Microcontroller HW and SW platforms

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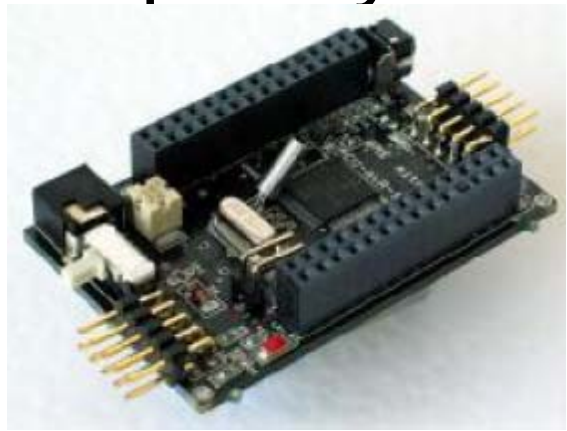
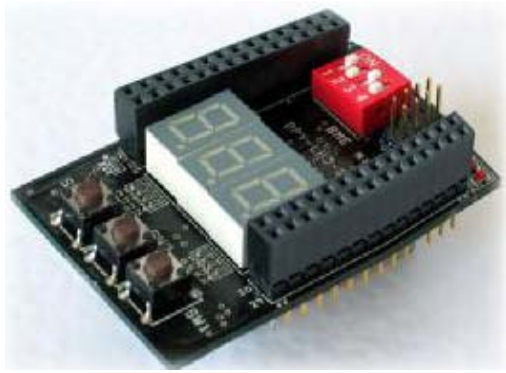
MITMÓT

- Modular mote system developed by BME-MIT
  - Processor modules
    - 32-bit ARM core
    - 8-bit ATMEL core
  - Communication modules
    - Radio 1: 433-866 MHz
    - Radio 2: 2 GHz, ZigBee
    - Ethernet
    - Power line

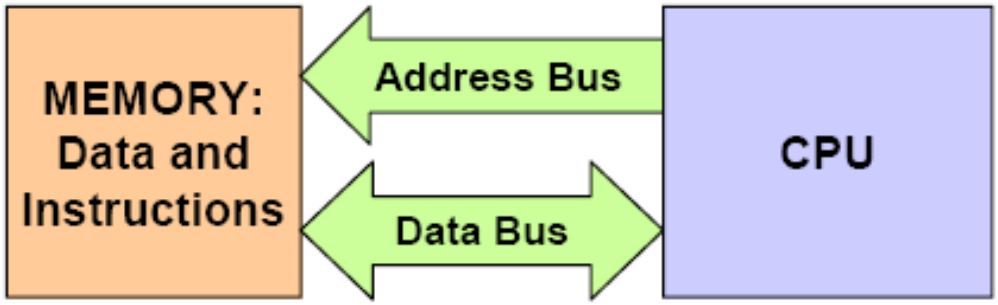


- Sensor, actuator modules
  - Basic I/O module
    - LED, 3-digit display
    - Pushbuttons, switches
    - I2C thermometer
  - Acoustic module
    - Analog in/out
    - Mic, speaker
  - DC motor driver module
    - 2 DC motor drivers
    - 2 rotation sensors



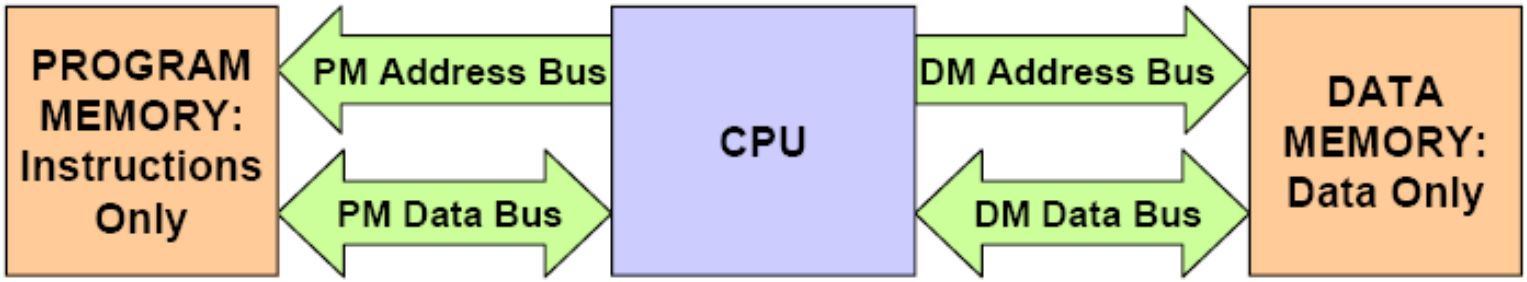
uC architectures

- von Neumann



  - Shared bus system and memory for program and data -> limited system performance
  - Self-modifying code is possible
  - General purpose computers, traditional uC

