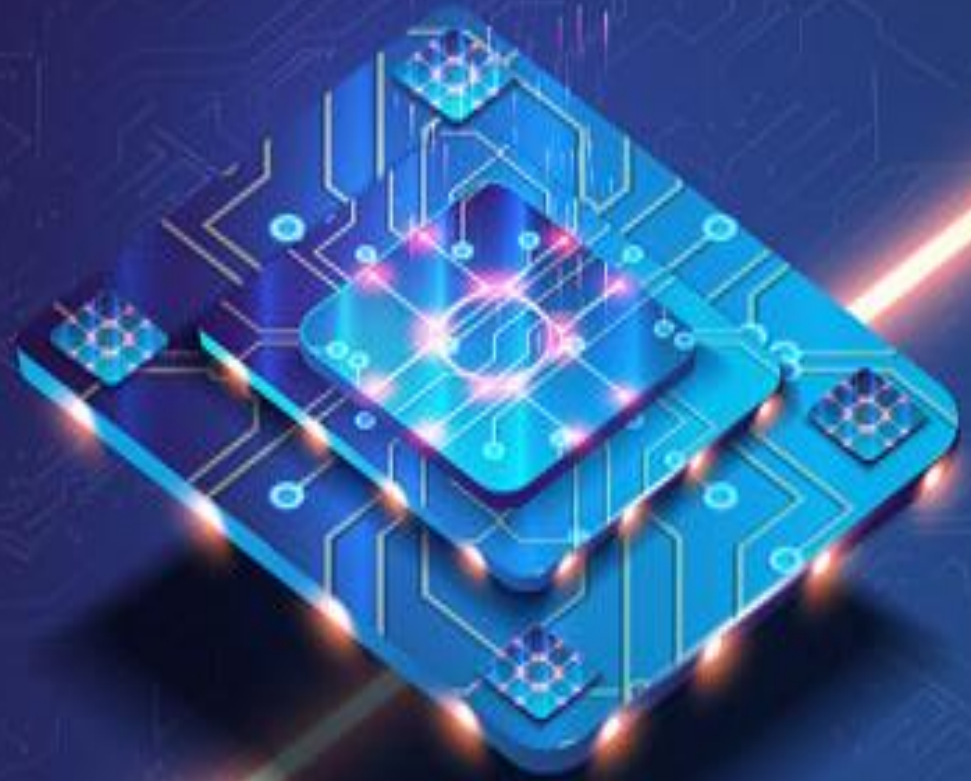
EMBEDDED SYSTEMS



By:

Mohamed Yanis Hiou

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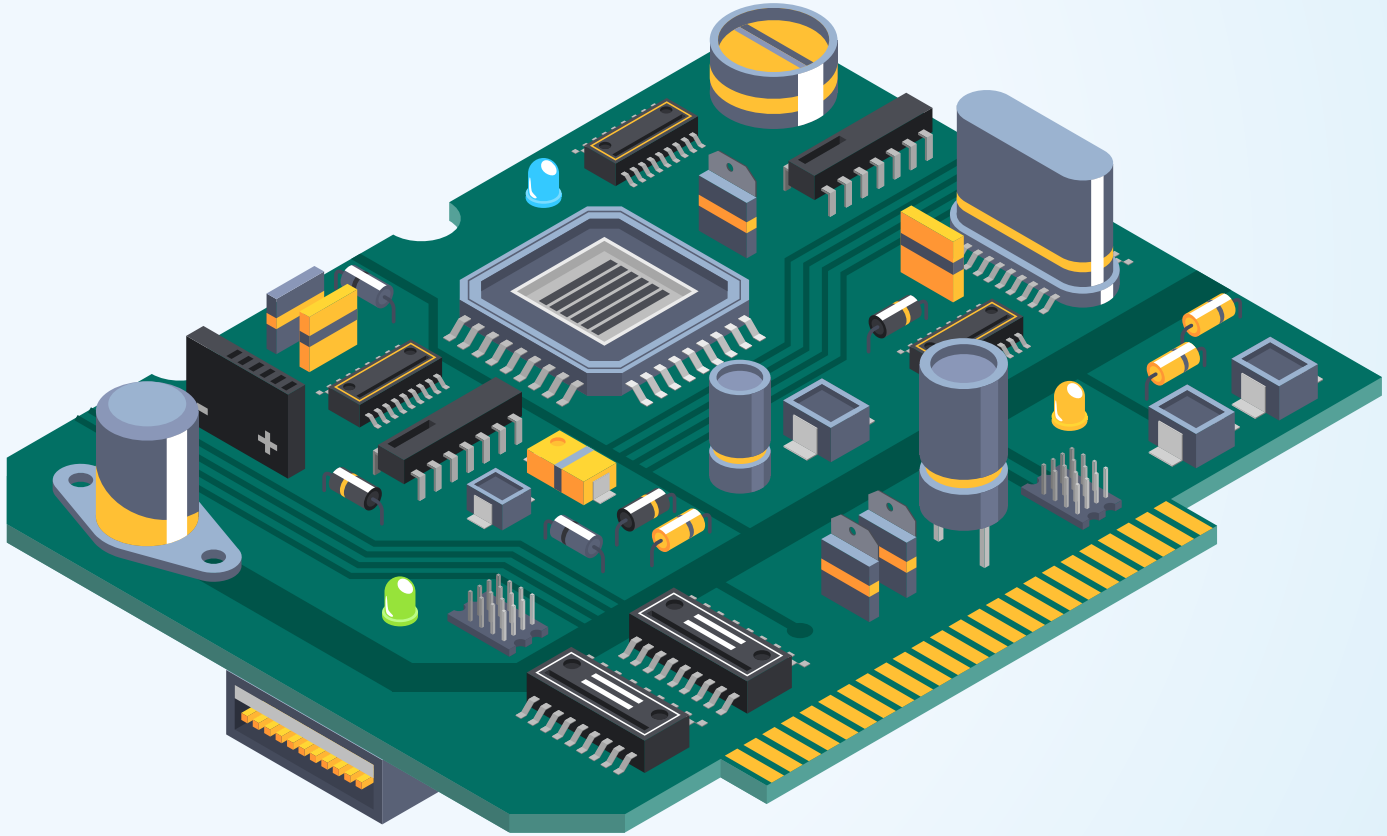
What is an Embedded System ?



