sdscc/sds++ automatically adds the -L option during compilation. For example, the attribute:

```
sdx:libraryPaths="aarch32-none/lib"
```

resolves to the path <path_to_platform>/sw/aarch32-none/lib, where <path_to_platform>/sw is the folder containing the <platform>.spfm file. When linking the application ELF, sdscc/sds++ adds the option "-L <path_to_platform>/sw/aarch32-none/lib".

When the SDSoC Compiler tool sdscc/sds++ links the application ELF, the library path order is:

- user library paths
- path to SDSoC generated board support package (BSP) libraries (standalone or FreeRTOS)
- platform library paths
- SDSoC installation library paths
- SDSoC generated libraries



TIP: Do not place the standalone BSP library libxil.a in a folder specified using the sdx:libraryPaths attribute, since SDSoC automatically builds this library for the user.

sdx:libraryNames Attribute

The sdx:libraryNames attribute is optional. It specifies the names of any platform software libraries that must be passed to the linker when linking the ELF file. Separate multiple library names with a colon character ':'. When specified, the SDSoC Compiler tool sdscc/sds++ automatically adds the –l option when linking the ELF. For example, the attribute:

```
sdx:libraryNames="numeric"
```

causes the —Inumeric option to be used when linking and the library <code>libnumeric.a</code> is linked in. The platform library path must be specified using the <code>sdx:libraryPaths</code> attribute.

The attribute is optional, since the user can specify the –l option in the SDSoC GUI C/C++ Build Settings dialog and in user Make files.

sdx:ldscript Attribute

The sdx:ldscript attribute specifies the path to a linker script file located in the software platform folder. For example, the attribute:

```
sdx:ldscript="standalone/lscript.ld"
```

resolves to the path <path_to_platform>/sw/standalone/lscript.ld, where <path_to_platform>/sw is the folder containing the <platform>.spfm file.

The linker script is used by the SDSoC Compiler tool sdscc/sds++ when linking your application ELF.

sdx:bspConfig Attribute



The sdx:bspConfig attribute is optional and specifies the path to a board support package (BSP) configuration file (.mss) located in the software platform folder. For example, the attribute:

```
sdx:bspConfig="bsp/system.mss"
```

resolves to the path <path_to_platform>/sw/bsp/system.mss, where <path_to_platform>/sw is the folder containing the <platform>.spfm file.

When the sdx:bspConfig attribute is used for generating a platform-specific standalone BSP, the sdx:includePaths attribute must be specified and refer to folder containing BSP header files. The SDSoC Compiler tool sdscc/sds++ command uses this .mss file instead of generating a default BSP configuration based on both the platform and hardware in the programmable logic (PL). Consequently the .mss file must specify drivers required in SDSoC user designs, including the Xilinx AXI DMA driver (scatter-gather mode). See *Generating Basic Software Platforms* (UG1138) for information about BSP configuration files (.mss).

sdx:bspRepo Attribute

The sdx:bspRepo attribute is optional and specifies the path to a board support package (BSP) repository folder located in the software platform folder. For example, the attribute:

```
sdx:bspRepo="bsp/repo"
```

resolves to the path <path_to_platform>/sw/bsp/repo, where <path_to_platform>/sw is the folder containing the <platform>.spfm file.



TIP: When the sdx:bspRepo attribute is used, the sdx:bspConfig attribute must also be specified.

The use case supports platforms which define drivers or libraries that must be included in the BSP. The SDSoC Compiler tool sdscc/sds++ command adds the folder to the repository search path when generating a standalone BSP llibrary (libxil.a). Refer to *Generating Basic Software Platforms* (UG1138) for information about BSP repositories.

sdx:compilerOptions Attribute

The sdx:compilerOptions attribute specifies compiler options required to compile an application that uses the platform, exclusive of include path attributes.

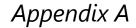
This attribute is optional and typically not required. The template.xml used by the SDSoC GUI when creating template applications supports a similar attribute and adds compiler options to the generated Make file, while the sdx:compilerOptions attribute causes the specified options to be inserted when the SDSoC Compiler tool sdscc/sds++ invokes the underlying cross-compiler to compile all source files for every application.

sdx:linkerOptions Attribute

The sdx:linkerOptions attribute specifies linker options required to link an application that uses the platform, exclusive of library path and library name attributes.