- Harvard



  - Separate memories for data and program -> different bus size is possible
  - Faster data fetch and so processing
  - Program cannot be self modifying

- Main general features of 8-bit uCs
  - Harvard architecture
  - 8-bit data bus
    - Address bus can be wider 14-16-bit (PIC16: 14-bit)
    - RISC – reduces instruction set computer
      - Generally 1 instruction / 1 clock pulse
        - » fetch+operation+store
    - Speed: 8-20 MIPS – million instruction per second
    - Static operation
      - Clock rate reduced -> power consumption reduced
      - Clock can be changed on needs -> can be 0,but <20MHz
    - Memory: RAM n*k, Flash 128k, EEPROM

- Power-on-reset: keeps resetting until power level stabilized after turning on the device
- Timer: 8-16-bit
- ADC: 8-10-12-bit (SAR ADC)
- PWM (pulse width modulation) output:
  - Using one of the timers
  - Usually can be used as DAC
- GPIO: general purpose I/O
- UART/USART: universal asynchronous/synchronous receiver transmitter

- SPI: serial peripheral interface
- I2C: inter-integrated circuits
- CAN: controller area network
- LIN: local interconnect network
- Interrupt: priorities, shared
- Reset
- Watchdog: detect & recover from malfunction
- Ports: TTL or Schmitt-trigger input

Development platform

- AVR Studio
  - Integrated development environment (IDE) for writing and debugging AVR applivations
  - Free to download from ATMEL webpage
    - AVR Studio 4.19. Build 730
  - Assembler: SW that translates assembly code into machine code
  - Compiler: code written in higher level language translated into assembly or machine code directly

  - Make file: a type of script that pass parameters for the compiler, loader, contains infromation of the compiling process and source files

- JTAG ICE
  - HW (converter chip)+SW for on-chip debugging
  - Happy JTAG: freeware SW to interface between AVR Studio and converter chip

- WinAVR
  - Tool chain under AVR Studio
  - Includes compiler for C/C++ (by GNU-GCC)
- MITMÓT system SW level considerations
  - CPU independent bus system
  - API – application programming interface
    - HW dependent: open HW specification
    - HW independent: application layer can be handled independently fro the HW on a general SW platform
      - Advantage of the layered structure

