Advanced Micro-controllers

Agenda

- Q & A
- ARM ISAs
  - SIMD instruction
  - TrustZone
- ARM Cortex-A Programmer's model
  - Registers
  - Modes

SIMD instruction

- Single Instruction Multiple Data
- ADD r0, r1, r2 // r0[31:0] = r1[31:0] + r2[31:0] and NZCV in PSR are set
  - r1 = 0x11223344
  - r2 = 0x44332211
  - r0 = 0x55555555
- QADD8 r0, r1, r2
  - r0[7:0] = r1[7:0] + r2[7:0] and GE[0] is set for carry
  - r0[15:8] = r1[15:8] + r2[15:8] and GE[1] is set for carry
  - r0[23:16] = r1[23:16] + r2[23:16] and GE[2] is set for carry
  - r0[31:24] = r1[31:24] + r2[31:24] and GE[3] is set for carry
  - Four 8-bit additions are carried out in single instruction.

ARM instructions

- ARM instruction set
  - Each instruction is of 4 bytes
- Thumb instruction set

    - Each instruction is of 2 bytes
    - Several limitations
- Thumb-2 instruction set
    - Overcomes major limitations of Thumb instruction set
    - Most of Thumb-2 instructions are of 2 bytes. Few instructions are of 4 bytes.
        - Few instructions allows 3 operands e.g. ADD r0, r1, r2
        - Higher registers r8-r12 are available e.g. ADD r8, r9
        - Conditional execution of instructions is allowed with IT (if-then) instruction.
        - Manipulation of status register is allowed
    - Whole program can execute only with Thumb-2 instruction set in Thumb state (T=1). No ARM state is mandetory.

ARM-v7 ISA

- ARM-v7 is also called as ARM-Cortex.
- ARM-v7 is classified in 3 types.
    - ARM-v7-A --> ARM-Cortex-A -- Application series
        - OS (Linux) Based Applications
        - e.g. RPi CPU -- Cortex-A8
    - ARM-v7-R --> ARM-Cortex-R -- Realtime series
        - Realtime Applications with RTOS
        - Lowest and Deterministic possible interrupt latency
    - ARM-v7-M --> ARM-Cortex-M -- Micro-controller series
        - Micro-controller Embedded Applications -- usually Bare-metal
        - Lowest cost

ARM Cortex-A Programmer's model

- Seven modes
    - Privileged modes: Svc, Fiq, Irq, Abt, Und, Sys
    - Unprivileged mode: Usr
- Registers
    - r0 to r12

    - r13 - stack pointer
    - r14 - link register
    - r15 - program counter
    - psr - program status register
- Refer slides