An Embedded System is

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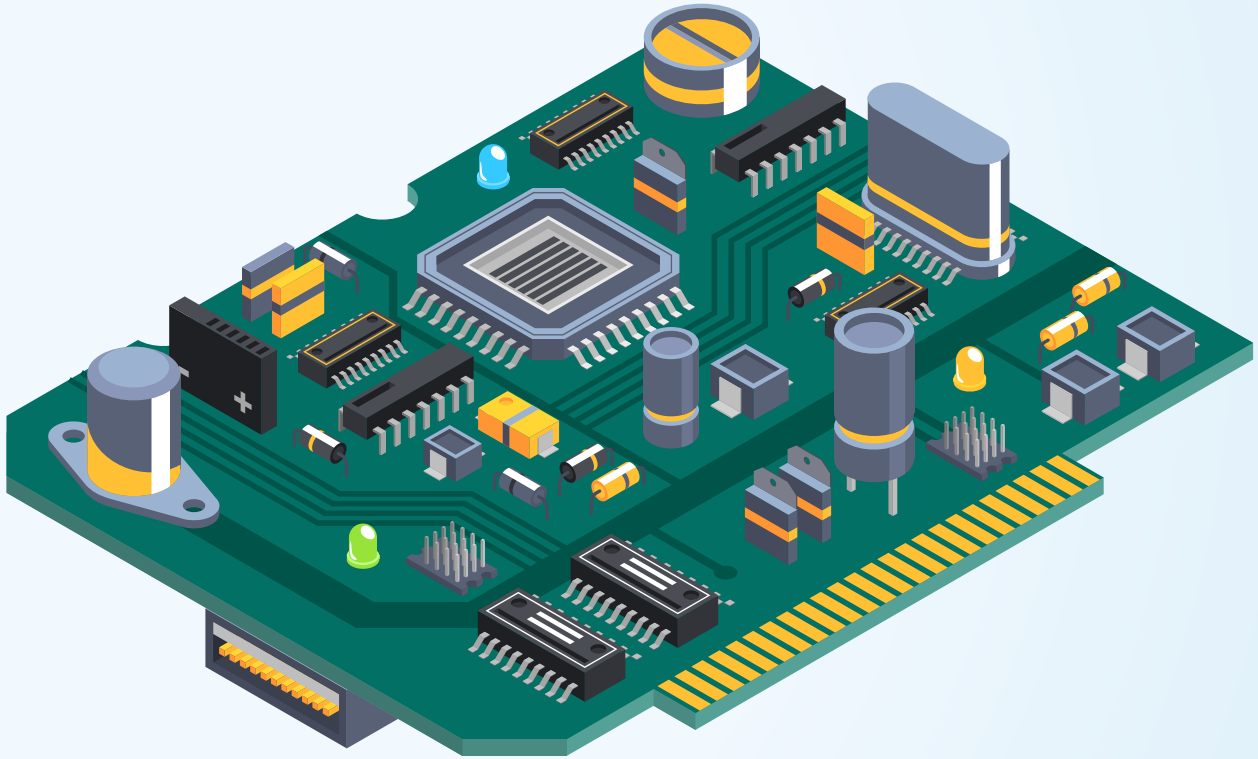
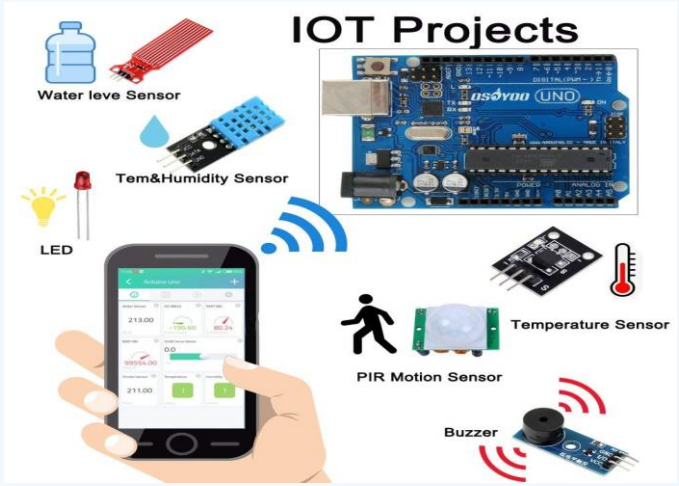
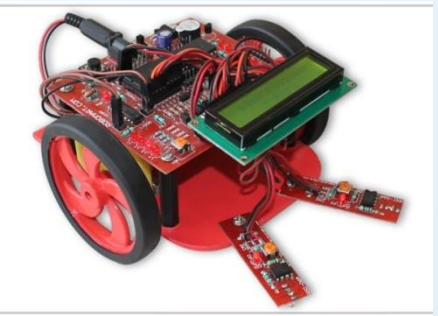
As the name implies, it is a combination between hardware and software that are integrated to perform a particular function.
It uses
a Microcontroller/Microprocessor to perform a single job. It is a stand-alone device with or without an operating system.



