

KYAMBOGO



UNIVERSITY

Tet la'ngech

Embedded Systems Technology

Second session – 27/08/2024

TETE 3102 MICROCONTROLLERS AND APPLICATIONS

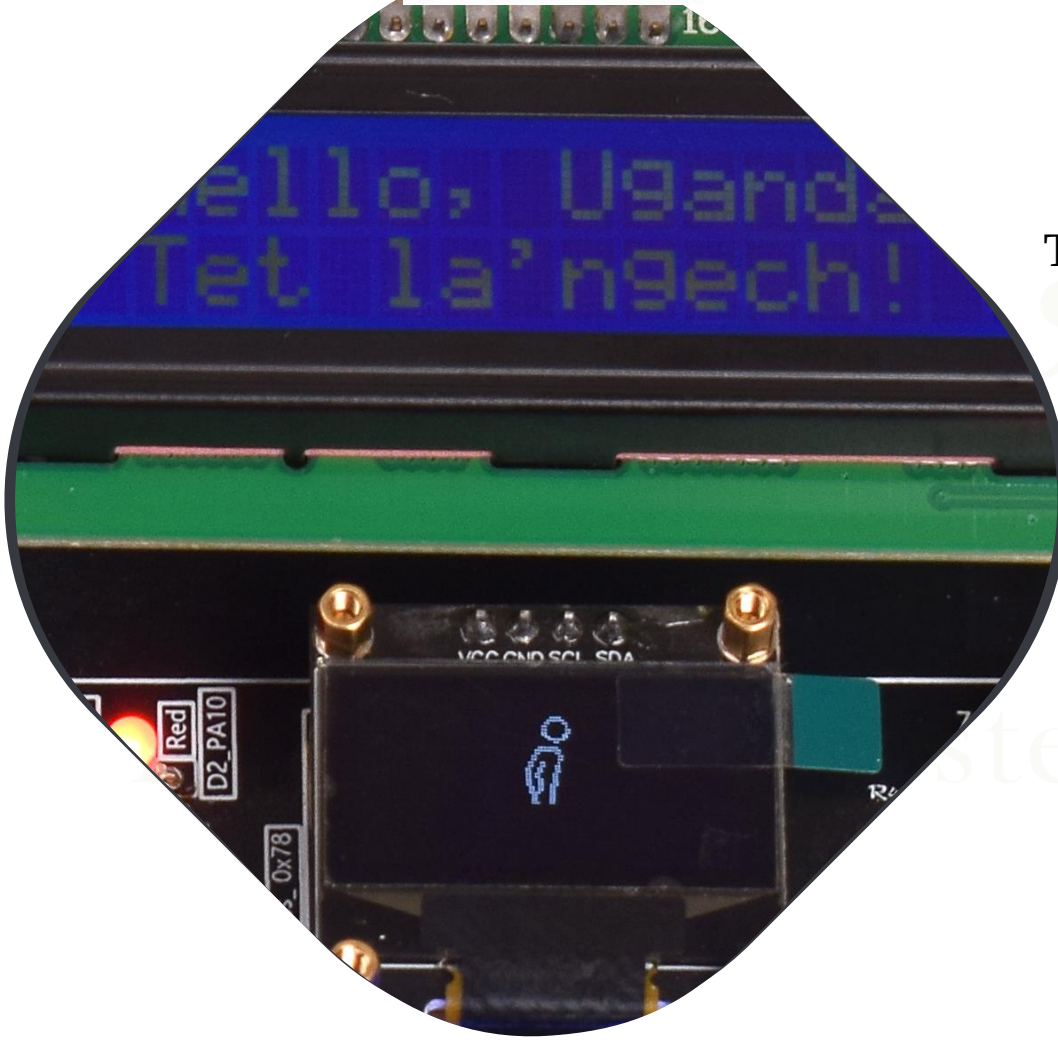
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Prac session: Mr. Matovu Paul

Department of Electrical and Electronics
Engineering

Embedded Systems

360 Degree Perspective on STM32 Firmware, Software and hands on



“Transforming Lives Through Advanced Embedded Systems Technology”



STM32 Tools and Software

- Welcome to today's lecture on the installation of STM32 and other related tools.
- Today, we will explore how to set up a **development environment for STM32 microcontrollers**, which are widely used in embedded systems.
- By the end of this session, you will learn how to install the necessary software, including **IDEs** and toolchains, and configure them to begin your journey in microcontroller programming.
- This hands-on experience will give you the foundation to start creating your own projects using STM32 and similar devices.

Let's dive in and get started!



