

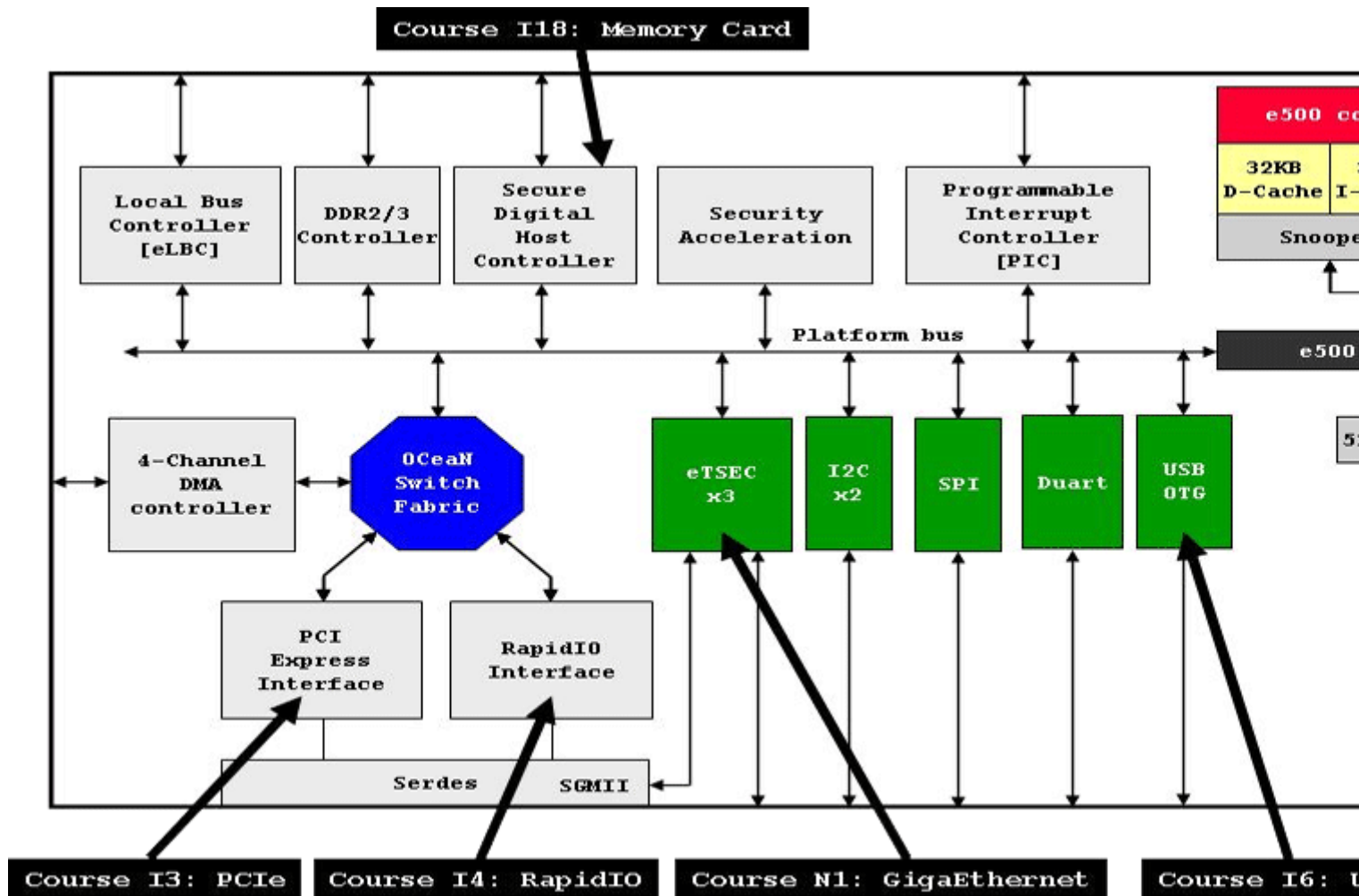


## This course covers NXP QorIQ P2010 and P2020

### Objectives

- The course clarifies the architecture of the P20X0, particularly the operation of the coherency module that interconnects the e500s to memory and high-speed interfaces.
- Cache coherency protocol is introduced in increasing depth.
- The e500 core is viewed in detail, especially the SPE unit that enable vector processing.
- The boot sequence and the clocking are explained.
- The course focuses on the hardware implementation of the P20X0.
- A long introduction to DDR SDRAM operation is done before studying the DDR2/3 SDRAM controller.
- An in-depth description of the RapidIO port and the PCI-Express port is done.
- The course explains how to implement QoS on GigaEthernet controllers.
  
- ACSYS has developed an optimized SPE based FFT coded in assembler language.
- Performance for 1024 complex floating point single precision samples is:
  - - 91\_386 core clock cycles without reverse ordering, 94\_124 with reverse ordering
- Performance for 4096 complex floating point single precision samples is:
  - - 470\_778 core clock cycles without reverse ordering, 511\_227 with reverse ordering
- For any information contact [formation@ac6-formation.com](mailto:formation@ac6-formation.com)

### Related courses



### Prerequisites

- Experience of a 32-bit processor or DSP is mandatory.
- Knowledge of RapidIO and PCI Express is recommended.