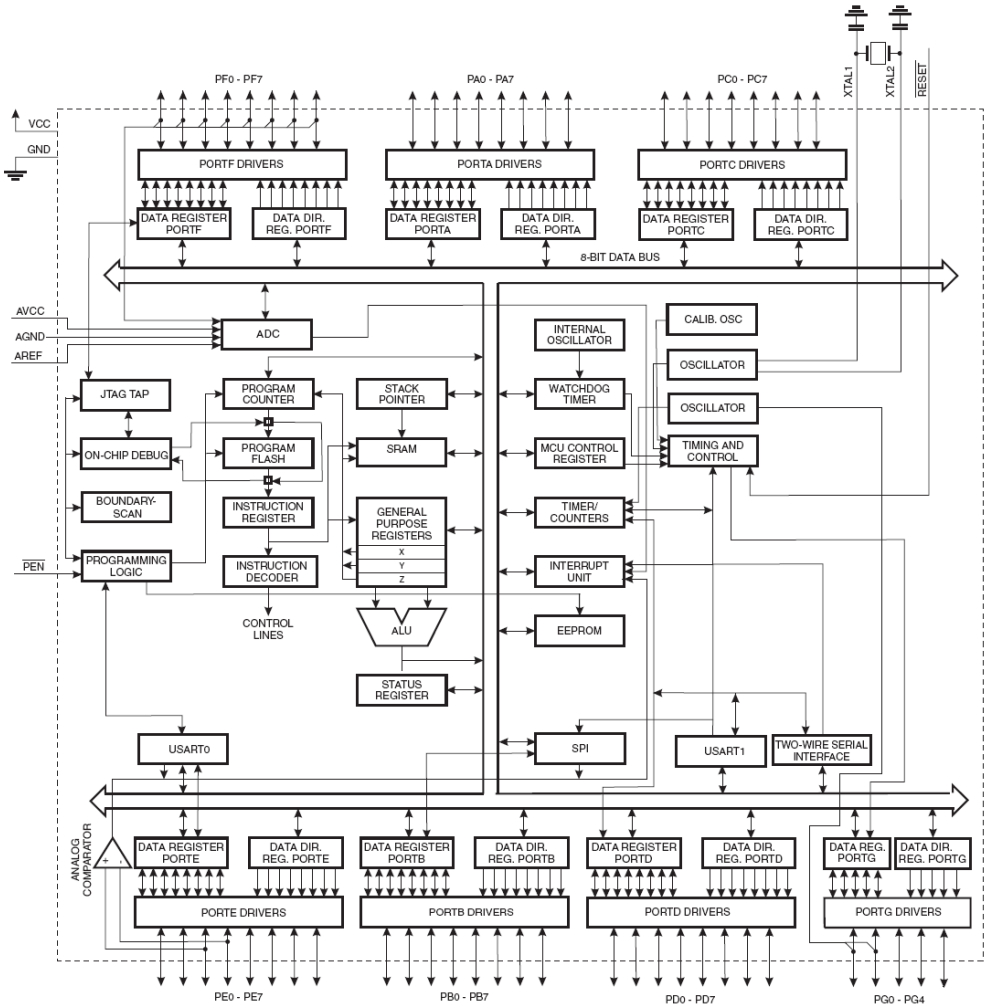
ATMEL AT Mega 128 uC

- Main features
  - Harvard architecture
  - 8-bit data bus
  - RISC, 133 instructions
  - Static operation
  - Max. 16 MHz crystal oscillator: 16 MIPS
  - On-chip HW multiplier

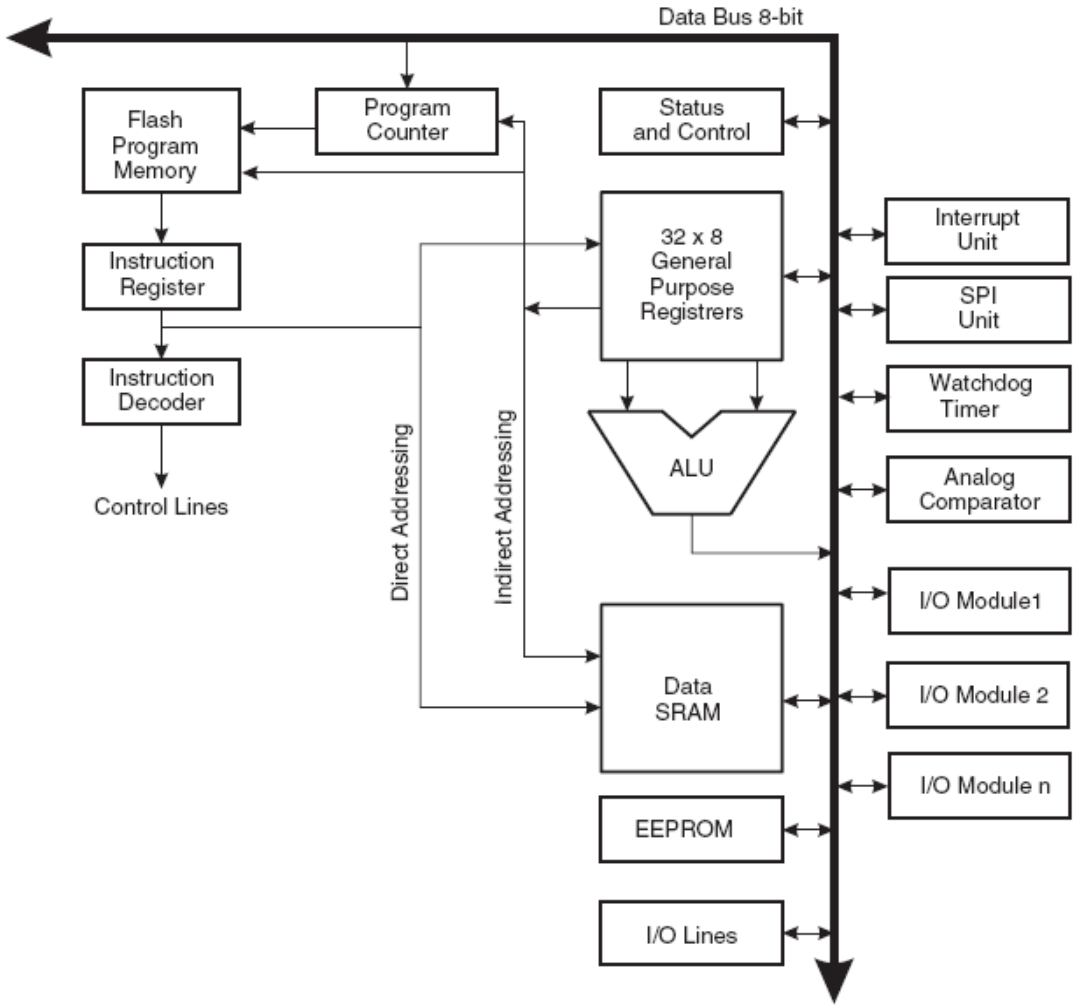
- Memory
  - 128 kb program Flash
  - 4 kb internal SRAM
  - 4 kb EEPROM
  - Optional external memory max. 64 kb
- JTAG/SPI programming interface
- Peripherals
  - 2x8-bit timer/counter
  - 2x16-bit timer /counter
  - 2x8-bit PWM output
  - 8-channel 10-bit SAR ADC