STM32 Tools and Software

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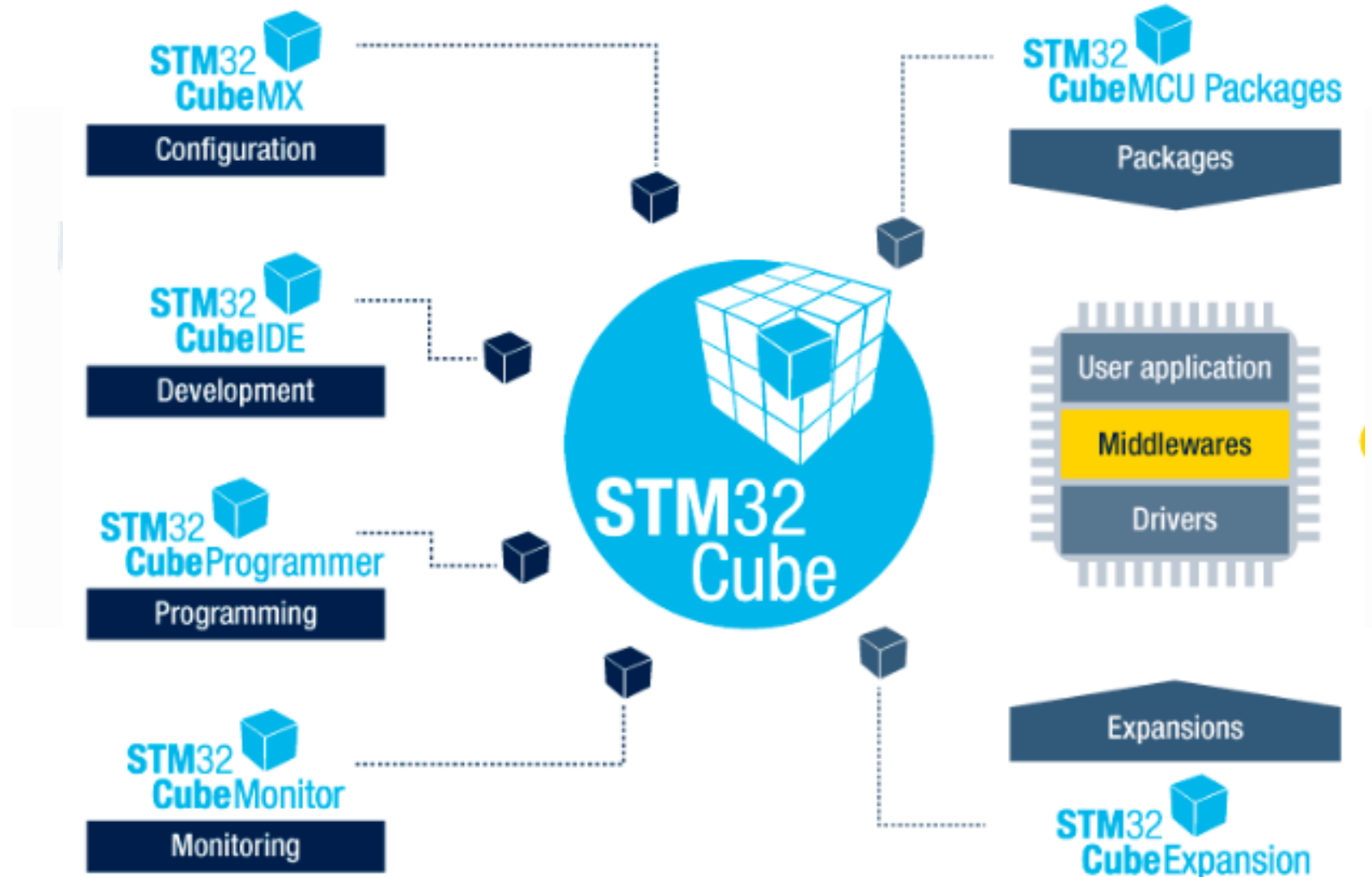
Software Tools



Embedded Software



Complemented
Microsoft Azure





STM32CubeMX & STM32 IDEs

- ❑ Initial project configurations (STM32CubeMX)
- ❑ Why choice of STM32CubeIDE
- ❑ Nowadays, everything is embedded in STM32CubeIDE



