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Implementation and performance comparation of MMC firmware on RISC-V and ARM-based MCUs

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Introduction

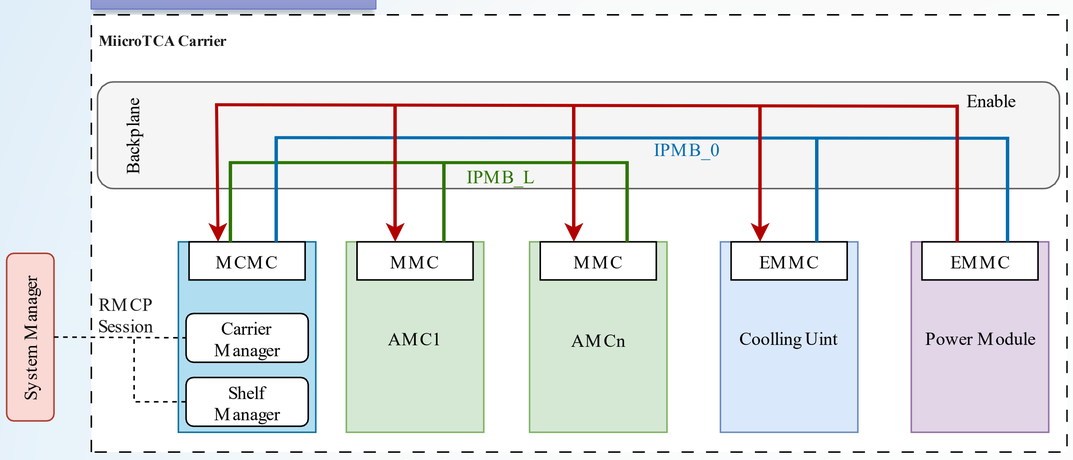


Fig. The internal management structure of MicroTCA

- The MicroTCA.4 Standard System is composed of several components including the Power Module, Cooling Unit, MCH (MicroTCA Carrier Hub), AMC (Advanced Mezzanine Card), RTM (Rear Transition Module), backplane, and more
- Intelligent management within the MicroTCA.4 system is accomplished through the use of the IPMI (Intelligent Platform Management Interface) bus
  - Communication between the MCH and AMC boards is achieved through the IPMB-L bus
  - The management communication between MCH, power supply, and cooling unit is facilitated through the IPMB-0 bus

- MCU is GigaDevice' GD32VF103, RISC-V architecture, max 108 MHz, 128kB ROM, 20 kB RAM
- MMC(module management controller) firmware based on FreeRTOS, improved real-time performance
- The firmware implements the basic functions and supports rear transition module
  - Power management and monitoring
  - Hot swap for AMC and RTM
  - Serial port commands for system debug
  - Firmware upgrade