- USART
- SPI
- Watchdog timer
- Analog comparator
- Power-on reset
- Brown-down detection – supply voltage dropped below threshold -> reset uC
- Internal RC oscillator
- External and internal interrupt sources
- 6 sleep modes

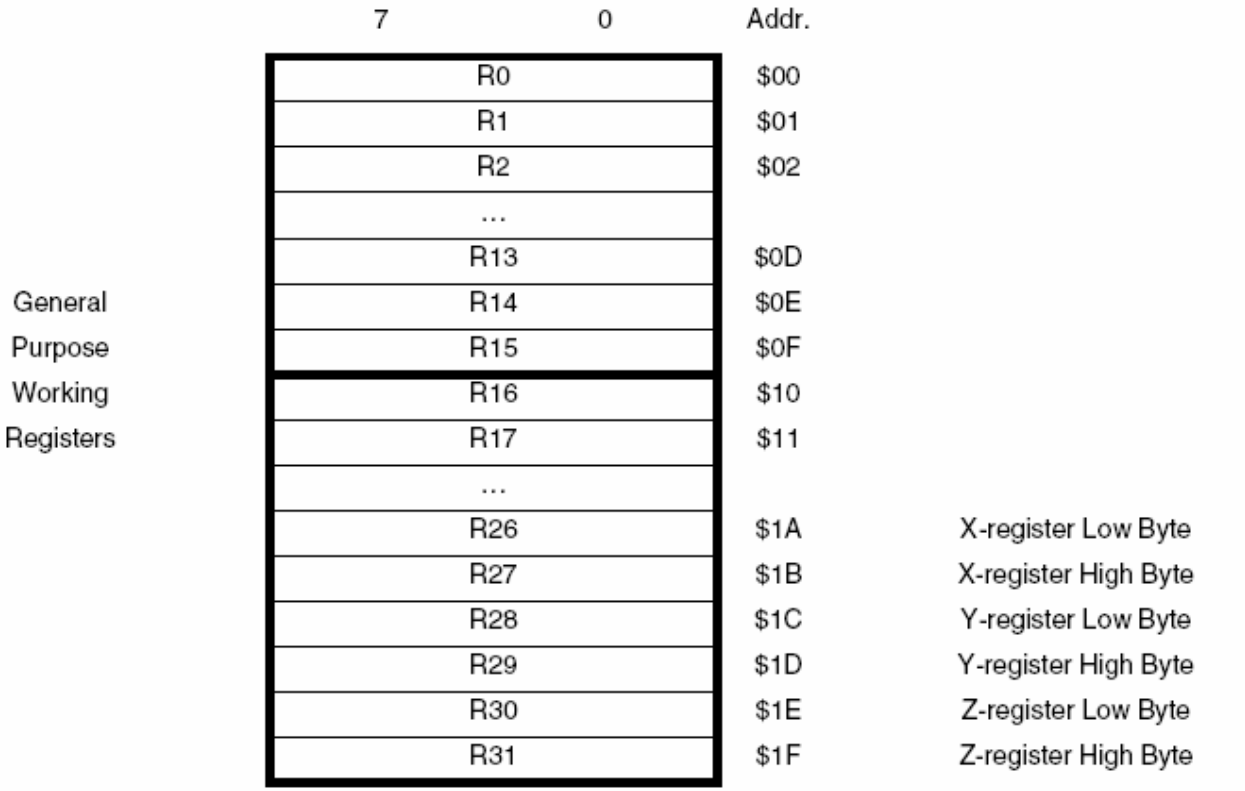
- AT mega 128 inside



– Architectural overview



– General purpose registers



– Special function registers: control or monitor chip components

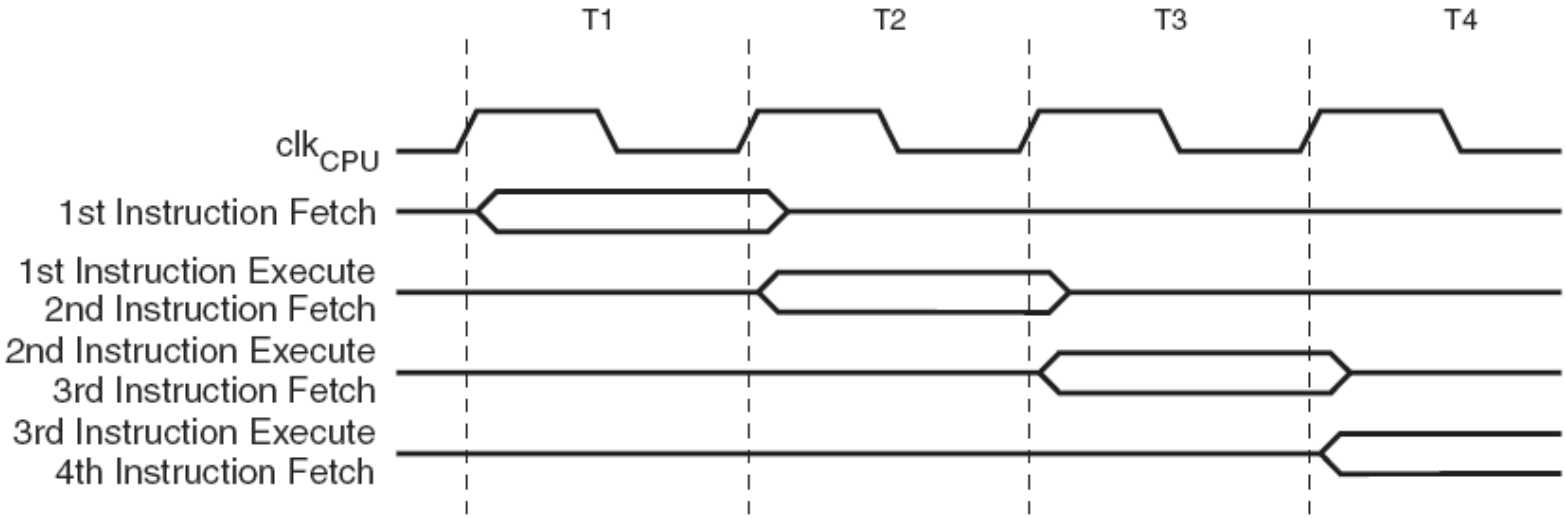
- Status register

Bit	7	6	5	4	3	2	1	0	
	I	T	H	S	V	N	Z	C	SREG
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

