1) Discuss The Difference Between ARM cortex A - R – M

Features	Cortex-M	Cortex-A	Cortex-R
Application Focus	Microcontroller and embedded systems	High-performance computing	Real-time and safety-critical systems
Performance	Moderate, optimized for low-power embedded tasks	High, optimized for demanding computational tasks	Moderate to high, optimized for real-time applications
Power efficiency	High, optimized for low-power operation	Variable, typically consumes more power than Cortex-M	Moderate, optimized for real-time performance
Real time capability	Limited, suitable for simple real-time tasks	Not designed for real-time applications	High, optimized for deterministic behavior
Fault tolerance	Basic error handling capabilities	Not typically prioritized	Advanced fault tolerance features
Multitasking	Limited support for multitasking	Full support for multitasking OS	Limited support, usually for dedicated tasks
Features	Simple architecture, scalable, low power	Advanced features like out-of-order execution, virtualization support	Optimized for real-time determinism, fault tolerance
Examples	Cortex-M0, Cortex-M3, Cortex-M4, Cortex-M7	Cortex-A53, Cortex-A72, Cortex-A76	Cortex-R4, Cortex-R5, Cortex-R7

2) compare Btw arm and avr Mc in more than 5 points

S.No.	AVR	ARM
01.	AVR micro controller refers to Advanced Virtual RISC (AVR).	ARM micro controller refers to Advanced RISC Micro-controller (ARM).
02.	It has bus width of 8 bit or 32 bit.	It has bus width of 32 bit and also available in 64 bit.
03.	It uses ART, USART, SPI, I2C communication protocol.	It uses SPI, CAN, Ethernet, I2S, DSP, SAI, UART, USART communication protocol.
04.	Its speed is 1 clock per instruction cycle.	Its speed is also 1 clock per instruction cycle.
05.	Its manufacturer is Atmel company.	Its manufacturer is Apple, Nvidia, Qualcomm, Samsung Electronics and TI etc.
06.	It uses Flash, SRAM, EEPROM memory.	It uses Flash, SDRAM, EEPROM memory.
07.	Its family includes Tiny, Atmega, Xmega, special purpose AVR.	Its family includes ARMv4, 5, 6, 7 and series.
08.	It is cheap and effective.	It provides high speed operation.
09.	Popular micro-controllers include Atmega8, 16, 32, Arduino Community.	Popular micro-controllers include LPC2148, ARM Cortex-M0 to ARM Cortex-M7, etc.

3) Application use Based on ARM Cortex M4

The versatility of ***ARM Cortex M4*** microcontrollers allows for their implementation in various industries and sectors. Some notable applications include:

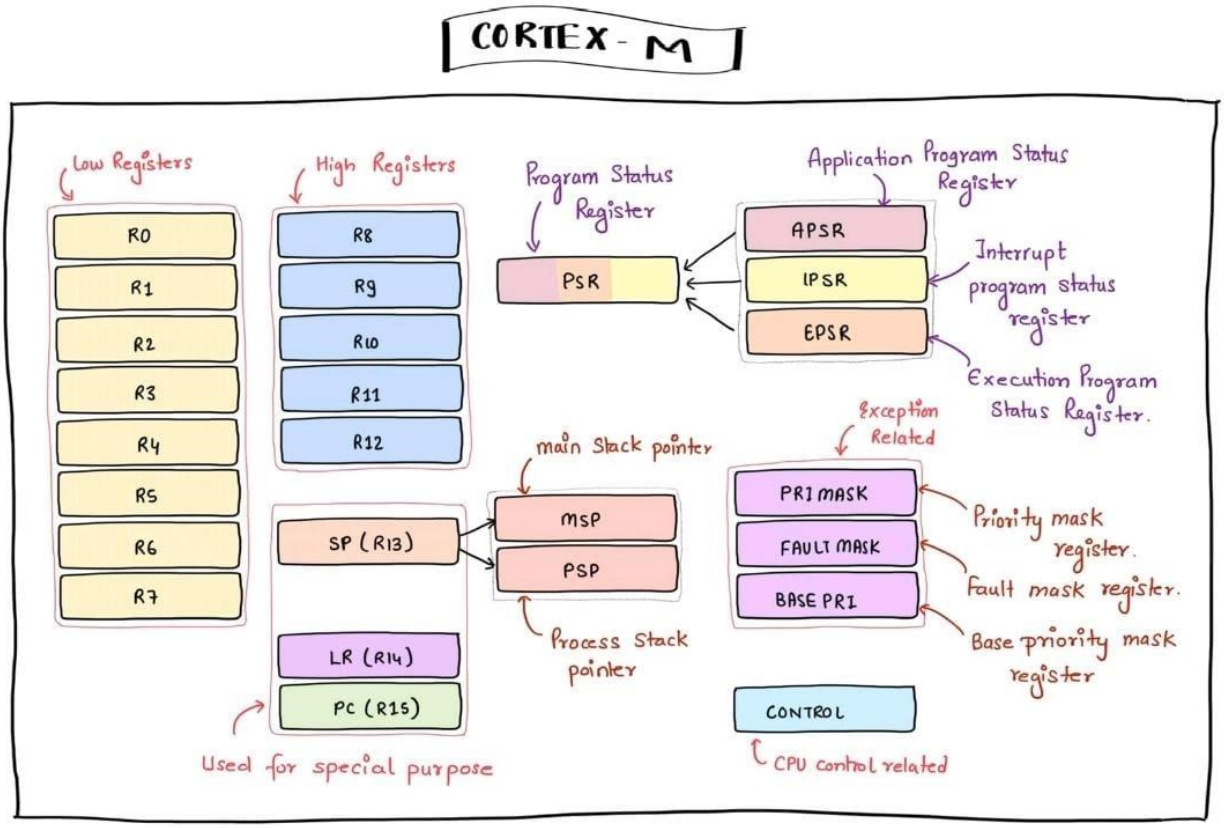
- **Automotive**: ARM Cortex-M4 is extensively used in automotive systems, such as engine control units (ECUs), advanced driver assistance systems (ADAS), and infotainment systems.