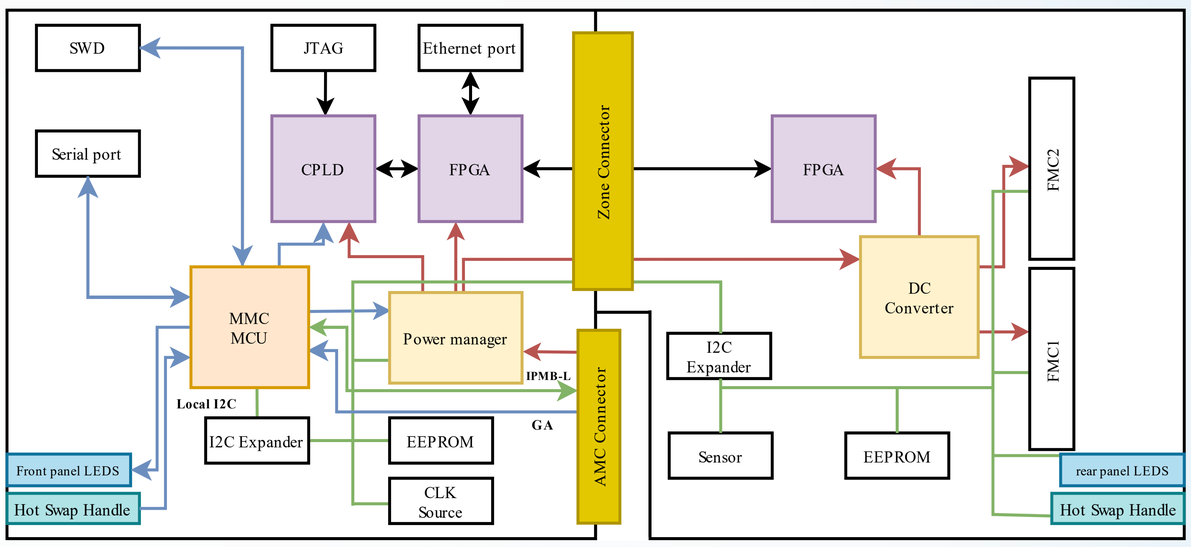


Fig. The block diagram of AMC and RTM

Solution of RTOS-MMC firmware

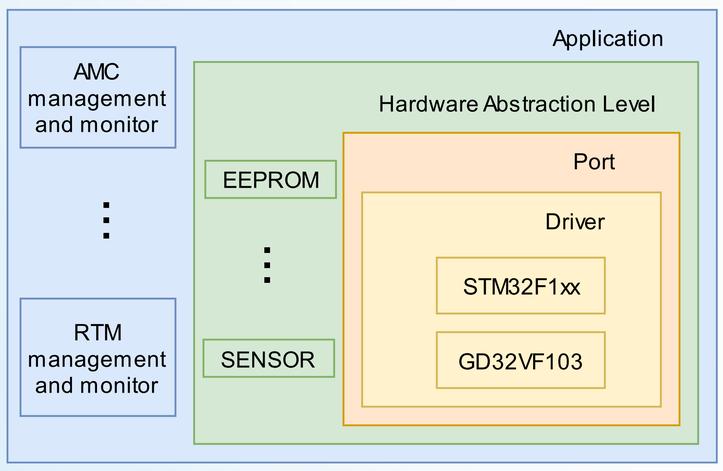


Fig. the block diagram of firmware structure

- The firmware implements four different abstraction layers
- The driver compatible with STM32F1xx series and GD32VF103

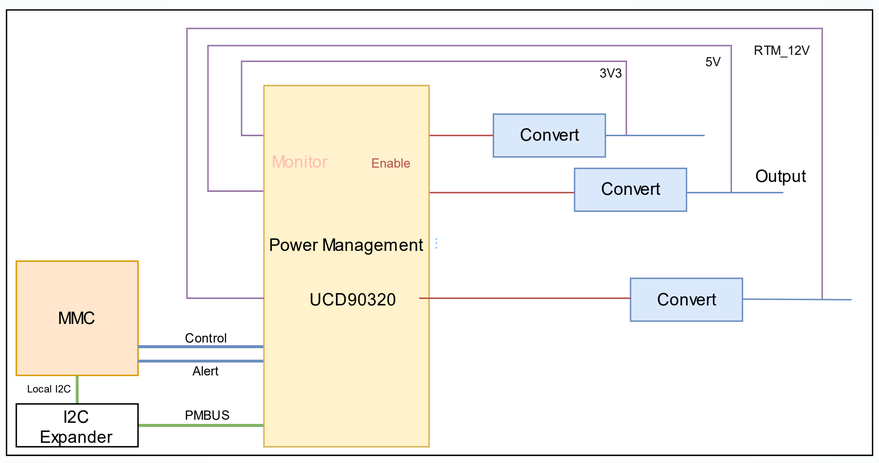


Fig. the block diagram of power management

- MMC communicates with the power management chip UCD90320 through the I2C expander
  - Control the power rail switch and monitor each voltage
  - send the board status to the chassis