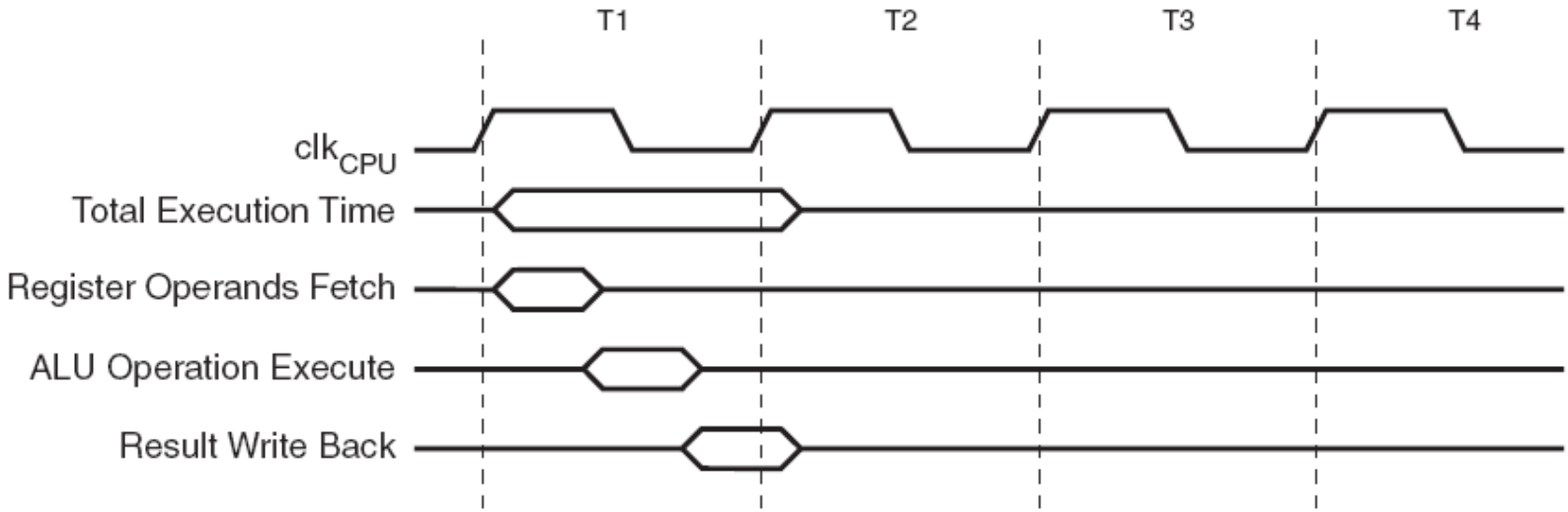
- Stack pointer

Bit	15	14	13	12	11	10	9	8	
	SP15	SP14	SP13	SP12	SP11	SP10	SP9	SP8	SPH
	SP7	SP6	SP5	SP4	SP3	SP2	SP1	SP0	SPL
	7	6	5	4	3	2	1	0	
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	

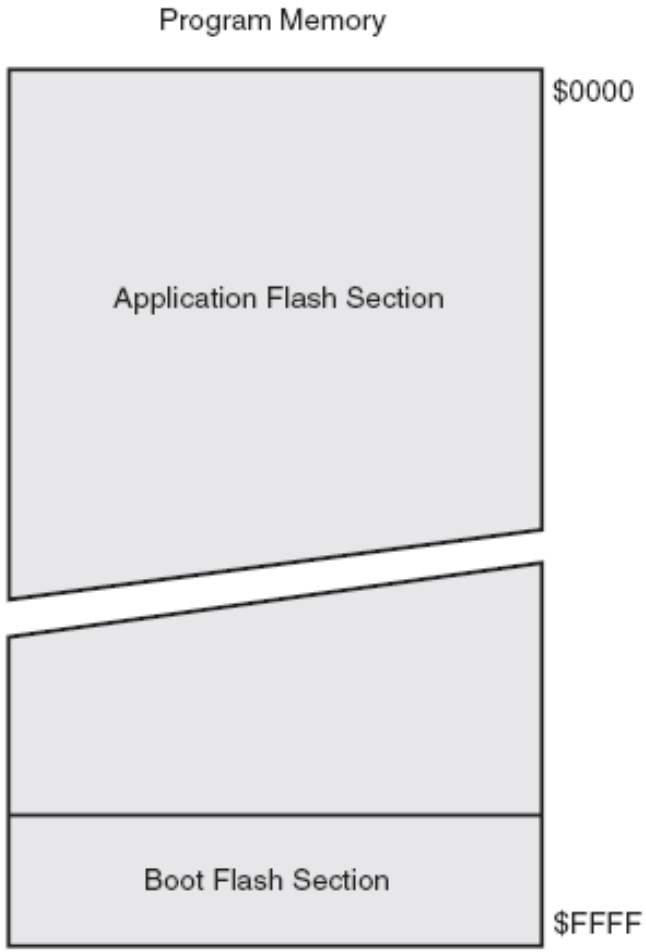
– Parallel instruction fetches and execution