Embedded System applications

- Smart Homes
- Offices
- Transportation
- Healthcare
- Industrial world
- Aerospace and Defense





Embedded System Software & Hardware

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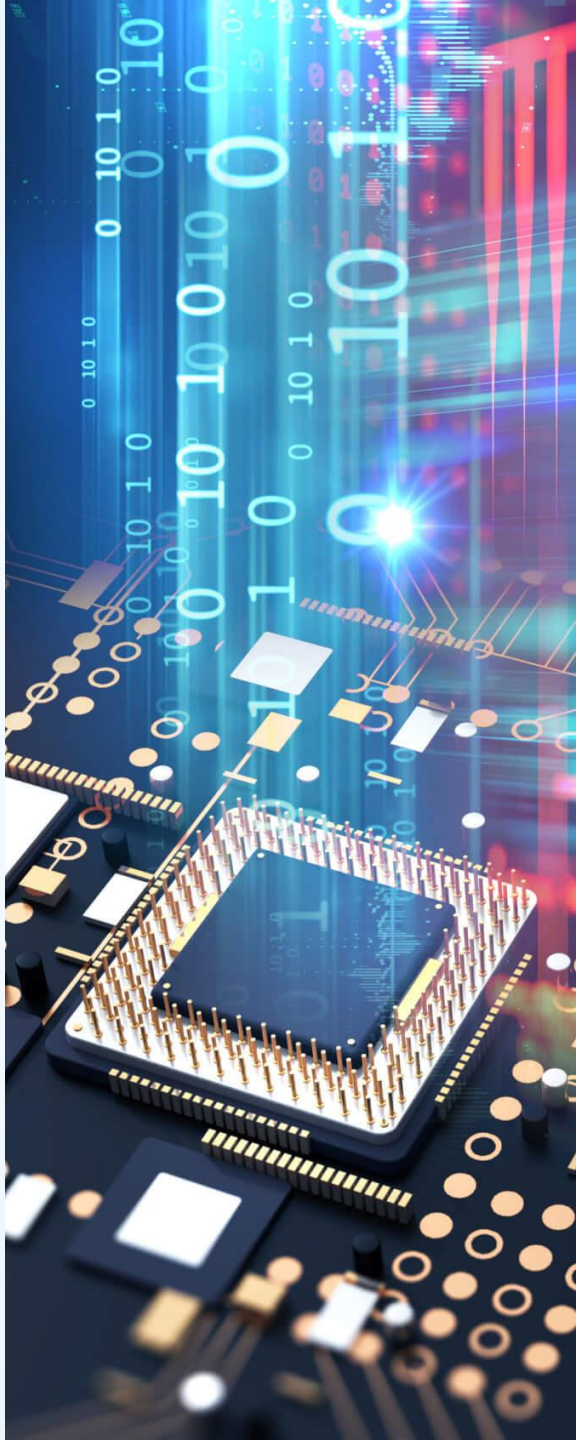
Every complex system in the world can be made based on Software and Hardware.

To achieve that you have to start building smaller modules and integrate them to create an efficient subsystem.

The embedded system can be divided into software and hardware components



Embedded Hardware

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The core of any embedded target is the electronic hardware – which resides on a Printed Circuit Board.
The embedded development board is divided into five modules. They are Processor, Memory, Input devices, Output devices, and Bus controllers

Embedded Hardware

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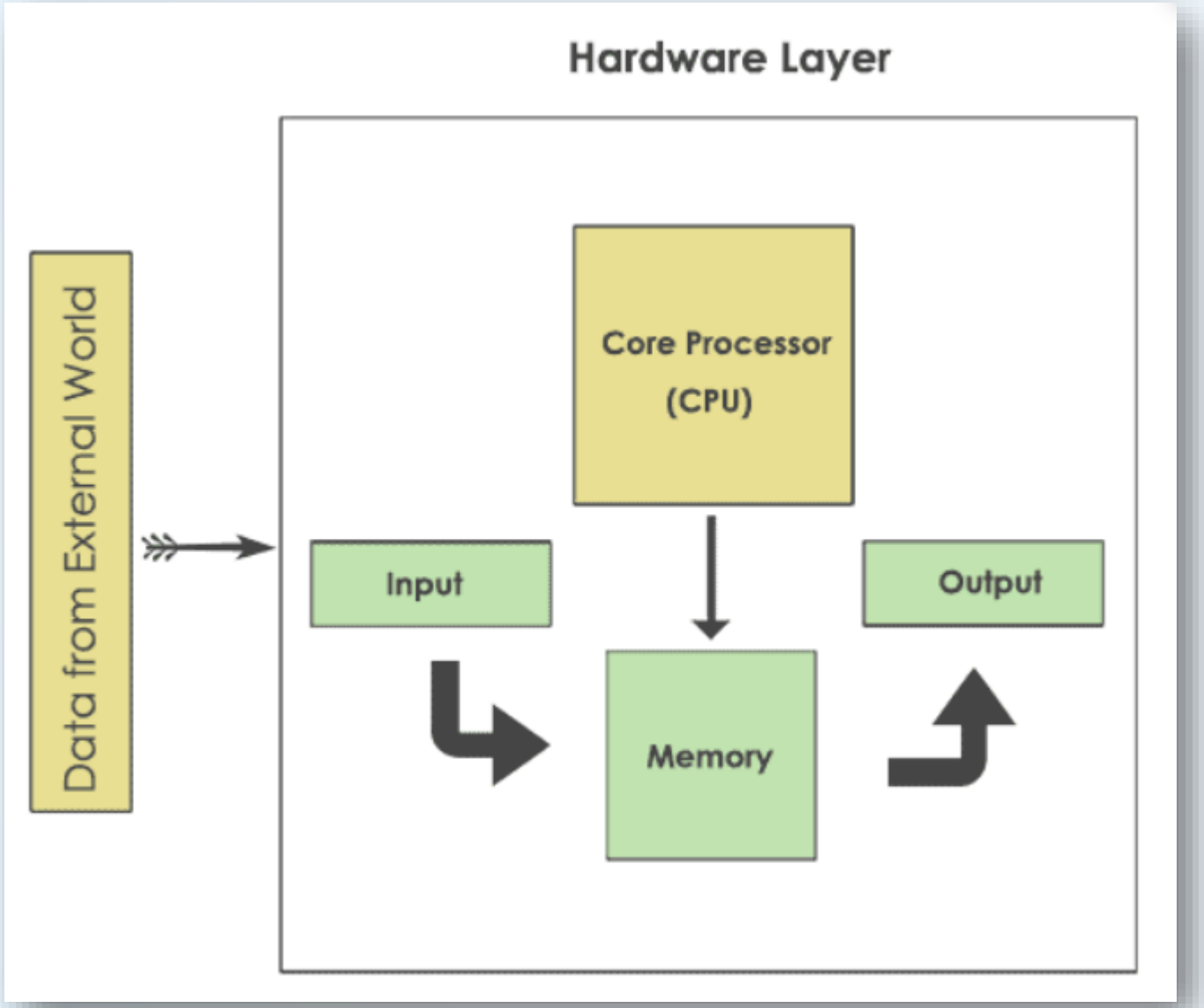