This attribute is optional and not typically used. The template.xml used by the SDSoC GUI when creating template applications supports a similar attribute and adds linker options to the generated Make file, while the sdx:linkerOptions attribute causes the specified options to be inserted when the SDSoC Compiler tool sdscc/sds++ invokes the underlying cross-compiler to link the ELF file for every application.





SDSoC 2016.2 Platform Migration

An internal command line utility, sdspfm_convert, is available to migrate an SDSoC 2016.2 platform for Zynq®-7000 All Programmable (AP) SoC or Zynq UltraScale+™ MPSoC device to the SDx 2016.3 directory structure and platform XML files. While not a general utility that is guaranteed to work for all platforms, it minimizes the time required for migrating platforms from 2016.2 to 2016.3.



TIP: The utility does not upgrade the Vivado Design Suite project defining the hardware platform, but it does create the new directory structure and platform XML files. After the initial conversion, you can manually update and modify the generated platform and files, including prebuilt platform files.

To use the command in a command shell with its environment set up to run SDx 2016.3, type the following command:

sdspfm_convert <path_to_existing_platform> <output_converted_platform>
<zynq | mpsoc>

Where:

- <path_to_existing_platform> defines the path to the existing 2016.2 hardware platform files.
- <output_converted_platform> defines the output folder to write the converted hardware platform for 2016.3.
- <zynq | mpsoc> specifies either the Zynq®-7000 All Programmable (AP) SoC or the Zynq UltraScale+™ MPSoC device as the processor targeted by the hardware platform being converted.

For example, the following command:

 ${\tt sdspfm_convert\ /home/mia/2016.2/platforms/zc702\ /home/mia/2016.3/platformszynq}$



reads the 2016.2 zc702 platform directory structure:

- /home/mia/2016.2/platforms
 - 。 zc702
 - aarch32-none
 - boot
 - freertos
 - hardware
 - qemu
 - vivado
 - zc702_hw.pfm
 - zc702_sw.pfm

and creates the 2016.3 platform structure and XML files, based on the existing platform structure and files in the 2016.2 platform folder.

- /home/mia/2016.3/platforms
 - 。 zc702
 - hw
 - vivado
 - zc702.hpfm
 - S\W
 - aarch32-none
 - boot
 - freertos
 - image
 - prebuilt_platform
 - qemu
 - zc702.spfm
 - zc702.xpfm



TIP: For clarity in the example the complete directory structure is not shown.

Conversion Results

The sdspfm_convert utility copies folders referenced in the .spfm file into the sw folder, copies the vivado folder into the hw folder, and copies other folders and files into the top-level folder.

If the original platform folder contained a "samples" folder and "README" file, they are copied into the top level of the new platform folder.

The .hpfm file is a renamed copy of the $_{hw.pfm}$ file, while the .xpfm and .spfm files are generated based on existing .pfm files.



After conversion, you can edit metadata for the descriptive names used in the GUI, for example sdx:displayName metadata.