STM32 IDEs



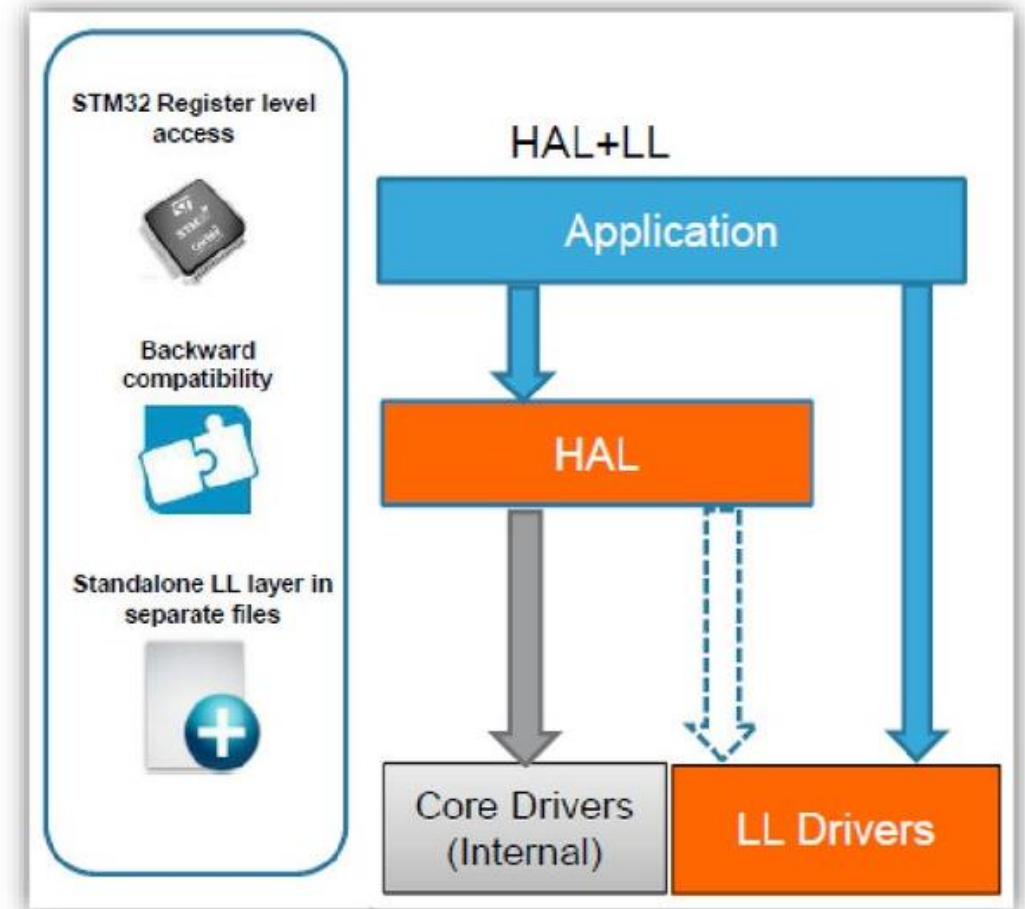


Libraries for STM32

- ❑ Libraries normally contain source (.c) and header (.h) files for programming STM32 microcontrollers

Options Available

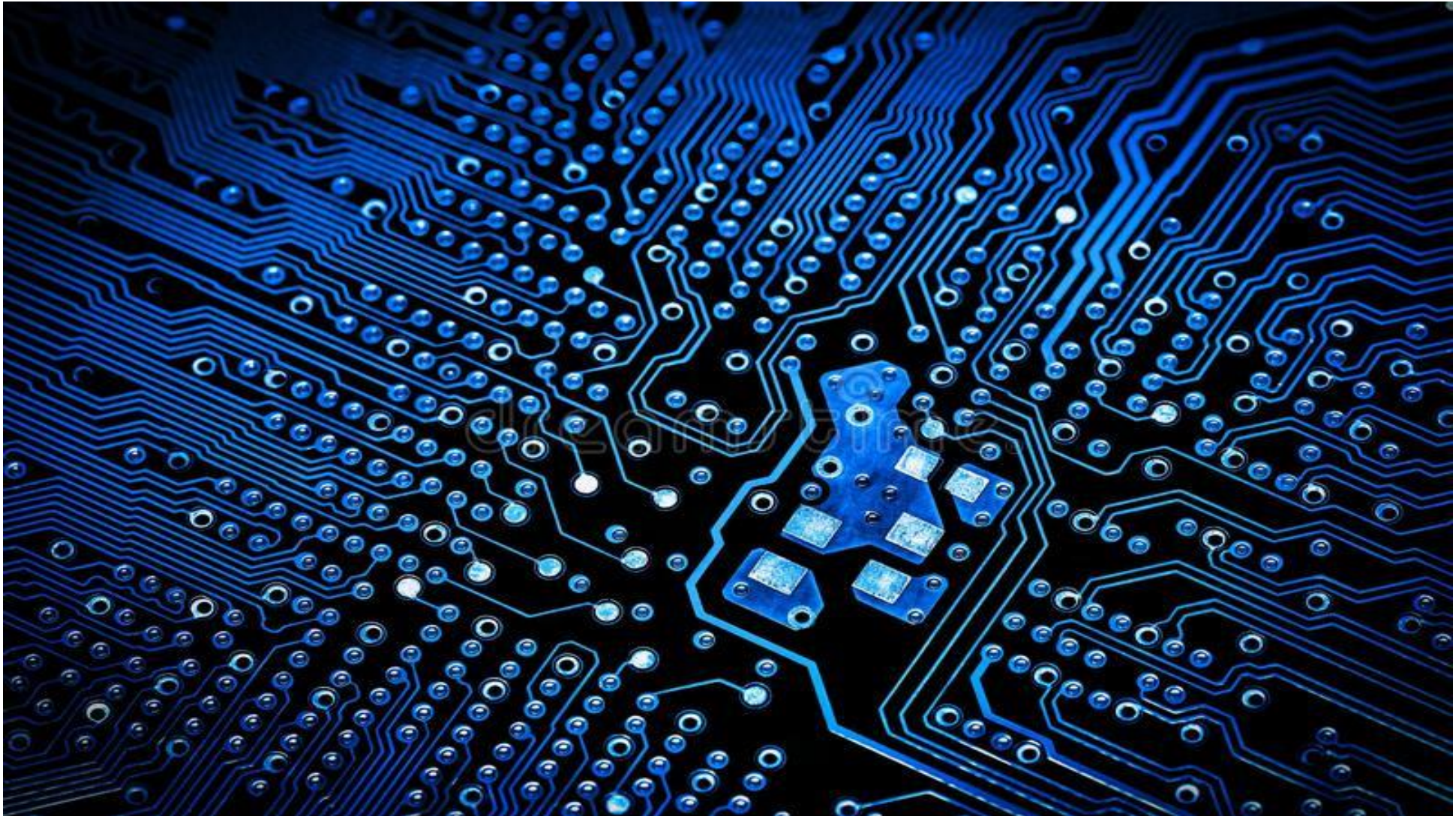
- ❑ Hardware Abstraction Layer (HAL)
- ❑ Low Level Layer (LL)
- ❑ Board Support Package (BSP)
- ❑ Register Based Programming