Embedded Hardware

ELECTRO CLUB

Hardware abstraction layer (HAL) is the fundamental resource of any embedded device and choosing a particular component depends on the requirement and specification of the designer. In the global market, there are many variants of hardware produced for different applications. Some of them are:

- Microcontroller
- System on Chip (SoC)
- ASIC processor
- DSP processor
- Output Devices
- Input Devices
- Bus controllers

Embedded Software

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Embedded software is computer software, written to control machines or devices

Embedded Software

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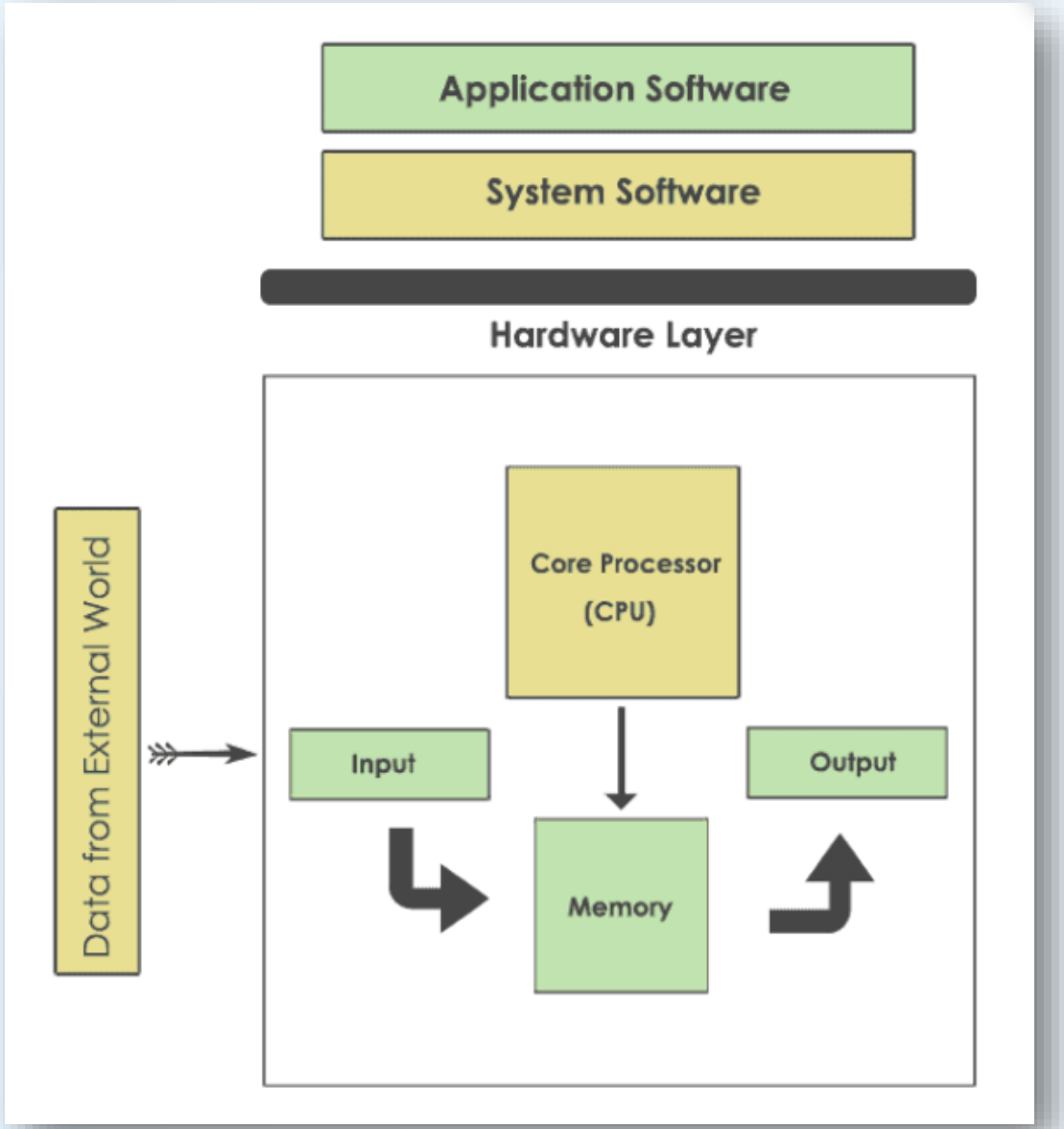
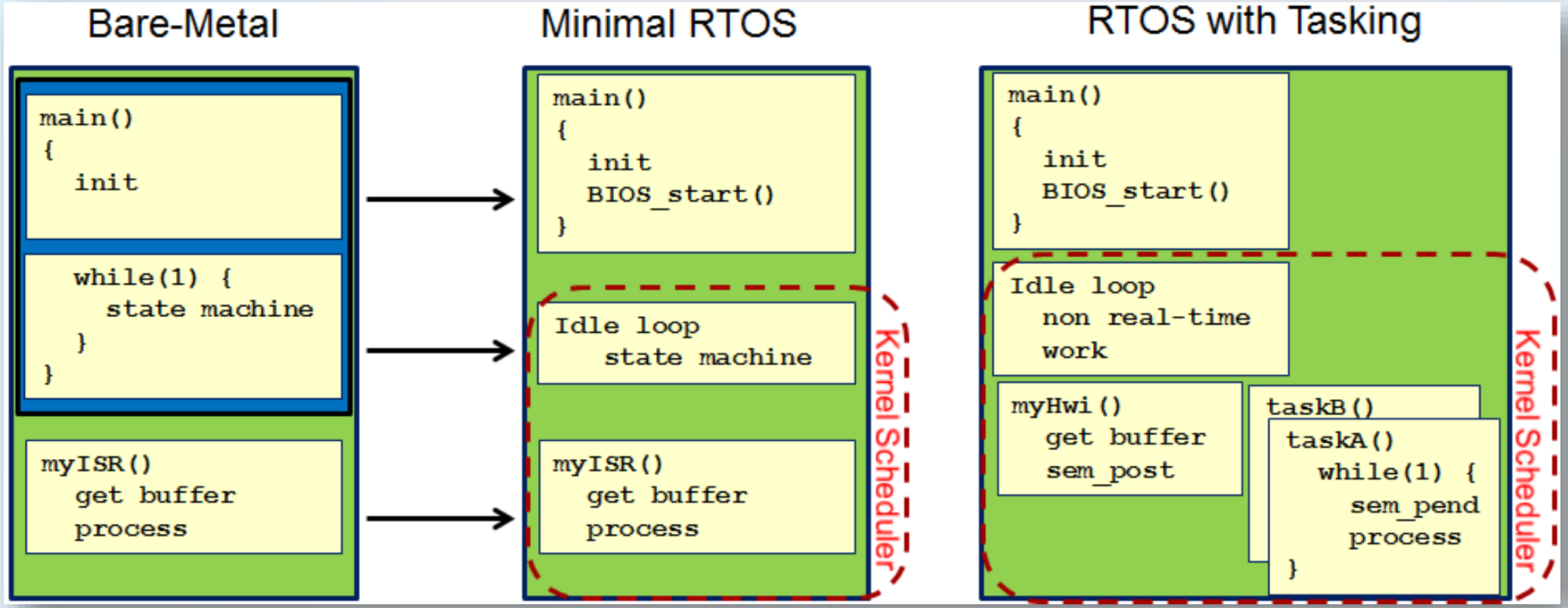