- **Smart IoT Devices**: With the growing popularity of the Internet of Things (IoT), *ARM Cortex M4* microcontrollers find applications in various smart devices like wearables, home automation systems, and medical devices.

- **Industrial Automation**: ARM Cortex-M4 is widely used in industrial automation systems, including programmable logic controllers (PLCs), motor control, and robotics.

- **Consumer Electronics**: Numerous consumer goods, such as cellphones, game consoles, and digital cameras, use ***ARM Cortex M4*** microcontrollers.

4) Discuss ARM M4 Core Registers



R0 – R12: general purpose registers

● Low registers (R0 – R7) can be accessed by any instruction

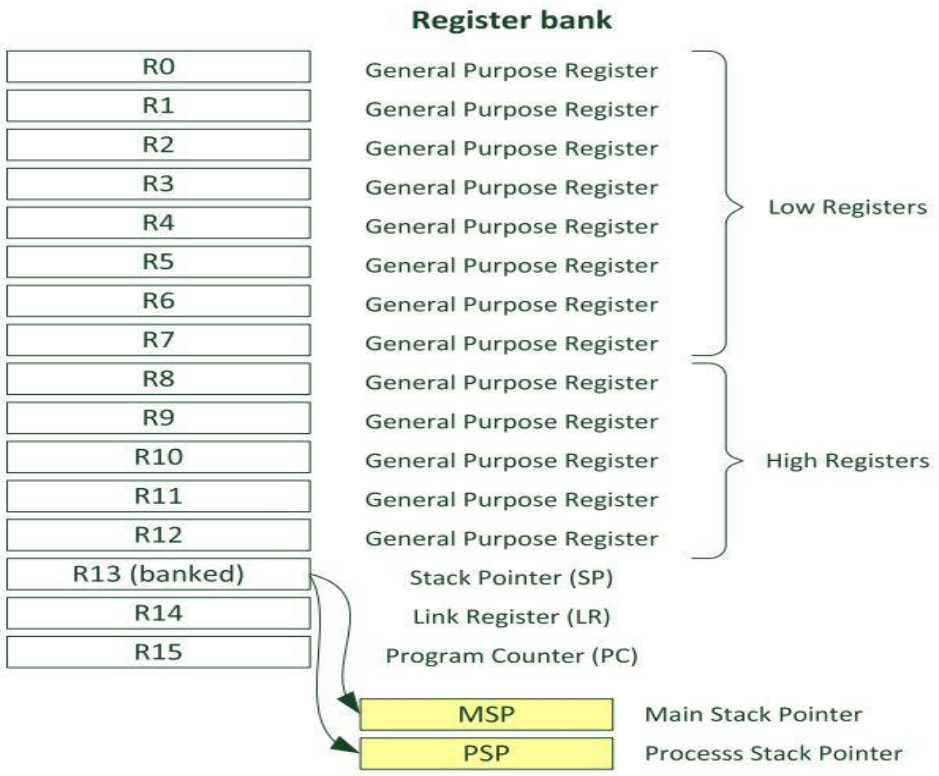
● High registers (R8 – R12) sometimes cannot be accessed e.g. by some Thumb (16-bit) instructions