The SDSoC 2016.2 and 2016.3 software platform XML files contain similar information, but the 2016.3 schema groups metadata for the same OS, allows more groupings to be defined, and enables tools to be more data driven. The table below shows the 2016.2 metadata file structure on the left, and the 2016.3 structure on the right.

```
<xd:libraryFiles
 xd:os="standalone"
 xd:libDir="aarch32-none/lib"
 xd:ldscript="aarch32-none/
lscript.ld"
/>
<xd:libraryFiles
 xd:os="freertos"
xd:osDepend="standalone"
xd:includeDir="/aarch32-none/
include/freertos"
xd:libDir="/aarch32-none/lib/
freertos"
xd:libName="freertos"
xd:ldscript="freertos/lscript.ld"
<xd:bootFiles
xd:os="linux"
xd:bif="boot/linux.bif"
 xd:readme="boot/generic.readme"
xd:devicetree="boot/devicetree.dtb"
xd:linuxImage="boot/uImage"
xd:ramdisk="boot/uramdisk.image.gz"
 />
<xd:bootFiles
xd:os="standalone"
xd:bif="boot/standalone.bif"
xd:readme="boot/generic.readme"
/>
<xd:bootFiles
xd:os="freertos"
 xd:bif="boot/freertos.bif"
xd:readme="boot/generic.readme"
```

```
<sdx:configuration
sdx:name="standalone"
sdx:displayName="Standalone OS
(Zyng 7000)"
sdx:defaultProcessorGroup="a9 0">
<sdx:description>Standalone OS
running
  on Zynq 7000</sdx:description>
<sdx:prebuilt
sdx:data="prebuilt platform"/>
<sdx:bootImages
sdx:default="standard">
    <sdx:image sdx:name="standard"
    sdx:bif="boot/standalone.bif"
    sdx:readme="boot/
generic.readme"
    sdx:qemuDevicetree="qemu/
devicetree.dtb"
    sdx:qemuArguments="qemu/
qemu args.txt"
    />
 </sdx:bootImages>
 <sdx:processorGroup
sdx:name="a9 0"
  sdx:displayName="A9 0"
sdx:cpuInstance="ps7_cortexa9_0"
  sdx:cpuType="cortex-a9">
 <sdx:os sdx:name="standalone"
  sdx:displayName="Standalone OS"
  sdx:libraryPaths="aarch32-none/
lib"
  sdx:ldscript="aarch32-none/
lscript.ld"
  />
  </sdx:processorGroup>
</sdx:configuration>
```

The sdspfm_convert utility creates an updated platform folder structure and platform XML files which the platform provider can update, but the platform provider must manually update the Vivado project in hw/vivado for 2016.3, and any prebuilt platform data, if used. Refer to this link in the Vivado Design Suite User Guide: Designing IP Subsystems Using IP Integrator (UG994) for more information on updating block design projects.





IMPORTANT: Do not reuse prebuilt platform files from 2016.2 – certain files are no longer created in 2016.3 (like devreq.c and devreq.h) and if a design with accelerators is built with old files (portinfo.c and portinfo.h), the build will fail when compiling these files.

To summarize the platform migration process:

- 1. Use the sdspfm_convert utility for the initial migration.
- 2. Manually update the Vivado Design Suite project (hw/vivado) to 2016.3.
- 3. Use the platform to create a software only design using the <code>-rebuild-hardware</code> option when linking, to force the bitstream to be regenerated and prevent using any prebuilt data files in the platform.
- 4. Replace any existing "prebuilt" files from the 2016.2 platform with the 2016.3 versions you just created:
 - bitstream.bit:found in sds/p0/ipi/<platform>.runs/impl 1/bitstream.bit
 - <platform>.hdf:foundin sds/p0/ipi/<platform>.sd.
 - apsys 0.xml and partitions.xml:found in sds/.llvm.
 - portinfo.c and portinfo.h: found in sds/swstubs (devreg.c and devreg.h are no longer created in 2016.3).
- 5. The platform migration is complete.



Additional Resources and Legal Notices

Xilinx Resources

For support resources such as Answers, Documentation, Downloads, and Forums, see Xilinx Support.

Solution Centers

See the Xilinx Solution Centers for support on devices, software tools, and intellectual property at all stages of the design cycle. Topics include design assistance, advisories, and troubleshooting tips

References

These documents provide supplemental material useful with this guide:

- 1. SDx Environments Release Notes, Installation, and Licensing Guide (UG1238)
- 2. SDSoC Environment User Guide (UG1027)
- 3. SDSoC Environment Optimization Guide (UG1235)
- 4. SDSoC Environment Tutorial: Introduction (UG1028)
- 5. SDSoC Environment Platform Development Guide (UG1146)
- 6. SDSoC Environment Tutorial: Creating a Platform from a Reference Design (UG1236)
- 7. SDSoC Development Environment web page
- 8. UltraFast Embedded Design Methodology Guide (UG1046)
- 9. ZC702 Evaluation Board for the Zynq-7000 XC7Z020 All Programmable SoC User Guide (UG850)
- 10. Vivado Design Suite User Guide: High-Level Synthesis (UG902)
- 11. PetaLinux Tools Documentation: Workflow Tutorial (UG1156)
- 12. Vivado® Design Suite Documentation
- 13. Vivado Design Suite User Guide: Creating and Packaging Custom IP (UG1118)



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