Course Description
This three-day course focuses on the Zynq® UltraScale+™ MPSoC family and the development methods needed to start designing your custom embedded system. It includes an overview of the features and capabilities of the device, encompassing implementation options, virtualization, various Linux implementations, booting and configuring a system, safety & security, and power management. Details of the Processor System (PS) and Programmable Logic (PL) are also covered in detail, including best-practices for interfacing the two with one another. All aspects of defining your embedded system architecture, starting with the hardware configuration and then running through the software implementation, will be covered.

Level – Embedded Hardware 3
Course Duration – 3 days
Price – $2400 or 24 Training Credits
Course Part Number – HDT-ZUPSAW-ILT
Who Should Attend? – Hardware designers, software developers, and system architects interested in understanding the capabilities and ecosystem of the Zynq UltraScale+ MPSoC device.

Prerequisites
- Suggested: Understanding of the Zynq-7000 architecture
- Basic familiarity with embedded software development using C/C++
- General understanding of embedded and real-time operating systems
- Familiarity with issues related to implementing a complex embedded system

Software Tools
- Vivado® Design Suite and Software Development Kit (SDK)
  - May require special Zynq UltraScale+ MPSoC family license
- Native Linux or virtual machine for development and emulation
  - QEMU
  - PetaLinux
  - Xen

Hardware
- Host computer for running the above software*

* This course focuses on the Zynq UltraScale+ MPSoC architecture. This version of the class does not use a physical board, but rather a local emulation environment running on Linux.

After completing this comprehensive training, you will have the necessary skills to:
- Outline the high-level architecture of the Zynq UltraScale+ MPSoC device
- Define the underlying implementation of the application processing unit (APU) and real-time processing unit (RPU) to make best use of their capabilities
- Effectively use power management strategies and leverage the capabilities of the platform management unit (PMU)
- Utilize QEMU to emulate hardware and software behavior
- Define the boot sequences appropriate to the needs of the system
- List the various power domains and how they are controlled
- Describe the connectivity between the processor system (PS) and programmable logic (PL)
- Distinguish between asymmetric multi-processing (AMP) and symmetric multi-processing (SMP) environments
- Identify several Linux options for the MPSoC
- Identify mechanisms to secure and safely run the system
- Identify situations when the ARM® TrustZone technology and/or a hypervisor should be used

Course Outline

Day 1
- Zynq UltraScale+ MPSoC Architecture Overview (Lectures, Lab)
- Application Processing Unit (Lectures)
- Real-Time Processing Unit (Lectures)
- System Coherency (Lectures)
- The Quick Emulator (QEMU) (Lectures, Lab)
- Power Management (Lectures)
- Platform Management Unit (Lectures, Lab)

Day 2
- Video Codec Unit (Lectures)
- DDR and QoS (Lectures)
- Clocks and Resets (Lectures)
- AXI Interfaces and Variations (Lectures, Lab)
- Boot and Configuration (Lectures, Lab)
- Safety Capabilities (Lectures)
- Security Capabilities (Lectures)
- System Protection (Lectures)
- Ecosystem Support (Lectures)
- FreeRTOS (Lectures, Lab)

Day 3
- Software Stack (Lectures)
- Linux Basics and Symmetric Multi-Processing Linux (Lectures)
- PetaLinux (Lectures, Lab)
- Yocto (Lectures)
- OpenAMP (Lectures, Lab)
- HW-SW Virtualization (Lectures)
- The Xen Hypervisor (Lectures, Lab)

Topic Descriptions

Day 1
- Zynq UltraScale+ MPSoC Architecture Overview – Overview of the Zynq UltraScale+ MPSoC device.
- Application Processing Unit – Introduction to the components of the APU, specifically the Cortex™ A53 processor and how the cluster is configured and managed.
- Real-Time Processing Unit – Introduction to the various elements within the RPU and different modes of configuration.
- System Coherency – Detailed discussions concerning shared memory and the AXI masters involved.
- The Quick Emulator (QEMU) – Introduction to the Quick Emulator, the tool used to emulate software for the Zynq UltraScale+ MPSoC device when hardware is not available.
- Power Management – Explore the granular power management features of MPSoC devices.
- Platform Management Unit – Learn how the dedicated PMU can be used to control system-level power and how it can be extended for user custom processes.

Day 2
- Video Codec Unit – Learn the basic capabilities of the H.264 and H.265 encoders and decoders.
Embedded System Design for the Zynq UltraScale+ MPSoC
Embedded Hardware 3

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Course Specification

- DDR and QoS – Learn how DDR can be configured to provide the best performance for your system.
- Clocks and Resets – Overview of clocking and reset, focusing more on capabilities than specific implementations.
- AXI Interfaces and Variations – Discover how the PS and PL connect enables designers to create more efficient systems.
- Boot and Configuration – Explores the Power-on-reset boot requirements and options.
- Safety Capabilities – Basic exposure to the elements designed into the MPSoC for safety critical designs.
- Security Capabilities – Explores the processing elements used to ensure a secure device. Includes both hardware and software components.
- System Protection – Covers all the hardware and software elements that support the separation of software domains.
- Ecosystem Support – Overview of supported operating systems, software stacks, hypervisors, etc.
- FreeRTOS – Overview of FreeRTOS, with examples of how it can be used.

Day 3

- Software Stack – Learn what a software stack is and the many stacks used with the Zynq UltraScale+ MPSoC.
- Linux Basics and Symmetric Multi-Processing Linux – A basic look at what a Linux distribution is made up of and how it leverages the multiple processors of the MPSoC.
- PetaLinux – Become familiar with the Xilinx productivity tool used to build a custom Linux distribution.
- Yocto – Compares the kernel building methods between a “pure” Yocto build and the PetaLinux build tool.
- OpenAMP – Introduction to the Asymmetric Multi-Processing capabilities of the MPSoC.
- HW-SW Virtualization – Covers the hardware and software elements of virtualization.
- Xen Hypervisor – Description of hypervisors and discussion of some of the details of implementing a hypervisor using Xen.

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Email: training@hardent.com
Telephone: 514-284-5252