

## This course covers the IBM Power 445 core

### Objectives

- A boot firmware that initializes the MMU has been developed to explain the boot sequence.
- Internal debug facilities are described.
- The course focusses on 440 low level programming, especially the PowerPC EABI.
- Examples of exception handlers are provided.
- A DFT has been developed to explain how to use mac instructions.
- The Floating Point Unit operation is described.
- The PLB ports as well as debug related signals are described to facilitate the hardware implementation.
- This course has been delivered several times to engineers developing ASICs based on PPC440 and to engineers implementing Xilinx FPGAs containing PPC440 core(s).

*Labs are compiled with Diab Data compiler and run under Lauterbach Trace32 debugger.  
A more detailed course description is available on request at [formation@ac6-formation.com](mailto:formation@ac6-formation.com)*

### Prerequisites

- Experience of a 32 bit processor or DSP is mandatory.

### 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.

### Evaluation modalities

- The prerequisites indicated above are assessed before the training by the technical supervision of the trainee in his company, or by the trainee himself in the exceptional case of an individual trainee.
- Trainee progress is assessed by quizzes offered at the end of various sections to verify that the trainees have assimilated the points presented
- At the end of the training, each trainee receives a certificate attesting that they have successfully completed the course.
  - In the event of a problem, discovered during the course, due to a lack of prerequisites by the trainee a different or additional training is offered to them, generally to reinforce their prerequisites, in agreement with their company manager if applicable.

## Plan

### **INTRODUCTION TO 440**

- Internal architecture overview
- Connection to peripheral IPs
- Clocking
- Programming model

### **THE CORE ARCHITECTURE**

- Pipeline basics
- 5-stage pipeline operation
- Speculative execution, guarded memory
- Cache basics
- Data flow between external memory and caches
- Cache programming interface
- Process vs thread
- Memory Management Unit
- Translation Lookaside Buffer initialisation
- Cache control and debugging features
- Load / store buffer, speculative loads

### **BOOK E COMPLIANT CORE**

- Book E objectives
- Branch instructions
- Load / store instructions
- Semaphore management with lwarx / stwax. Instructions
- Arithmetical and logical instructions
- The PowerPC EABI
- Cache related instructions
- 16-bit mac instructions to develop fixed point DSP algorithms
- Exception processing
- Syndrome registers updating when an exception is taken
- Core timers : PIT, FIT and WDT
- Reset

### **INTEGRATED DEBUG FACILITIES**

- JTAG emulator use
- Real time trace when the PowerPC core executes cached instructions
- Hardware vs software breakpoints

### **HARDWARE IMPLEMENTATION OF THE PPC440 CORE**

- External connections
- Clock and power management interface
- CPU control interface
- Reset interface
- External interrupt controller interface
- Instruction-side local bus interface
- Data-side local bus interface
- DCR interface

### **APU CONTROLLER**

- Connection to the native instruction pipeline

- External coprocessor module
- Software interface
- Class of instruction
- Developing a custom instruction set relying on an external coprocessor
- Floating point simple and double precision instructions

## Renseignements pratiques

**Inquiry : 3 days**