



## FCQ3 - P204X QorIQ implementation

*This course covers NXP QorIQ P2040 and P2041*

### Objectives

- This course has 6 main objectives:
  - Describing the hardware implementation, particularly the boot sequence and the DDR3 controller
  - Understanding the features of the internal interconnect and related units and mechanisms such as PAMU, CPC and stashing
  - Describing the units which are interconnected to other modules, such as clocking, interrupt controller and DMA controller, because the boot program generally has to modify the setting of these units
  - Explaining the standard bus interface controllers, PCIe, SRIO, USB, SATA and MMC-SD
  - Clarifying the operation of the Datapath Acceleration Architecture that assists the processor core in taking in charge buffer allocation, queue management, frame management and particularly incoming frame classification, pattern searching, and encryption
  - Describing the various debug units and their utilization to fix errors in a multicore / multimaster SoC.
- Products and services offered by ACSYS:
  - ACSYS is able to assist the customer by providing consultancies
  - Typical expertises are done during board bringup, hardware schematics review, software debugging, performance tuning.
  - Note that ACSYS has delivered several consultancies on NXP Netcomm SoCs to companies developing avionic equipments.

A more detailed course description is available on request at [formation@ac6-formation.com](mailto:formation@ac6-formation.com)

This document is necessary to tailor the course to specific customer needs and to define the exact schedule.

### Prerequisites

- Experience of a 32-bit processor or DSP is mandatory.
- Note that the e500mc Power core is covered in a separate course reference [FCC1 - e500mc implementationcourse](#).
- The e500mc cores implemented in the P2040 do not support L2 caches.

### Related courses

- Ethernet and switching, reference [N1 - Ethernet and switchingcourse](#)
- IEEE1588, reference [N2 - IEEE1588 - Precise Time Protocolcourse](#)
- 10 Gigabit Ethernet, reference [N3 - Ethernet 10 Gigabitcourse](#)
- PCI express gen2, reference [IC4 - PCI Express 3.0course](#)
- RapidIO 2.1, reference [IC5 - RapidIO 3.0course](#)
- USB Full Speed High Speed and USB On-The-Go, reference [IP2 - USB 2.0course](#)
- SD / MMC, reference [IS2 - eMMC 5.0course](#)
- Serial-ATA, reference [IS3 - Serial ATA IIIcourse](#)

### Course Environment

- Theoretical course
  - PDF course material (in English) supplemented by a printed version for face-to-face courses.
  - Online courses are dispensed using the Teams video-conferencing system.
  - The trainer answers trainees' questions during the training and provide technical and pedagogical assistance.
- At the start of each session the trainer will interact with the trainees to ensure the course fits their expectations and correct if needed

## Target Audience

- Any embedded systems engineer or technician with the above prerequisites.

# Course Outline

## P2040 ARCHITECTURE

### SOC ARCHITECTURE

- Internal architecture
- CoreNet coherency fabric
- Coherency subdomains
- Memory map, local access windows
- Multicore processing scenarios

### SOC PLATFORM

### POWER, RESET AND CLOCKING

- Power management control
- Configuration signals sampled at reset
- Reset configuration words source
- Pre-boot loader
- Clocking, system clock domains
- Dynamically changing core clocks
- SerDes high speed lanes configuration

### SECURE BOOT

- Objectives of trust architecture
- Secure boot sequence
- External tamper detection
- Run time integrity checker

### CORENET PLATFORM CACHE

- Operation as memory-mapped SRAM
- Partitioning between coherency domains
- Stashing
- Soft error detection and correction

### PERIPHERAL ACCESS MANAGEMENT UNIT (PAMU)

- Controlling master access permissions through Logical I/O Device Number
- Address translation
- Descriptor organization
- Operation mode translation
- Steps in processing of DSA operations by pamu
- PAMU caches

### LOW SPEED PERIPHERALS

- UART

- I2C controller
- eSPI controller

## **ENHANCED SDHC**

- Transfer protocol, single block, multiple block read and write
- Internal and external DMA capabilities
- SD protocol unit
- Card insertion and removal detection

## **USB CONTROLLERS**

- Host or device support
- EHCI support, scheduling the various transactions into frames
- Integrated PHY
- Endpoint configuration
- Non-EHCI tuning control registers