Embedded Software Type



Embedded Software Development Life Cycle

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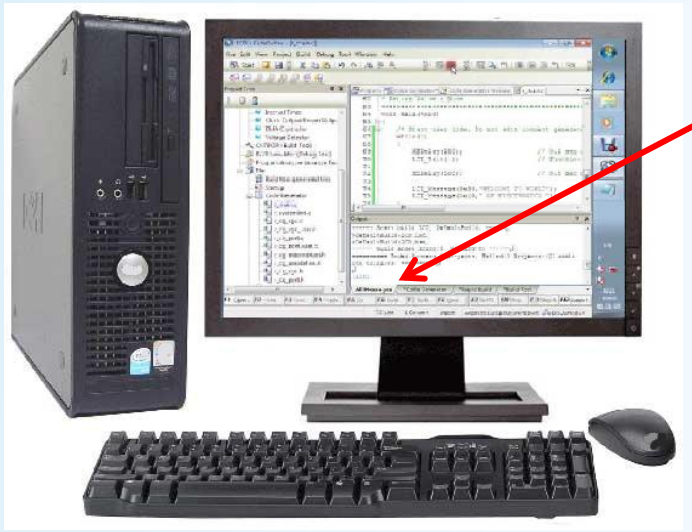
- Step 1: Understand the requirements
- Step 2: Examine
- Step 3: Design
- Step 4: Develop
- Step 5: Test
- Step 6: Deploy
- Step 7: Support and Upgrade

Development

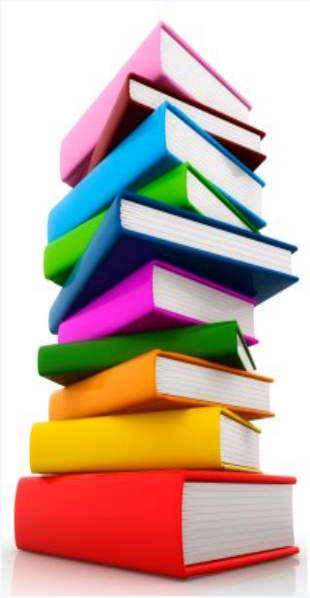


Tools user's guide

- Getting Started
- Release Notes
- Complete Users Guide Selection

Board Books

- Development board Reference manual
- Getting started
- Quick Start Guide
- Schematic
- User-manual
- .....



Device Data Books

- Data sheet
- Schematic
- Reference manual
- AN
- ------

What's a Microcontroller?