### 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

### INTRODUCTION TO P20X0

#### **Overall description**

- Internal data flows, OCEAN switch fabric, packet reordering
- Implementation examples
- Address map, ATMU, OCEAN configuration
- Local vs external address spaces, inbound and outbound address decoding
- Accessing memory-mapped registers from external master

### THE e500 CORES

#### **THE INSTRUCTION PIPELINE**

- Dual-issue superscalar control, out-of-order execution
- Execution units : 2 simple Integer Units + 1 Complex Integer Unit
- Dynamic branch prediction using a 128-set 4-way set associative Branch Target Buffer
- Execution timing, rename register operation, instruction serialization

#### **DATA AND INSTRUCTION PATHS**

- The Core Complex Bus : high speed on-chip local bus with data tagging
- The LMQ, the store queue, the castout queue
- Store miss merging and store gathering
- Memory access ordering
- Lock acquisition and import barriers

#### **THE MEMORY MANAGEMENT UNITS**

- The first level MMU and the second level MMU, consistency between L1 and L2 TLBs
- Snooping of TLBs
- TLB software reload, page attributes WIMGE
- Process protection, variable number of PID registers and sharing
- MMU implementation in real-time sensitive applications

#### **CACHES**

- The L1 caches, PLRU replacement algorithm, 8-way set associativity, cache block and unlock APU
- Level 2 cache, partition into L2 cache plus SRAM
- Allocation of data transferred by external masters into the cache: stashing
- Snooping mechanism, stashing mechanism
- L2 cache locking

#### **PROGRAMMING**

- Differences between the new Book E architecture and the classic PowerPC architecture
- Floating Point units, Double-Precision FP
- Signal Processing APU (SPU) : implementation of the SIMD capability without using a separate unit
- PowerPC EABI : sections, C-to-assembly interface

#### **EXCEPTIONS**

- Book E exception handling

- Critical versus non critical
- Handler table
- Exception nesting, recoverability from interrupt
- Core timers : Decrementer, Time Base, Fixed Interval Timer and Software Watchdog

## **DEBUGGING**

- Performance monitoring, counting of events
- JTAG emulation, real time trace when the e500 core executes cached instructions
- Watchpoint logic, triggering capabilities based on user programmable events

## **INFRASTRUCTURE**

### **RESET, CLOCKING AND INITIALIZATION**

- Platform clock
- Voltage configuration selection
- Power-on reset sequence, using the I2C interface to access serial ROM
- Boot page translation
- eSDHC boot
- eSPI boot ROM

### **e500 COHERENCY MODULE**

- I/O arbiter
- CCB arbiter
- Transaction queue
- CCB interface

### **DDR2/DDR3 SDRAM MEMORY CONTROLLER**

- DDR2 and DDR3 Jedec specification
- On-Die termination
- Mode registers initialization, bank selection and precharge
- Command truth table
- Bank activation, read, write and precharge timing diagrams, page mode
- Introduction to the DDR-SDRAM controller
- Initial configuration following Power-on-Reset
- Timing parameters programming
- Initialization routine

### **ENHANCED LOCAL BUS CONTROLLER**

- Multiplexed or non-multiplexed address and data buses
- Dynamic bus sizing
- GPCM, UPMs states machines
- Flask Control Machine
- NAND flash controller

### **SERIAL RapidIO INTERFACE**

- Message Unit, direct vs chaining mode operation
- RapidIO doorbell and port-write unit
- Accessing configuration registers via RapidIO packets
- Programming inbound and outbound ATMUs
- Error handling

### **PCI EXPRESS INTERFACE**

- 8-lane PCI Express interface
- Modes of operation, Root Complex / Endpoint
- Transaction ordering rules
- Programming inbound and outbound ATMUs
- Configuration, initialization

## **PROGRAMMABLE INTERRUPT CONTROLLER**

- PIC in multiple-processor implementation
- Interrupt sources : external interrupts, internal interrupts, message interrupts
- Integrated timers
- Interprocessor interrupts
- Per-CPU register usage, message registers
- Nesting implementation

## **INTEGRATED DMA CONTROLLER**

- Priority between the 4 channels
- Support for cascading descriptor chains
- Scatter / gathering
- Selectable hardware enforced coherency

## **PERFORMANCE MONITOR AND DEBUG FEATURES**

- Event counting
- Threshold events
- Chaining, triggering
- Watchpoint facility
- Trace buffer

## **INPUTS/OUTPUTS**

## **THE ETHERNET CONTROLLERS**

- Address recognition, pattern matching
- Buffer descriptors management
- Physical interfaces : GMII, MII, TBI, RGMII, SGMII
- Buffer descriptor management
- Layer 2 acceleration accept or reject on address or pattern match
- 256-entry hash table for unicast and multicast
- Management of VLAN tags and priority, VLAN insertion and deletion
- Quality of service, managing several transmit and receive queues
- TCP/IP offload engine, filter programming
- IEEE1588 compliant time-stamping

## **ENHANCED SECURE DEVICE HOST CONTROLLER**

- Storing and executing commands targeting the external card
- Multi-block transfers
- Moving data by using the dedicated DMA controller
- Dividing large data transfers
- Card insertion and removal detection

## **USB CONTROLLER**

- Dual-role (DR) operation
- EHCI implementation
- ULPI interfaces to the transceiver
- OTG support

- Dedicated DMA channels
- Endpoints configuration

## **SECURITY ENGINE**

- Overview of the encryption mechanism
- Introduction to DES and 3DES algorithms
- Data packet descriptors
- Crypto channels
- XOR acceleration

## **LOW SPEED PERIPHERALS**

- Description of the NS16552 compliant Uarts
- I2C controller
- Enhanced SPI, transmit and receive sequences

## **Renseignements pratiques**

**Renseignements : 5 jours**