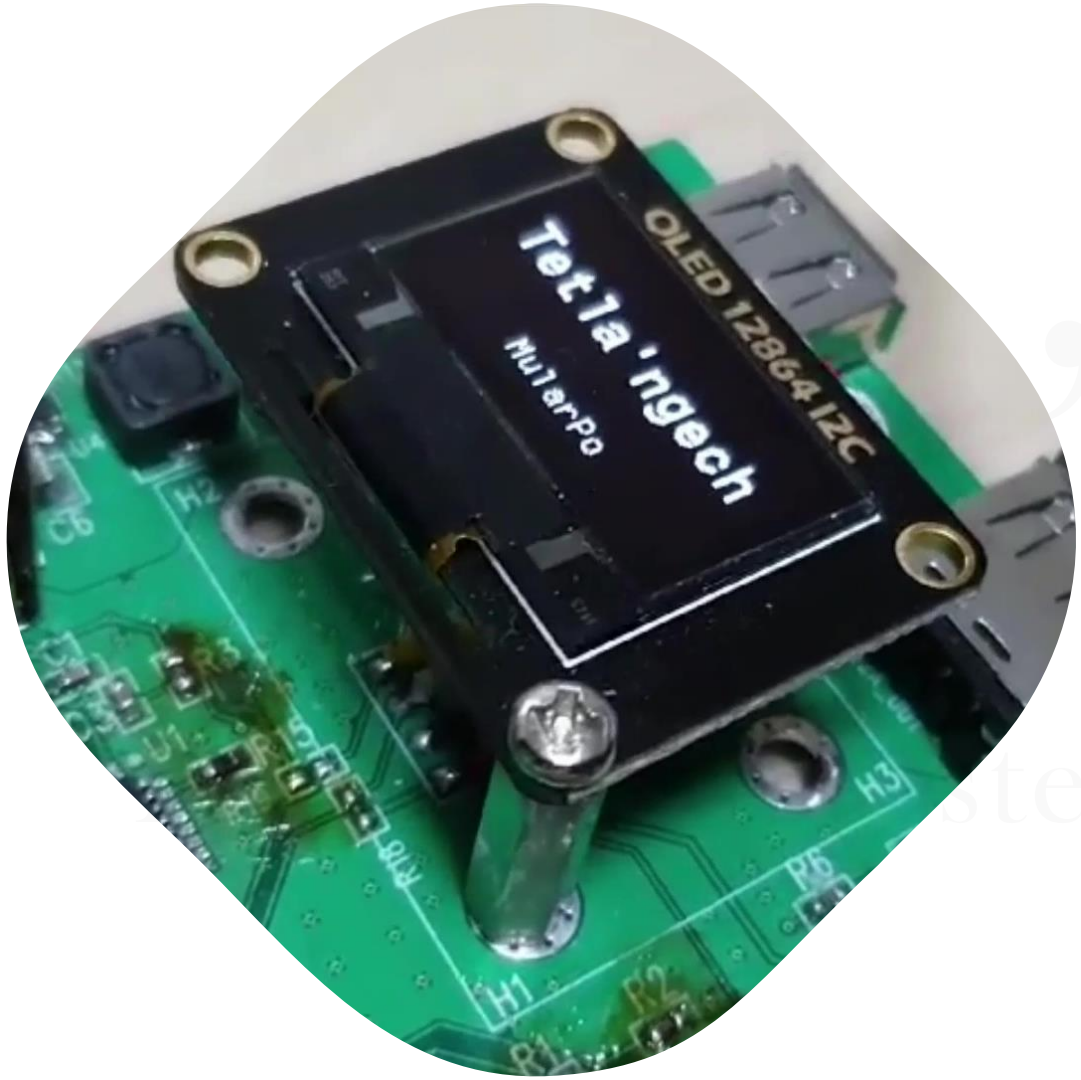
Tet la'ngech

Embedded Systems Technology



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Embedded Systems

INTERRUPTS

"Innovating for progress with embedded systems"