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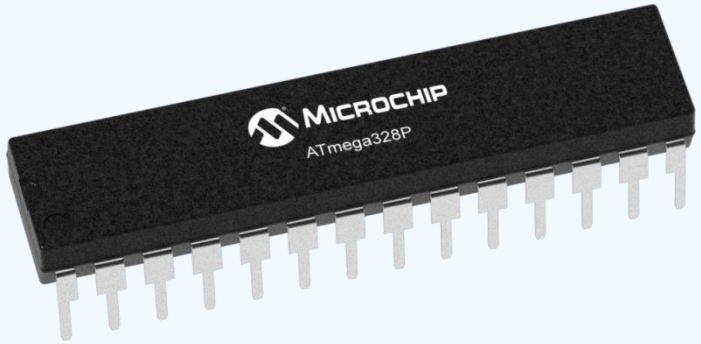
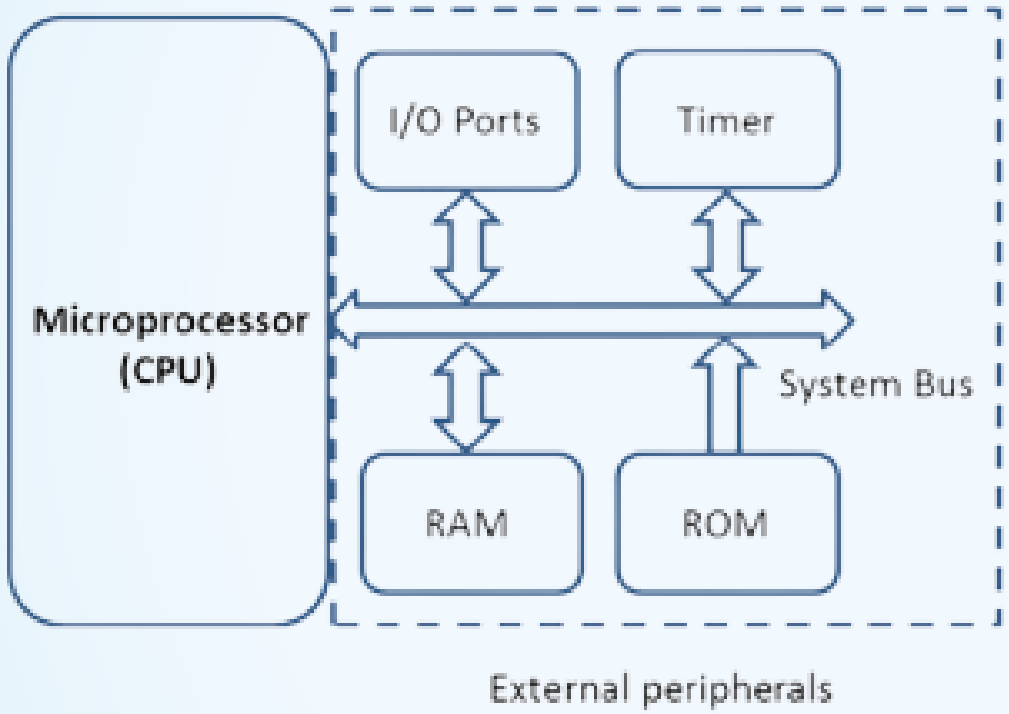
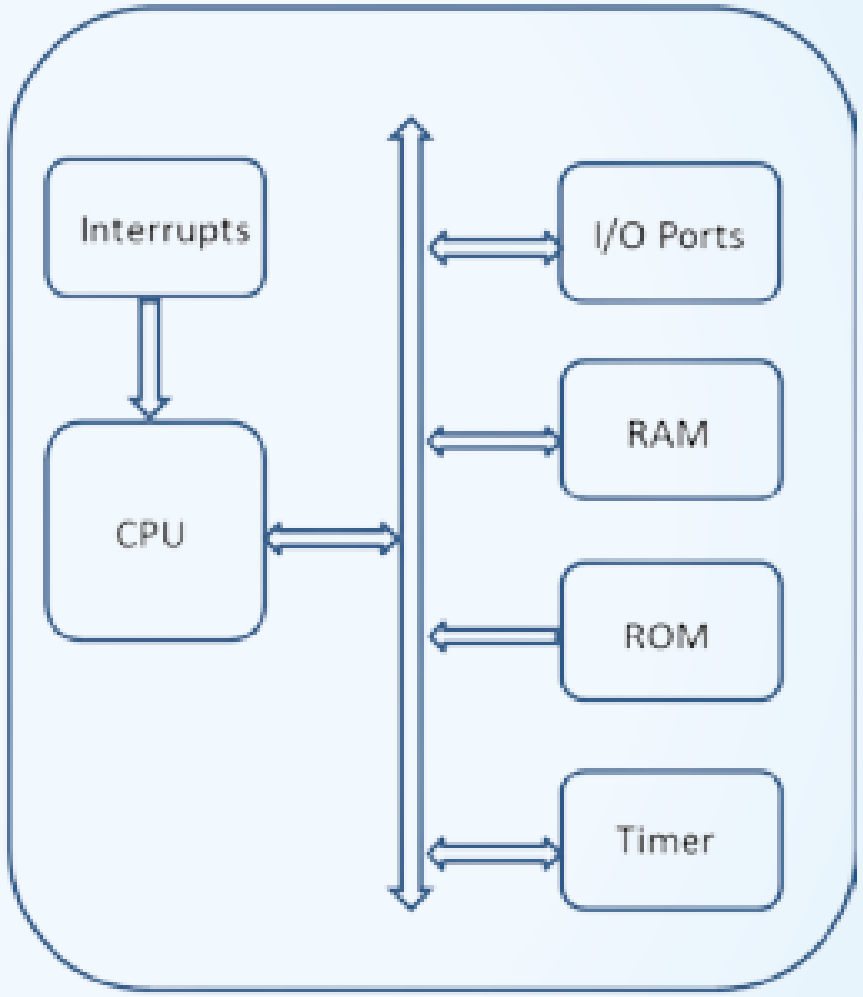
A Microcontroller or an **MCU** is a small computer that contains **RAM**, **ROM**, **Flash Memory**, and other **Peripherals** all in a single **Integrated Circuit (IC).**



A Microcontroller have **very limited hardware!**
So they generally run a **Single Program** and are used for **Specific Purposes** applications.

MPU vs MCU





Micro-Processor

Micro-Controller

What's a Development Board?