# **HARDWARE IMPLEMENTATION**

## **THE DDR3 / 3L MEMORY CONTROLLER**

- DDR3 fly-by architecture, write leveling
- ZQ calibration
- Command truth table
- Hardware interface
- Initial configuration following Power-on-Reset
- Controller interleaving support
- Address decode unit
- Timing parameters programming

## **ENHANCED LOCAL BUS CONTROLLER**

- Multiplexed or non-multiplexed address and data buses
- Connecting 8- and 16-bit devices
- Burst support
- GPCM, UPMs states machines
- NAND flash controller

## **INTEGRATED DMA CONTROLLERS**

- Priority between the 4 channels
- Scatter / gathering
- Selectable hardware enforced coherency
- Ability to start DMA from external 3-pin interface

## **PCI EXPRESS INTERFACE**

- Acting as a bridge when Root Complex
- Transaction ordering rules
- Programming inbound and outbound ATMUs
- Benefits of MSIs
- Low power management
- Configuration, initialization
- Enhanced error reporting

## **SERIAL RAPIDIO INTERFACE**

- RapidIO port
- RapidIO doorbell and port-write unit
- Programming inbound and outbound ATMUs

## **SATA CONTROLLERS**

- Support for SATA II extensions
- Bringing the SATA controller online/offline
- Native command queuing, command descriptor
- Interrupt coalescing
- Initialization steps

## **DATAPATH PROCESSING SUBSYSTEM**

### **DPAA OVERVIEW**

- Data formats
- Frame formats
- Packet walk through
- DPAA Configuration and initialization

### **QUEUE MANAGER**

- Objectives if this accelerator
- Structure of frame queues
- Active and suspended frame queues
- Frame queue descriptor, frame queue descriptor cache
- Frame queue state machine
- Work queues and channels
- Enqueue and dequeue portals
- Utilization of rings
- Dequeue dispatcher operation
- Message ring
- Congestion avoidance, Weighted Random Early Discard
- Order definition point implementation

### **BUFFER MANAGER**

- Objectives if this accelerator
- Central resource pool management function
- Per-pool stockpile
- CoreNET software portals
- Direct connect portals
- Buffer Pool State Change Notifications

### **FRAME MANAGER**

- Objectives if this accelerator
- FMAN submodules
- Rx BMI features
- Tx BMI features
- Offline parsing, host command features
- Frame processing manager
- FMan controller

- Parser
- Key generator
- Policer

## DATA PATH THREE-SPEED ETHERNET CONTROLLERS

- Frame format with and without VLAN option
- Connection to packet FIFO interface
- Physical interfaces
- 256-entry hash table for unicast and multicast
- Accessing PHY registers
- RMON statistic counters, carry registers
- Client IEEE1588 timers

## 10-GIGABIT MAC

- XAUI interface to PHY
- Multicast address filtering
- Dynamic inter packet gap (IPG) calculation
- MAC address insertion
- Support for VLAN
- IEEE 1588 timestamping

## RAPIDIO MESSAGE MANAGER

- 2 inbox/outbox mailboxes (queues) for data and one doorbell message structure
- Multicasting
- Outbound segmentation units

## SECURITY ENGINE

- Introduction to DES, 3DES and AES algorithms
- Job management using QMan interface
- Input / output rings
- Cryptographic operations
- Data movement, FIFOs
- Scatter / gather DMA
- Selecting the authentication / cryptographic algorithm
- Run Time Integrity Checking
- Example, implementing IPSec

## PATTERN MATCHER

- Objective of this unit, identifying signatures in incoming gigabit streams
- Connection to QMan and BMan
- Ability to track stateful relationships between patterns found in the data it scans
- Updating the pattern database
- Definition of a regular expression
- Comparing the string under inspection with the programmed patterns
- Processing pipeline, work units
- Pattern Matcher Frame Agent
- Pattern description block caching
- Key Element Scanner
- " Data Examination Engine
- " Stateful Rule Engine

# GLOBAL FUNCTIONS, DEVELOPMENT AND DEBUG

## PERFORMANCE MONITOR AND DEBUG FEATURES

- Introduction to NEXUS specification
- NEXUS Aurora link
- Event processing unit
- Watchpoint facility
- Trace buffer
- Event Combining for the Creation of Advanced Triggers
- Cross-Functional Debug Components
- DDR SDRAM interface debug, measuring per-master bandwidth