Interrupts- Read about

- **Define interrupts**
- **Interrupt types (five)**
- **Interrupt Vector Table**
- **Applications of interrupts**
- **Advantages and disadvantages of interrupts**

Assignment (deadline-15th- Oct-2025)

- Following the lecture on interrupts
  - Investigate advanced interrupt methods e.g. nested interrupts, interrupt latency optimization, or critical section management
    - Their impact on system performance.
  - Interrupts in RTOS: Study how interrupts integrate with real-time operating systems for task scheduling and synchronization.
  - What are some of the common issues and mitigation strategies
    - **Hint**: interrupt storms, race conditions

GPIO: Interrupt Functionality

External Interrupt – Temporarily halt the normal execution of the program to service an event.

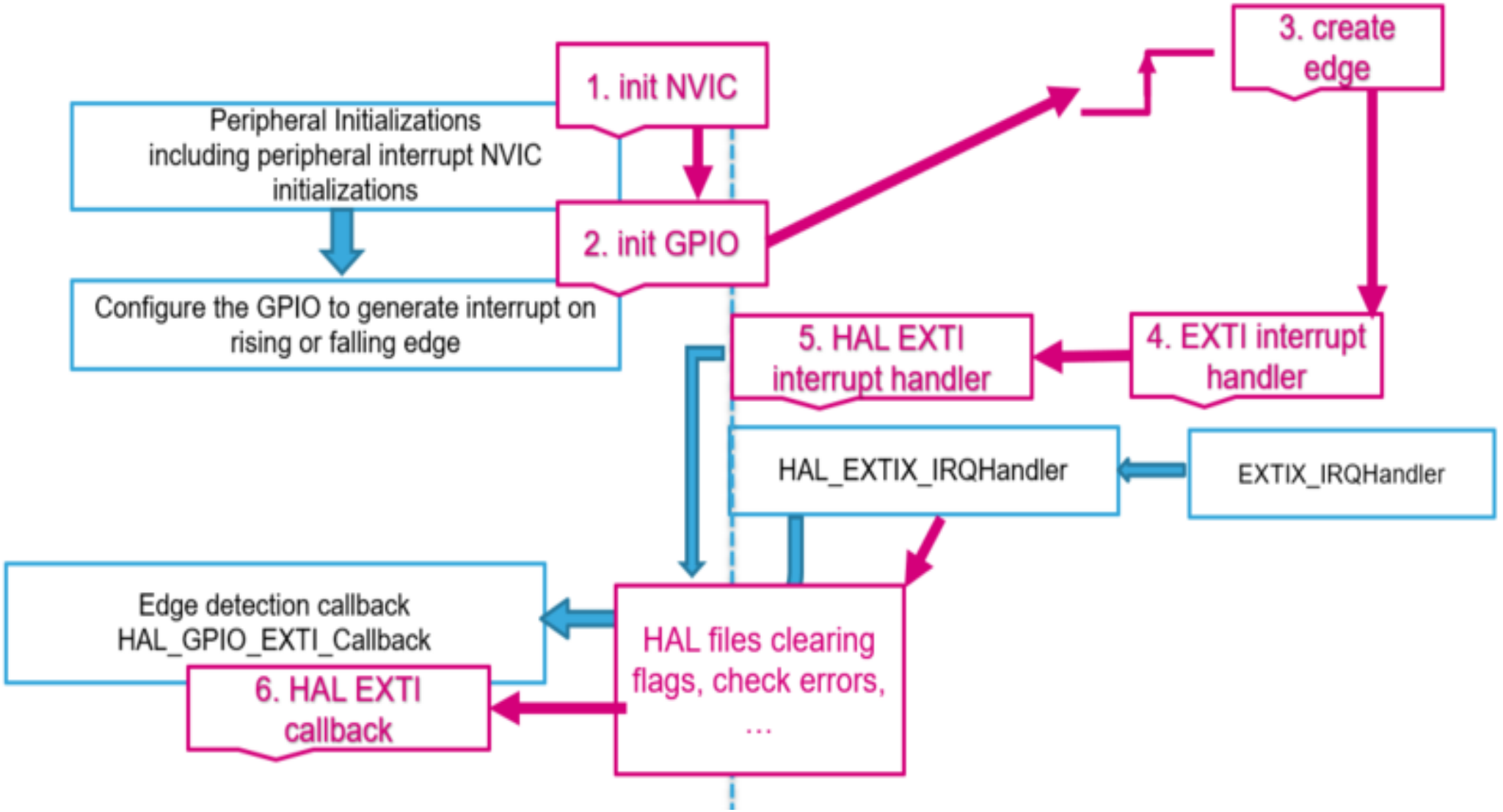
Nested Vectored Interrupt Controller (NVIC)Should always be shorter