R13: Stack Pointer (SP)

● Store the current address of the stack for saving the context of a program while switching between tasks

● Cortex-M4 has two SPs: Main SP, used in applications that require privileged access e.g. OS kernel, and exception handlers, and Process

SP, used in base-level application code (when not running an exception handler)



R15:Program Counter (PC)

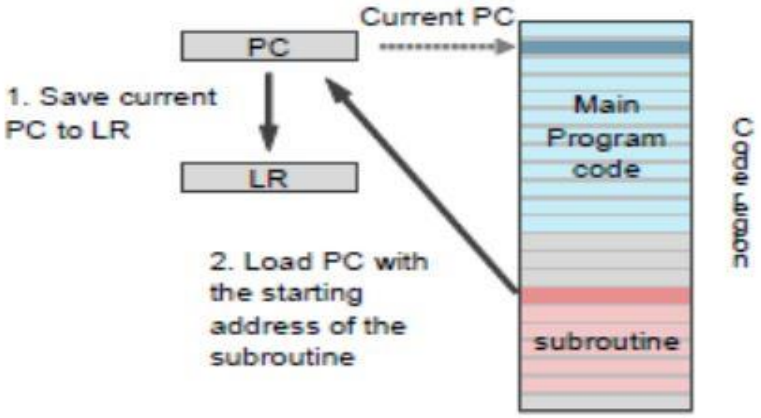
● Store the address of the current instruction code

● Automatically incremented by 4 at each operation (for 32-bit instruction code), except branching operations

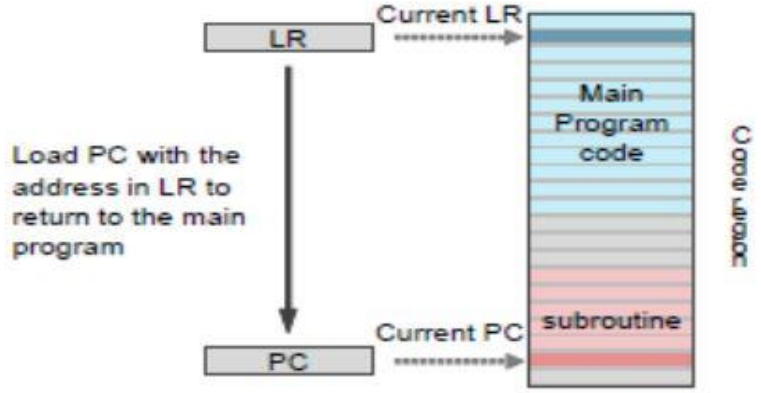
● A branching operation, such as function calls, will change the PC to a specific address, meanwhile it saves the current PC to the Link Register (LR)

R14: Link Register (LR)

● The LR is used to store the return address of a subroutine or a function call



Call a subroutine



Return from a subroutine to the main program

Program Status Register

- Provides information about program execution and ALU flags
- Application PSR (APSR)
- Interrupt PSR (IPSR)
- ISR number – current executing interrupt service routine number
- Execution PSR (EPSR)

Table 4.2 Bit Fields in Program Status Registers

Bit	Description
N	Negative flag
Z	Zero flag
C	Carry (or NOT borrow) flag
V	Overflow flag
Q	Sticky saturation flag (not available in ARMv6-M)
GE[3:0]	Greater-Than or Equal flags for each byte lane (ARMv7E-M only; not available in ARMv6-M or Cortex®-M3).
ICI/IT	Interrupt-Continuable Instruction (ICI) bits, IF-THEN instruction status bit for conditional execution (not available in ARMv6-M).
T	Thumb state, always 1; trying to clear this bit will cause a fault exception.
Exception Number	Indicates which exception the processor is handling.

REFERENCE:

1) What is the difference between ARM Cortex-M Vs Cortex-A Vs Cortex-R (rfwireless-world.com)
2) Difference between AVR and ARM - GeeksforGeeks
3) ARM Cortex M4 in Embedded Systems: Benefits and Applications (iies.in)
4) Cortex-M (Photo)
5) ARM CORTEX M4 Memory layout
6) The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors, Third Edition (DataSheet)