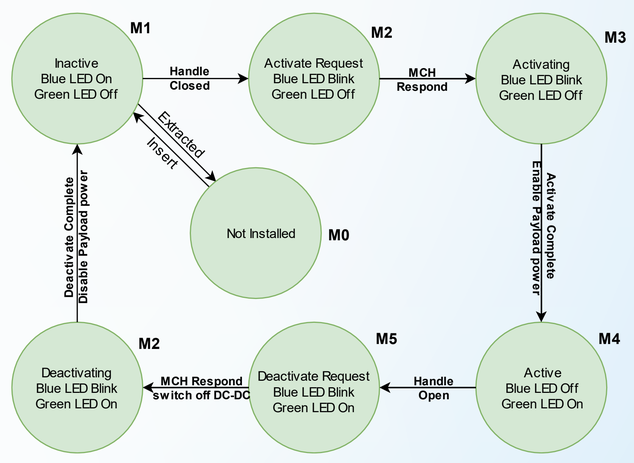


Fig. Hot Swap state machine

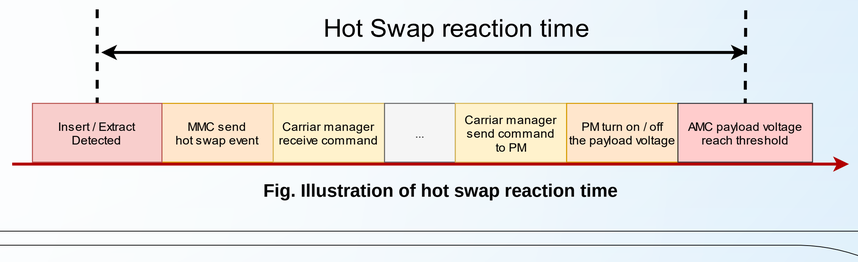


Fig. Illustration of hot swap reaction time

Comparation of two MCUs

		stm32f100CBT6	GD32VF103CBT6
Core		ARM	RISC-V
Flash		128 kB	128 kB
SRAM		8 kB	32 kB
GPIO		37	37
Timers	General-purpose Timer	6	4
	Advanced-control Timer	1	1
	watch dog	2	2
	Systick Timer	1	1
	Basic Timer	2	2
Communication interface	SPI	2	3
	I2C	2	2
	USART	3	3
	CEC	1	x
	USBD	x	1
	CAN	x	2
ADC		1	2

Tab. Comparation about features and peripheral of MCUs

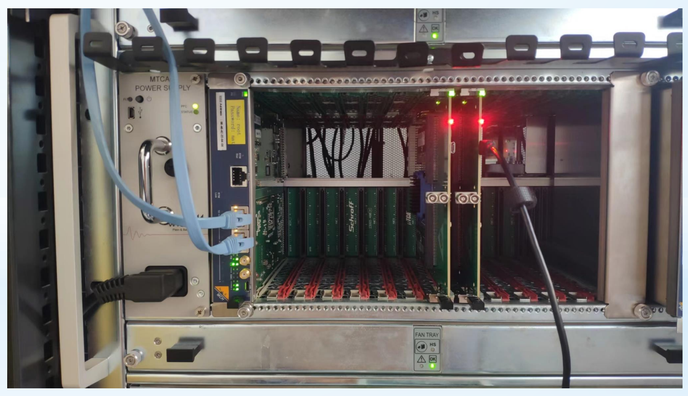
- Different ISA(Instruction Set Architecture) and microarchitecture
- MCU compatibility
  - pin-compatible
  - Consistent size and packaging
  - Electrical connection compatibility
- The address mapping space is basically the same
- Same Peripheral functions

- RTOS can achieve multitasking processing, FreeRTOS is an open-source operating system
- The processing of FreeRTOS under the ARM architecture and RISC-V architecture is different