Best Practices:

- Keep Interrupt Service Routines (ISRs) short.
- Avoid complex operations inside ISRs.
- Use callback functions for handling logic.

```
void HAL_GPIO_EXTI_Callback(uint16_t GPIO_Pin)
{
   // User code here
}
```

GPIO: Interrupt Functionality



Hands-On

GPIO: Interrupt Functionality

External Interrupt – Rising, Falling, Rising or Falling

- ❑ Rising – Rise in Voltage
- ❑ Falling – Fall in Voltage
- ❑ Rising or Falling – Rise or Fall in Voltage

void HAL_GPIO_EXTI_Callback(uint16_t GPIO_Pin)

void HAL_GPIO_EXTI_Callback(Pin Number)

Sample application:

- ❑ Programming almost all sensors,
- ❑ Using sipi tactile switches to perform a certain task e.g. blink an BLUE_LED

Hands-On

Analog-to-digital converter (ADC) in STM32

ADC Conversion Time

- Depends on [Reference manual] of MCU (STM32F411RE)
- ADC samples voltage
- Cycles depends on ADC resolution
- ADC clock, ADCCLK derived from APB2
- Use prescalar to further control ADC clock
- Temperature sensor internally connected to ADC1
- For STM32F411RE, internal temp sensor requires a minimum of 10 µs to work; $T_{conv} \geq 10\ \mu s$.

$$T_{conv} = \frac{\text{sampling time + cycles}}{\text{ADC Clock}}$$ [Reference manual]

Resolution	Normal conversion mode	Fast conversion mode
12 bit	12 cycles	15 cycles
10 bit	10 cycles	13 cycles
8 bit	8 cycles	11 cycles
6 bit	6 cycles	9 cycles

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Analog-to-digital converter (ADC) in STM32

ADC Conversion Time (STM32F411RE)

- 12-bit ADC resolution (15 cycles – fast mode)
- $T_{conv} \geq 10\ \mu s$ eg 12 µs.
- Adjust sampling time, ADC clock values to obtain the target of T_{conv}
- APB2 at 84MHz

$$T_{conv} = \frac{\text{sampling time + cycles}}{\text{ADC Clock}}$$ [Reference manual]

$$\text{sampling time} = (T_{conv} \times \text{ADC Clock}) - \text{cycles}$$

$$\text{sampling time} = (12 \times 10.5) - 15$$

$$\text{ADC clock} = \frac{84}{8} = 10.5\ \text{MHz}$$

$$\text{sampling time} = 111\ \text{cycles}$$

- Prescaler of 8

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Programming Light sensor

Single channel

- Continuous conversion mode
- Interrupts

Task:

- Read ADC values from light sensor
- Visualize light sensor ADC values using a serial terminal
- Low light intensity: turn on blue LED
- High light intensity: turn on red LED

```
//Start ADC with interrupt
HAL_ADC_Start_IT (&hadc1);
```

```
/* INTERRUPT callback function */
void HAL_ADC_ConvCpltCallback(ADC_HandleTypeDef* hadc)
{
        //get the adc value
        LightSensor_val = HAL_ADC_GetValue(&hadc1);
}
```

Get In Touch With Us

Contact Us

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