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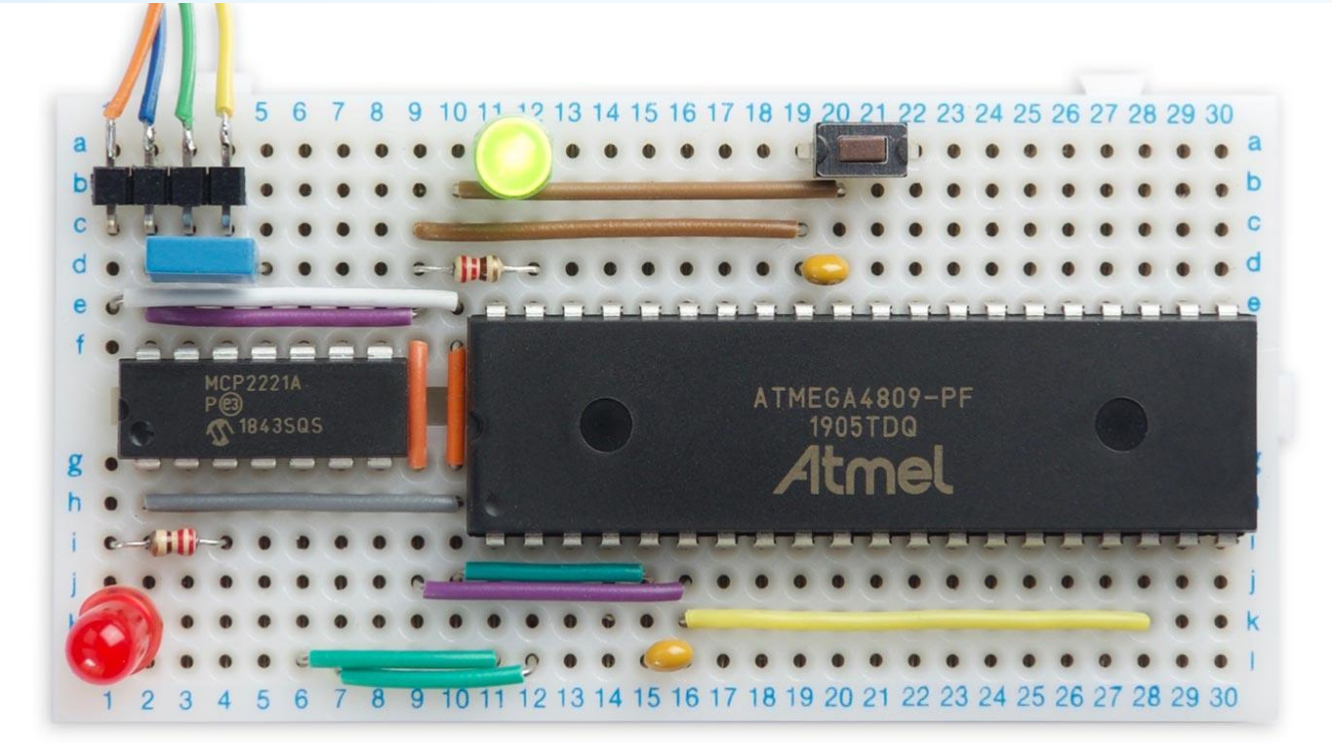
The **Dev Board** is meant for hobbyists and for people who don't have background in **Electronics**. Without a development board, you'll have to do this:



Which is already a too **Steep Learning Curve** for begginers.

Fast Prototyping

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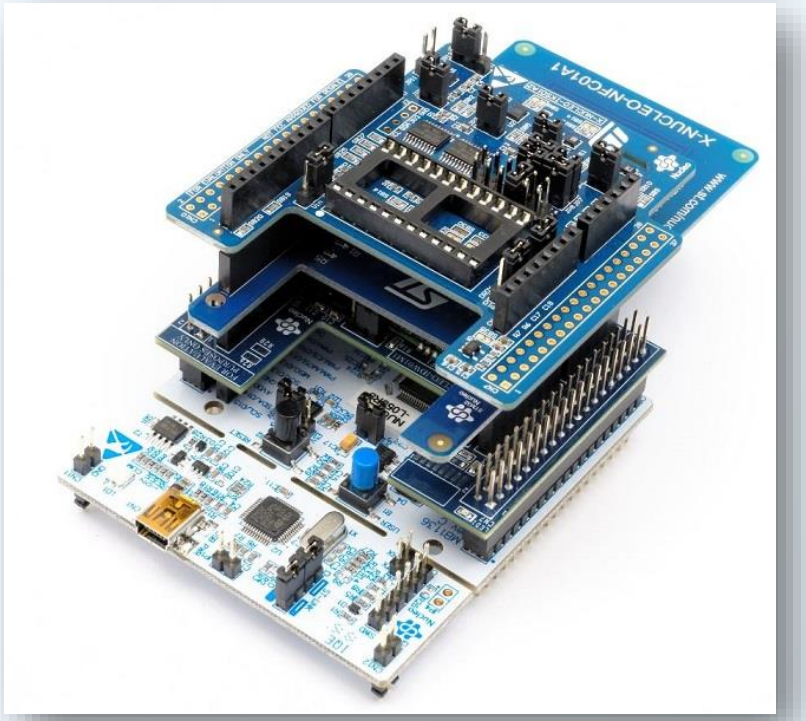
This concept of rapid prototyping based on the reuse of what already exists helps designers and system integrators to develop ideas through assembled modules (shield) on the basis of a Prototype Board