	STM32F1xx	GD32VF1xx
Interrupt management / critical area	Interrupt Mask Register: BASEPRI	Interrupt Mask Register: MTH
context switch	SVC_handler starts the first task; PendSV_ Handler executes task switching	software interrupt handler
Systick Timer	24 bit counter , clock source: system clock	64 bit counter, clock source: system clock/4

Tab. Differences in the operation of FreeRTOS under two microarchitecture

Real-time Performance Measurement



- Inserting the hot swap handle, we tested the reaction time under two different MCUs for 300 times. The table and pictures show a comparison of the response times.

reaction time	STM32F100	GD32VF103
Mean (ms)	1519.66447	586.7133333
minimum (ms)	1072	84
maximum (ms)	2067	1072
median (ms)	1523.5	626

Tab. Description and statistics of response time

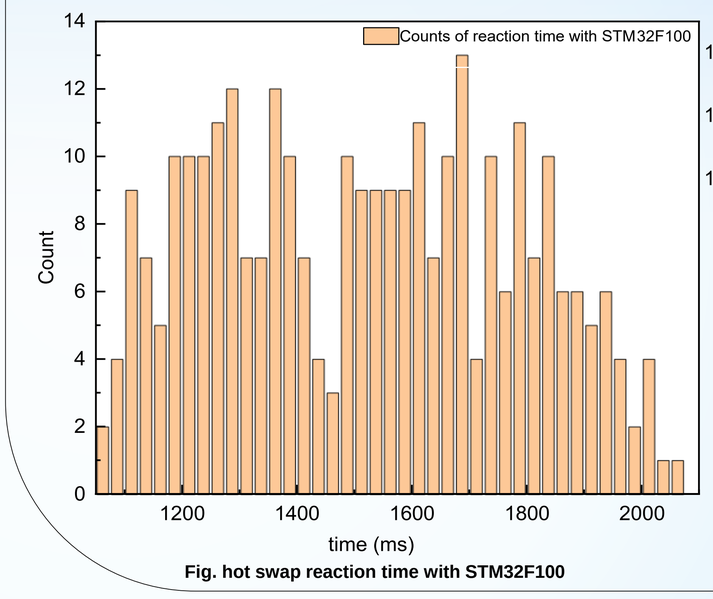


Fig. hot swap reaction time with STM32F100

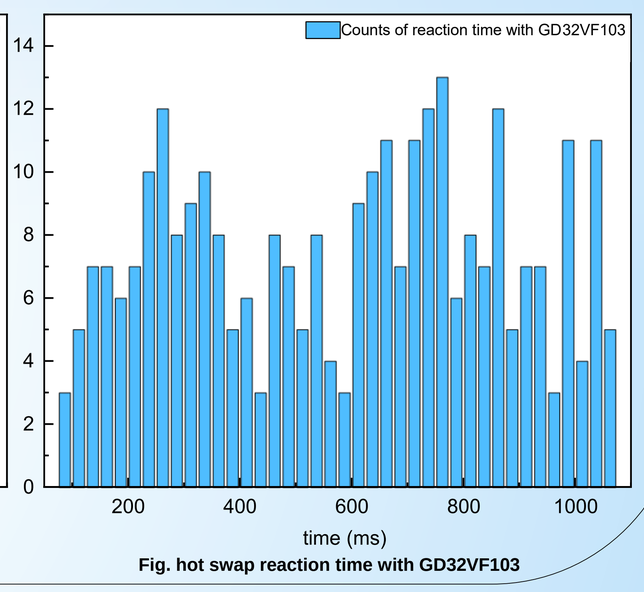


Fig. hot swap reaction time with GD32VF103

Summary

- Implements MMC firmware on GD32VF103 ,compatible with STM32F1xx
- For the average hot swap reaction time ,the board with GD32VF103 is faster than the one with STM32F100, by approximately 1 second