What can you do with STM32?

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Common Data Types

Common data types available for stm32 microcontrollers

1. Char

- ❑ Character eg `char somevariable = 'a';`
- ❑ Many characters eg `char manychar [5] = "Hello";`

2. Signed: `int8_t`, `int16_t`, `int32_t`, `int64_t`

- ❑ Both positive and negative integers
- ❑ `int8_t` ($2^8 = 256$, $256/2 = 128$).
- ❑ Eg `int8_t` used for integers that range between -128 & 128

3. Unsigned; `uint8_t`, `uint16_t`, `uint32_t`, `uint64_t`

- ❑ Only positive integers. `uint16_t` ($2^{16} = 65,536$).
- ❑ Eg `uint16_t` used for integers that range between 0 & 65,535



Installations for STM32

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- ❑ Create an account to download software from stm32 website

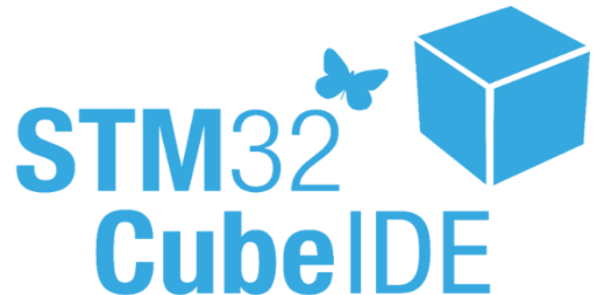
https://www.st.com/content/st_com/en.html

