RA0 - Cortex-A5 implementation

This course covers the ARM Cortex-A5 CPU

OBJECTIVES

- This course is split into 3 important parts:
  - Cortex-A5 architecture
  - Cortex-A5 software implementation and debug
  - Cortex-A5 hardware implementation.
- MMU operation under Linux is described.
- Interaction between level 1 caches, level 2 cache and main memory is studied through sequences.
- The exception mechanism is detailed, indicating how virtualization enables the support of several operating systems.
- The course also details the hardware implementation and provides some guidelines to design a SoC based on Cortex-A5.
- An overview of the Coresight specification is provided prior to describing the debug related units.
- The course explains the mechanisms dedicated to SMP implementation, exclusive resource management, snooping, software generated interrupt.

A more detailed course description is available on request at formation@ac6-formation.com

PREREQUISITES

- Knowledge of ARM7/9 or having attended our course ARM fundamentals.
- This course does not include chapters on low level programming.
  - ACSYS offers a large set of tutorials to become familiar with RVDS, assembly level programming, compiler hints and tips.
- More than 12 correct answers to our Cortex-A5 prerequisites questionnaire.

Environnement du cours

- Cours théorique
  - Support de cours au format PDF (en anglais) et une version imprimée lors des sessions en présentiel
  - Cours dispensé via le système de visioconférence Teams (si à distance)
  - Le formateur répond aux questions des stagiaires en direct pendant la formation et fournit une assistance technique et pédagogique
- Au début de chaque demi-journée une période est réservée à une interaction avec les stagiaires pour s'assurer que le cours répond à leurs attentes et l'adapter si nécessaire

Audience visée

- Tout ingénieur ou technicien en systèmes embarqués possédant les prérequis ci-dessus.

Modalités d'évaluation

- Les prérequis indiqués ci-dessus sont évalués avant la formation par l'encadrement technique du stagiaire dans son entreprise, ou par le stagiaire lui-même dans le cas exceptionnel d'un stagiaire individuel.
- Les progrès des stagiaires sont évalués par des quizz proposés en fin des sections pour vérifier que les stagiaires ont assimilé les points présentés
- En fin de formation, une attestation et un certificat attestant que le stagiaire a suivi le cours avec succès.
  - En cas de problème dû à un manque de prérequis de la part du stagiaire, constaté lors de la formation, une formation différente ou complémentaire lui est proposée, en général pour conforter ses prérequis, en accord avec son responsable en entreprise le cas échéant.

Plan

First day

INTRODUCTION TO CORTEX-A5

- Cortex-A5 variants: single core vs multicore
- The 4 instruction sets
- Configurable options

ARM BASICS

- States and modes
- Exception mechanism
- Instruction sets

INSTRUCTION PIPELINE

- In-order pipeline operation
- Branch prediction mechanism
- Return stack

TRUSTZONE

- TrustZone conceptual view
- Secure to non secure permitted transitions
- Memory partitioning
- Interrupt management
- Boot sequence

INTRODUCTION TO MULTI-CORE SYSTEMS

- AMP vs SMP
- Boot sequence
- Exclusive access monitor
- Global monitor
- Spin-lock implementation
- Using events
- Basic concepts of RTOS supporting A5 SMP architecture

Second day

THUMB-2 INSTRUCTION SET (V7-A)

- General points on syntax
- Branch and control flow instructions
- Memory access instructions
- Exception generating instructions
- If&then conditional blocks
- Stack in operation
- Interworking ARM and Thumb states
  - Demonstration of assembly sequences aimed to understand this new instruction set

MEMORY MANAGEMENT UNIT

- MMU objectives
- Address translation
- Page access permission, domain and page protection
- Utilization of memory barrier instructions
- Format of the external page descriptor table
- Tablewalk
- TLB organization
- Utilization of microTLBs
- Abort exception, on-demand page mechanism
- MMU maintenance operations
- Maintaining coherency of multiple TLBs

LEVEL 1 MEMORY SYSTEM

- Cache organization
- Supported maintenance operations
- Memory hint instructions
- Describing transient cache related transactions: line fills and line eviction
- 64-bit merging store buffer
- PMU related events

HARDWARE COHERENCY

- Snooping basics
- Snoop Control Unit: cache-to-cache transfers
- MOESI state machine
- Address filtering
- Understanding through sequences how data coherency is maintained between L2 memory and L1 caches
- Accelerator Coherency Port
- Enabling coherency mode

Third day

AMBA 3

- AXI
  - Topology
  - PL301 AXI interconnect
  - AXI channels, channel handshake
  - Support for unaligned data transfers
  - Transaction ordering, out of order transaction completion
  - Cortex-A5 external memory interface, ID encoding
- APB 3

HARDWARE IMPLEMENTATION

- Clock domains
- Reset domains
- Power control, dynamic power management
- Wait For Interrupt architecture
- Level 2 memory interface
- Exclusive L2 cache

PL310 LEVEL 2 CACHE

- Cache configurability
- Understanding through sequences how cacheable information is copied from memory to level 1 and level 2 caches
- Transient operations, utilization of line buffers LFBs, LRBs, EBs and STBs
- Cache event monitoring

- Describing each maintenance operation
- Cache lockdown
- Initialization sequence

PERFORMANCE MONITOR

- Event counting
- Debugging a multi-core system with the assistance of the PMU

Fourth day

INTERRUPT CONTROLLER

- Cortex-A5 exception management
- Interrupt virtualization
- Integrated timer and watchdog unit in MPCore
- Interrupt groups: SGI, PPI, SPI, LSPI
- Prioritization of the interrupt sources
- Distribution of the interrupts to the Cortex-A5 cores
- Generation of interrupts by software
- Detailing the interrupt sequence, purpose of Interrupt Acknowledge register and End-Of-Interrupt register

LOW POWER MODES

- Voltage domains
- Communication to the power management controller
- Standby and wait for event signals
- SCU power status register

CORESIGHT DEBUG UNITS

- Benefits of CoreSight
- Invasive debug, non-invasive debug, taking into account the secure attribute
- Connection to the Debug Access Port
- Debug facilities offered by Cortex-A5
- Event catching
- Debug Communication Channel
- ETM interface
- Cross-Trigger Interface, debugging a multi-core SoC

Renseignements pratiques

Durée : 4 jours
Prix : 2370 € HT