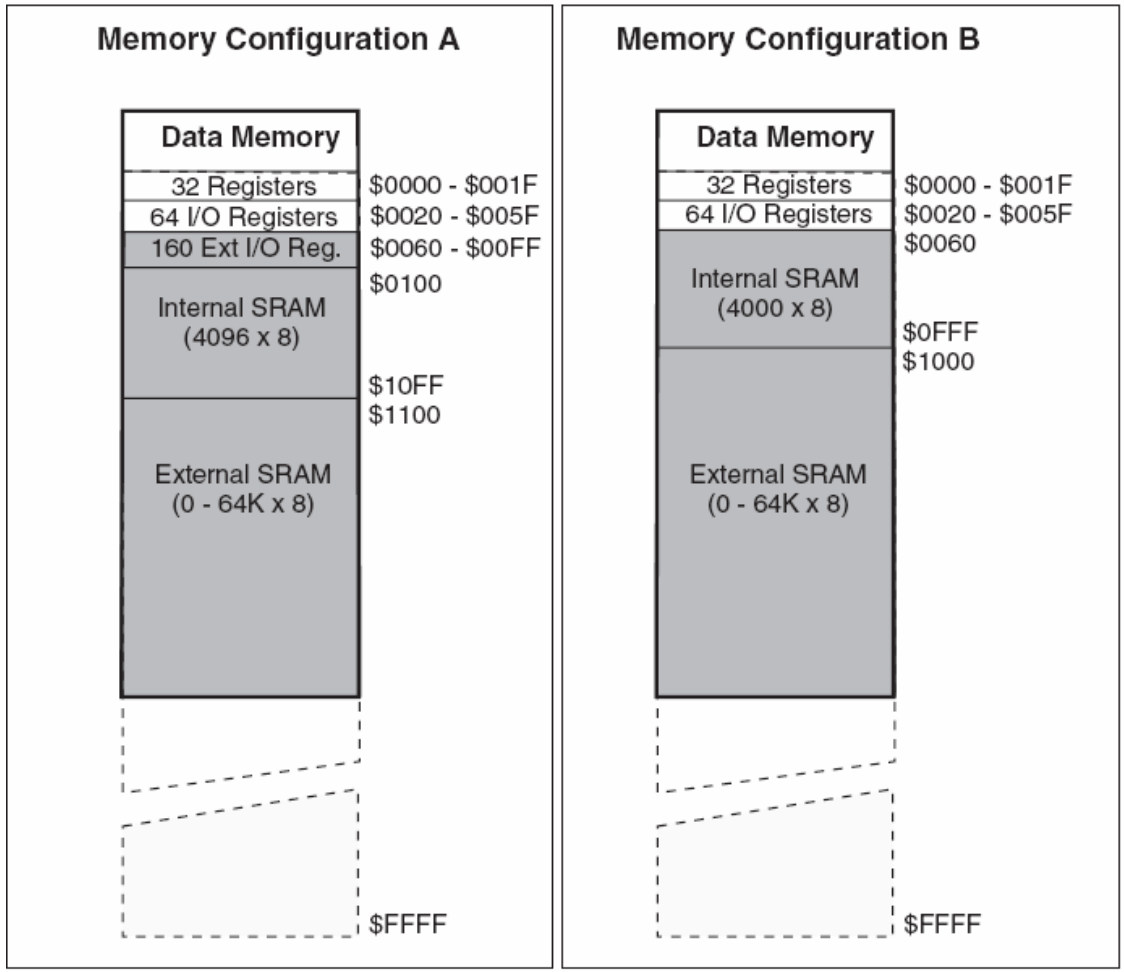
– Single cycle ALU operation



– Program memory map



- Data memory map



References

- ATMEL: 8-bit Atmel Microcontroller with 128KBytes In-System Programmable Flash
- Analog devices: Mixed signal and DSP design techniques