- ❑ Download STM32CubeIDE & STM32CubeProgrammer

<https://www.st.com/en/development-tools/stm32cubeide.html>

<https://www.st.com/en/development-tools/stm32cubeprog.html>

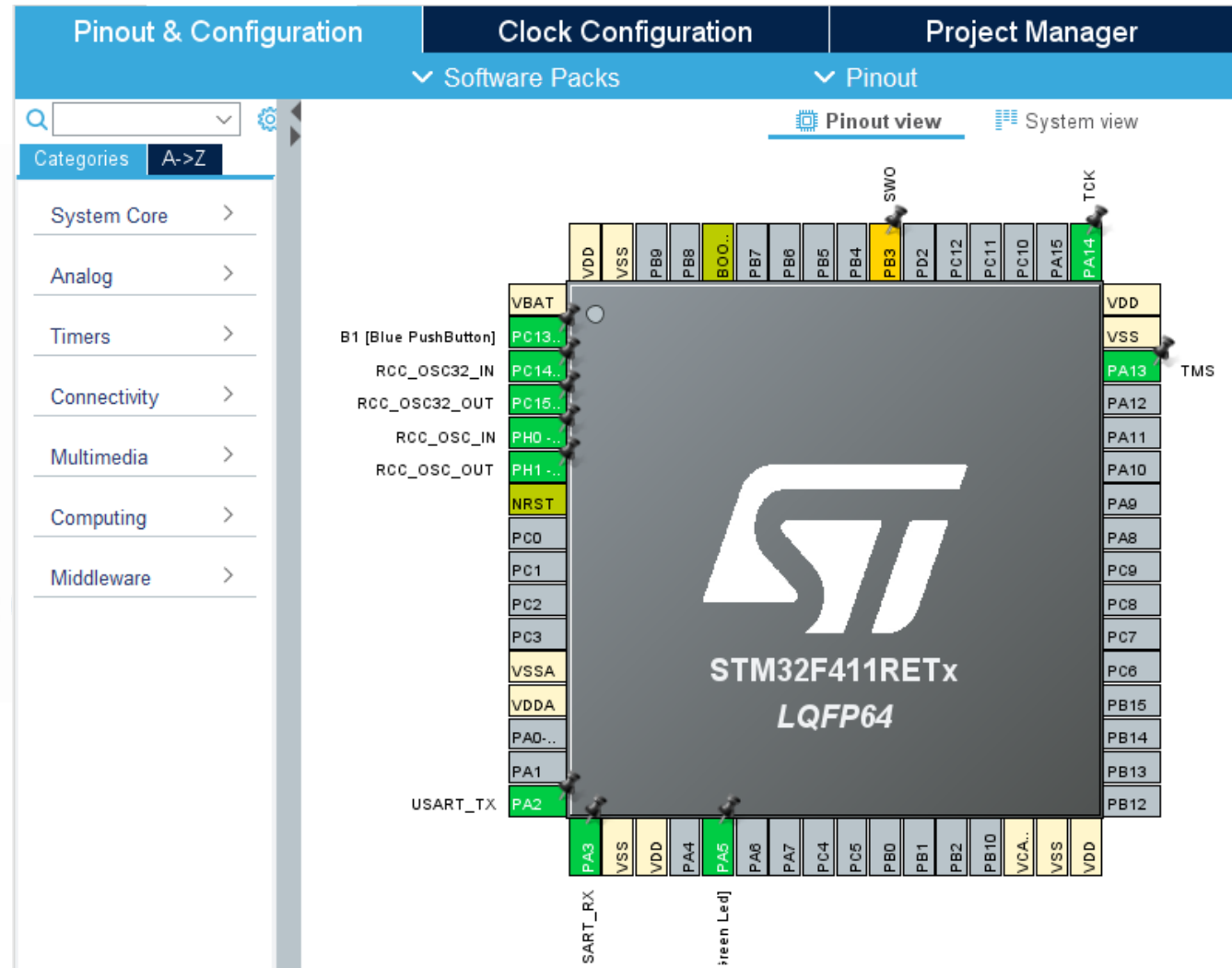
- ❑ STM32CubeMx: a tool to set and graphically program all STM32 boards and products
- ❑ STM32CubeIDE: The free IDE to develop STM32 software
- ❑ STM32CubeProgrammer: a tool to load/spy software in STM32 memory





1. Device Configuration perspective

- ☐ Select microcontroller
- ☐ Set pinouts configuration
- ☐ Select STM32 Peripherals
- ☐ Configure initial settings
- ☐ Generate Code





2. Programming perspective

- ☐ Program stm32 microcontroller
- ☐ Everything Performed during initial configuration is turned into code
- ☐ main file (main.c)
- ☐ Program flow in main.c
- ☐ Header files (.h files)
- ☐ Why build/compile (C/C++ faster than other programming languages)

