

## **An Overview of the Instruction Set Architecture of ARM7TDMI**

In this assignment, you will explore the ISA (Instruction Set Architecture) of the ARM microprocessor ARM7TDMI, and write a report of approximately 3,000 words.

You will work solo in this assignment. The deadline is **23:59 Sept 10, 2017**.

Please follow the following guidelines when writing your report.

As you know, an ISA consists of four components: memory models, registers, data types and instructions. Therefore, you need to explore each component of the ISA of the ARM microprocessor ARM7TDMI and present your results in your report. Specifically, your report should have the following sections.

1. Introduction. In this section, you give an overview of the ARM microprocessor ARM7TDMI. Your overview should focus on the salient features of ARM7TDMI. Examples include conditional execution, hardware support for power saving and caching.
2. Memory models. You need to explain the memory models in details. How many memory spaces are there in ARM microprocessors? Is there a separate memory space for program and constants? Are registers mapped into a memory space as in AVR microcontrollers? What is the maximum memory size for each memory space? What is the size of addressable cells of each memory space? How is the alignment problem handled? Which endianness is used?
3. Registers. Give detailed descriptions of all the registers. Why is the link register needed? Does PC always point to the next instruction? Pay special attention to the Current Program Status Register (CPSR).
  - a. N, Z, C and V flags. Explain how ARM7TDMI uses these flags for overflow, signed comparison and unsigned comparison.
  - b. The least significant 5 bits are reserved for operating modes. You need to give detailed descriptions for each operating mode. Why are these operating modes needed? How does each operating mode work?
  - c. There is an interrupt enable/disable bit. This bit is used to enable/disable ARM7TDMI interrupt system. Give detailed descriptions of ARM7TDMI interrupt structure. How many hardware interrupts does ARM7TDMI support? Explain in detail how ARM7TDMI handles a hardware interrupt. In addition to hardware interrupts, ARM7TDMI provides software interrupt. What is the software interrupt used for? How is the software interrupt processed?

4. Instruction Set. You don't need to describe each instruction. Instead, you need to focus on the salient features of ARM7TDMI instructions listed as follows.
- a. Describe the instruction formats including encoding scheme, the number of operands etc.
  - b. Describe all the addressing modes in ARM7TDMI.
  - c. ARM7TDMI provides conditional execution of an instruction i.e. the operation given in an instruction is executed only if some condition holds. Describe the conditional execution in detail. Why is the conditional execution a good feature?
  - d. Describe all the instructions for stack operations in ARM7TDMI in detail.
  - e. ARM7TDMI provides multiple-bit shift instructions. Describe them in detail.
  - f. AVR microcontrollers provide the special instructions *in* and *out* to access I/O registers (ports). Does ARM also provide *in* and *out*? If not, how do programmers access I/O ports and I/O registers in ARM7TDMI?
  - g. AVR microcontrollers provide a special instruction *sleep* for power saving. Does ARM also provide a similar instruction? Can ARM7TDMI operate in different frequencies? What are the major advantages with different frequencies?
  - h. AVR microcontrollers provide a watchdog timer to prevent software from corruption. The instruction *wdr* is to reset the watchdog timer. Does ARM also provide a similar instruction?
5. Data types. Describe all data types in ARM7TDMI in detail. How would you implement in software the data types such as 64-bit signed and unsigned integers that are not supported by ARM7TDMI? Write ARM7TDMI assembly programs for addition and subtraction of two 64-bit signed and unsigned integers.
6. Conclusion. You need to explain for what applications you need to use an AVR microcontroller and for what applications you need to use ARM7TDMI. The factors you may consider are cost-performance ratio, memory capacity and processor speed.

The datasheet of ARM7TDMI is available from

<http://infocenter.arm.com/help/index.jsp?topic=/com.arm.doc.set.arm7/index.html>.

The data sheet of ATmega2560 is available here

<http://www.cse.unsw.edu.au/~cs2121/AVR/ATmega2560datasheet.pdf>.

Please include your name and student number on the cover page of your report.

How to submit your report?

1. Prepare a pdf file for your report.
2. Follow the following steps:
  - a. Go to the course home page.
  - b. Click on “Assignment” in the left pane.
  - c. Click on “Make Submission”.
  - d. Upload your pdf file.
  - e. Click on “Submit”.

References:

1. Steve Furber. ARM System-on-Chip Architecture.
2. <http://www.heyrick.co.uk/assembler/index.html>.