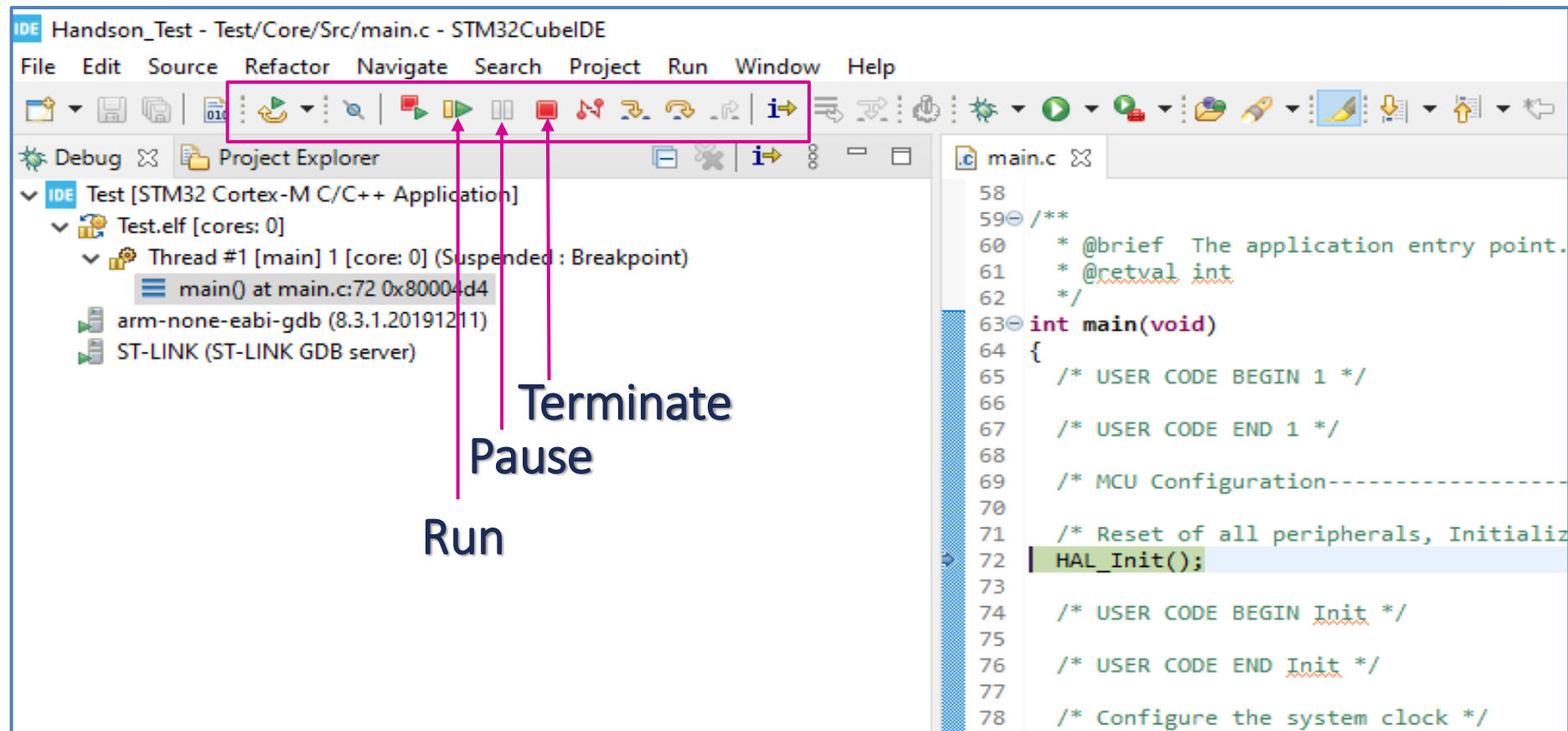
The screenshot displays the STM32CubeIDE IDE. The title bar reads 'IDE Handson_Test - F4_Blink_LED/Core/Src/main.c - STM32CubeIDE'. The menu bar includes File, Edit, Source, Refactor, Navigate, Search, Project, Run, Window, and Help. The toolbar contains various icons for file operations, editing, and running. The Project Explorer on the left shows a tree structure with folders like Binaries, Includes, Core, Inc, Src, Startup, Drivers, and Debug. The 'main.c' file is selected in the 'Src' folder. The main editor window shows the code for 'main.c' with line numbers 61 to 80. The code includes a brief description, a return type, and the start of the main function.

```
61 /**
62  * @brief The application entry point.
63  * @retval int
64  */
65 int main(void)
66 {
67     /* USER CODE BEGIN 1 */
68
69     /* USER CODE END 1 */
70
71     /* MCU Configuration-----
72
73     /* Reset of all peripherals, Initializes the Flash
74     HAL_Init();
75
76     /* USER CODE BEGIN Init */
77
78     /* USER CODE END Init */
79
80     /* Configure the system clock */
```



3.Debug Perspective

□ Run, Pause, terminate program. ➔ Break points to check status of program





Blink On-board LED

❑ Toggle (Blink) – Change the status of a GPIO pin

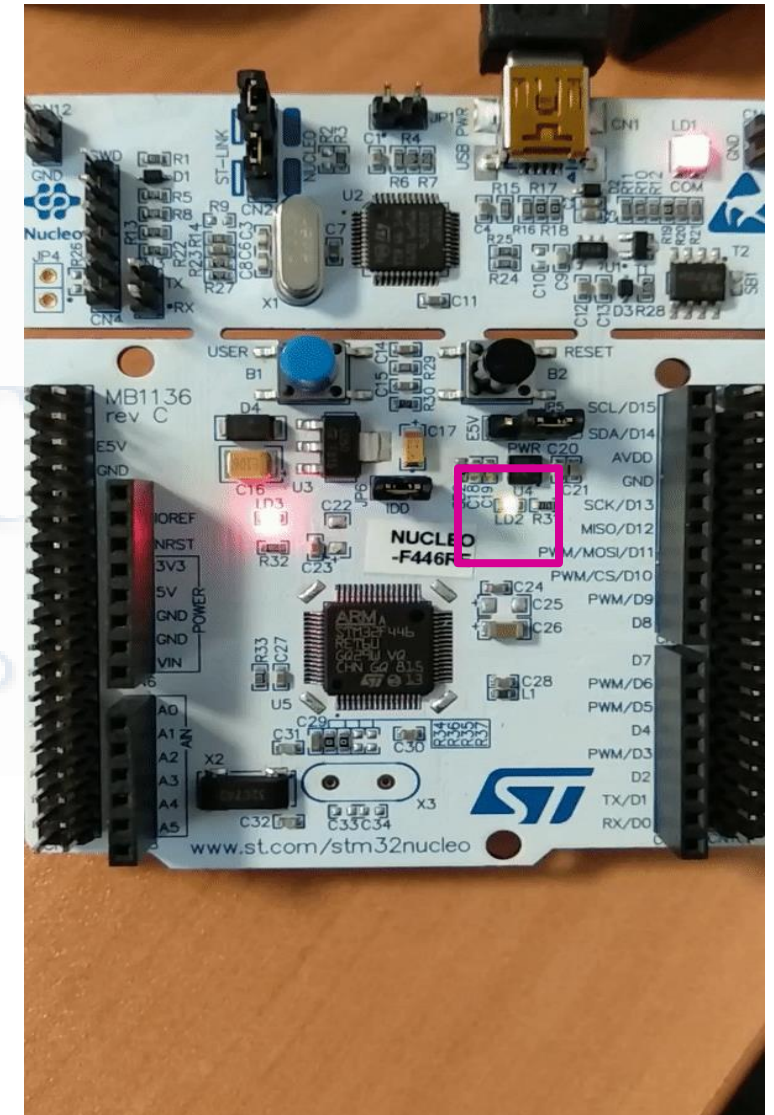
HAL_GPIO_TogglePin(GPIO_TypeDef* GPIOx, uint16_t GPIO_Pin)

HAL_GPIO_TogglePin(Port Number, Pin Number)

❑ Sample application: Blink LED (Turn LED on & off)



Hands-On



Quick Getting Started – Turn LED on & off



- ☐ Open project
- ☐ Close project
- ☐ Switch workspace
- ☐ Export project
- ☐ Import project
- ☐ Project properties
- ☐ User code
- ☐ Location of firmware & drivers
- ☐ Show project in file system
- ☐ Active project
- ☐ Clean, Build





- ☐ Examples provided by STM32
- ☐ How to load STM32 examples
- ☐ Post build files (.bin, .hex files) setting
- ☐ Reset perspective
- ☐ Debugging tools (Breakpoint, step-over, step-into, terminate, suspend, etc)
- ☐ Updates (STM32cubeide , firmware packages)
- ☐ Live Expressions





STM32CubeProgrammer

- ❑ A tool to load/spy software in STM32 memory
- ❑ Software loads code to target STM32 MCU through ST-Link debugger
- ❑ Upgrade firmware for ST-Link
- ❑ Erase data from STM32 MCU
- ❑ Set various code protection levels
- ❑ Efficient tool for custom & mass production of PCBs

The screenshot displays the STM32CubeProgrammer application window. The main interface is titled "Memory & File editing" and features a "Device memory" tab. A table shows memory addresses and their corresponding data in hexadecimal and ASCII. The table has columns for Address, 0, 4, 8, C, and ASCII. The data is as follows:

Address	0	4	8	C	ASCII
0x08000000	20000560	08002391	08002139	0800213B	` . . . # . . 9 ! . . ; ! . .
0x08000010	0800213D	0800213F	08002141	00000000	= ! . . ? ! . . A !
0x08000020	00000000	00000000	00000000	08002143	 C ! . .
0x08000030	08002145	00000000	08002147	08002149	E ! G ! . . I ! . .
0x08000040	080023FD	08002401	08002405	08002409	ý # . . . \$. . . \$. . . \$. .
0x08000050	0800240D	08002411	08002415	08002419	. \$. . . \$. . . \$. . . \$. .
0x08000060	0800241D	08002421	08002425	08002429	. \$. . ! \$. . % \$. . .) \$. .
0x08000070	0800242D	08002431	08002435	08002439	- \$. . ! \$. . . 5 \$. . . 9 \$. .

The right sidebar shows the "ST-LINK configuration" panel with various settings like Serial number, Port, Frequency, Mode, Access port, Reset mode, Speed, and Shared. The "Target information" panel at the bottom right displays details about the target device, including Board (NUCLEO-F411RE), Device (STM32F411xC/E), Type (MCU), Device ID (0x431), Revision ID (Rev A), Flash size (512 KB), CPU (Cortex-M4), and Bootloader Version (0xD0).

Hands-On



The Internet has everything:

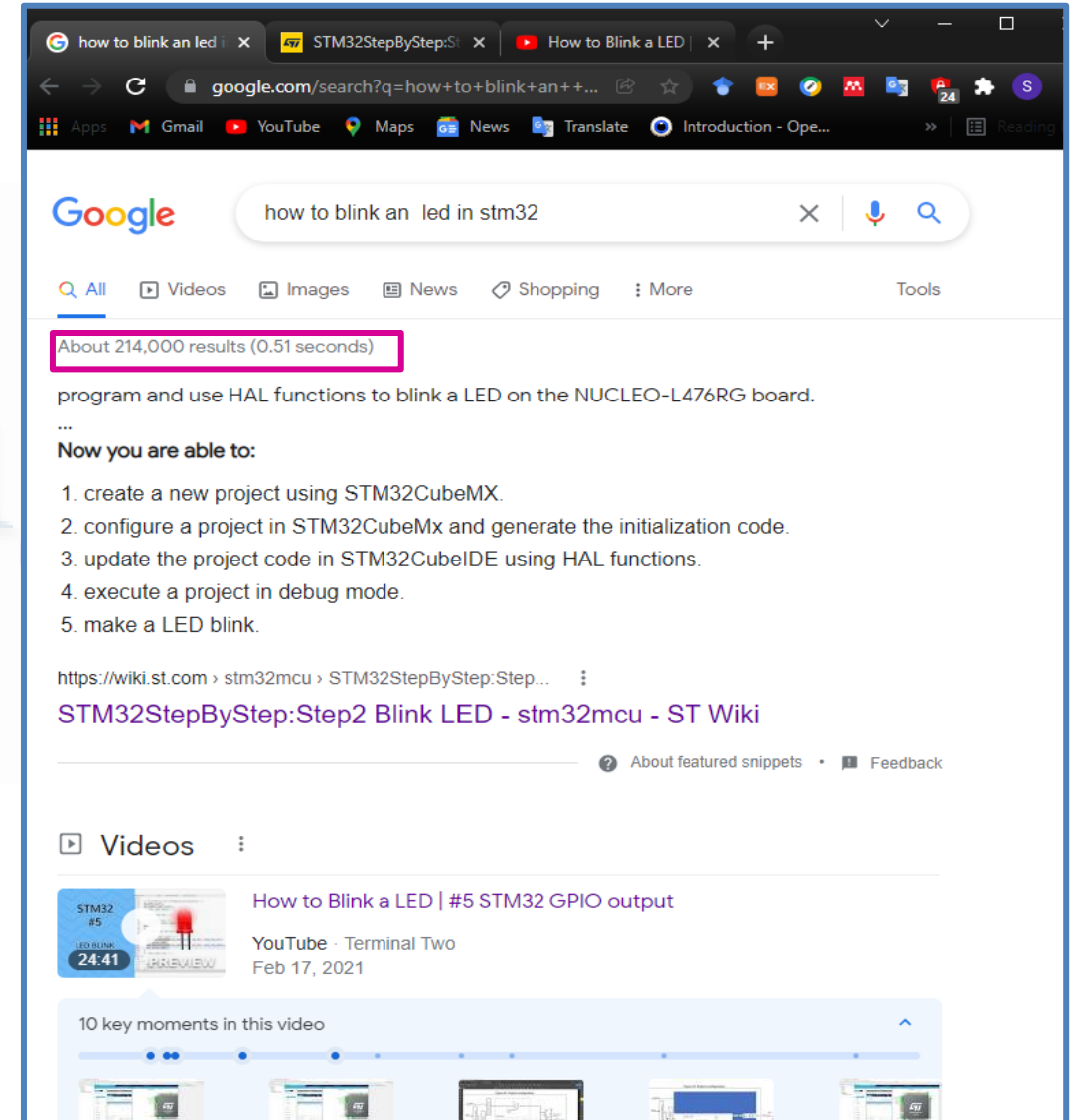
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Copilot/Google/Chatgpt/YouTube it

❑ Give a man a fish, you feed him for a day.

Teach him to fish, and you feed him for life.

❑ The internet has everything, you can get most of the code to guide you.





Task: Trainees

- ☐ Blink the LED five times every second

Details:

- ☐ Blink the LED five times every second.
- ☐ Use a delay of one minute between the blinks.
- ☐ Get familiar with sippi

Contact Us

Get In Touch **With Us**



Contact **Us**

For more information and inquiries



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