STM32 Hardware Toolkit

ELECTRO CLUB

STM32 Nucleo development boards

Flexible prototyping

Discovery kits

Key feature prototyping

Evaluation boards

Full feature evaluation

STM32 Nucleo expansion boards

Add-on functionalities

Accessories for STM32 boards

Add-on functionalities

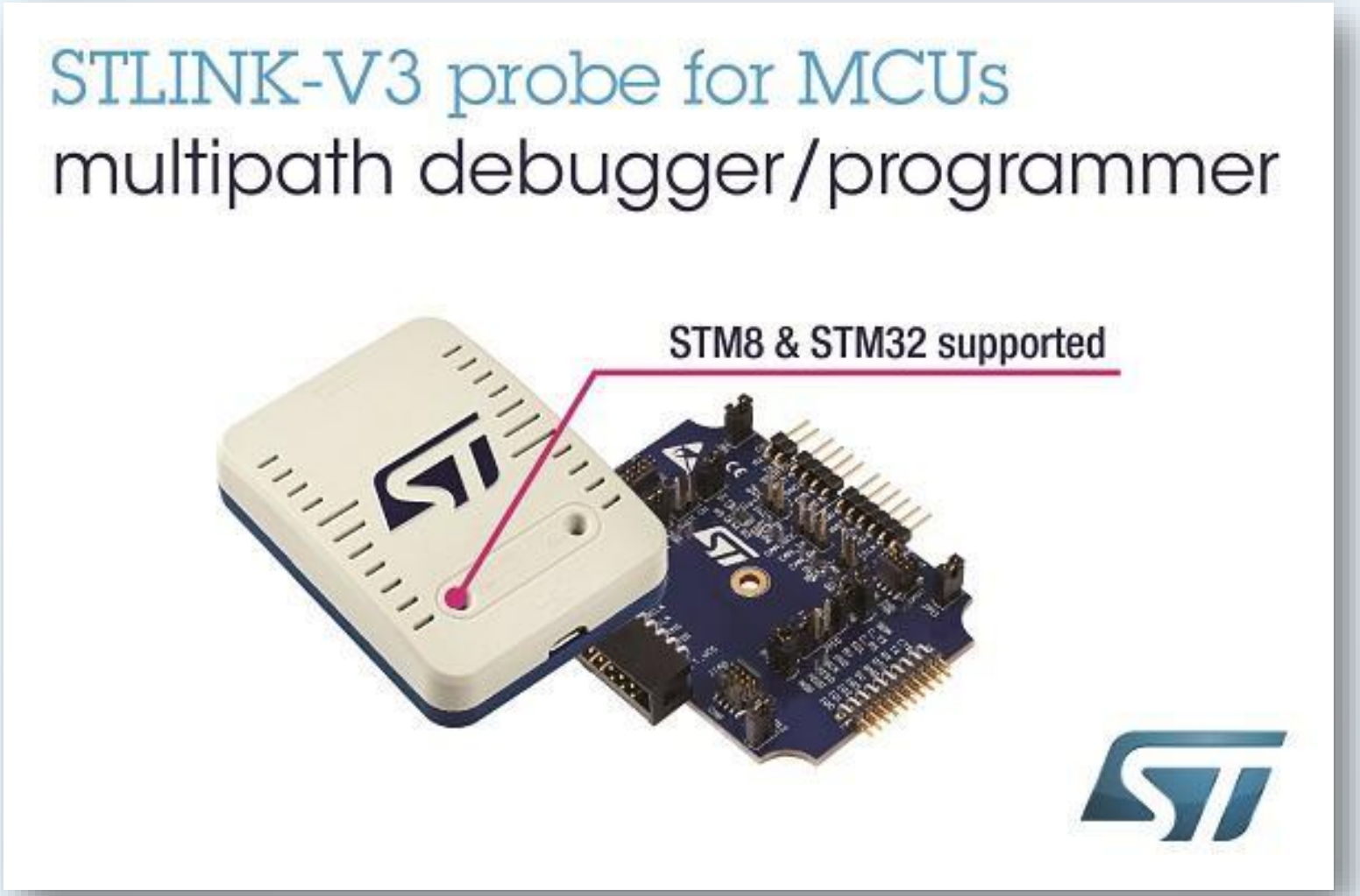
Partners boards

From full evaluation to open hardware

STM32 Hardware Toolkit

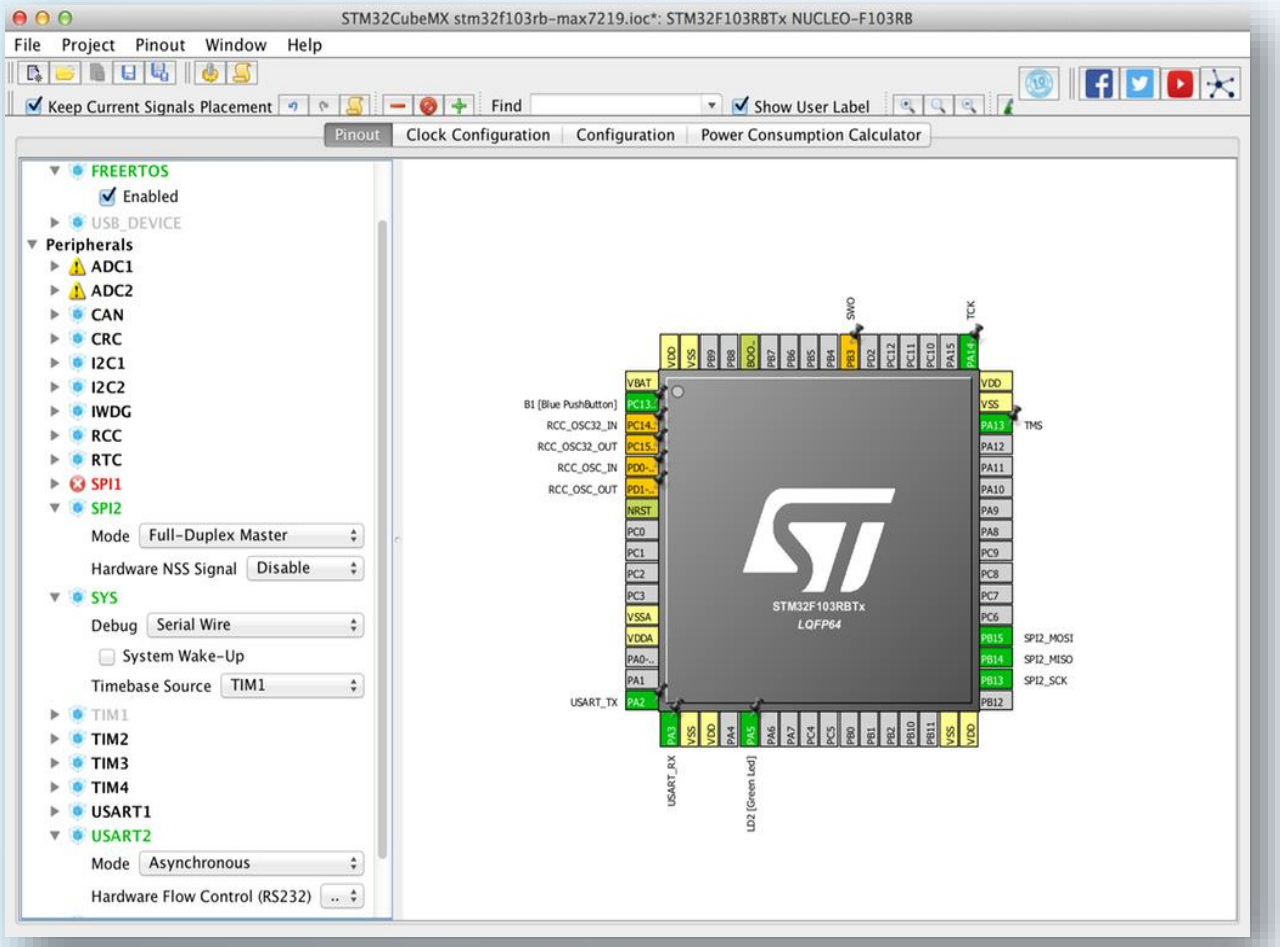
STM32 Hardware Toolkit

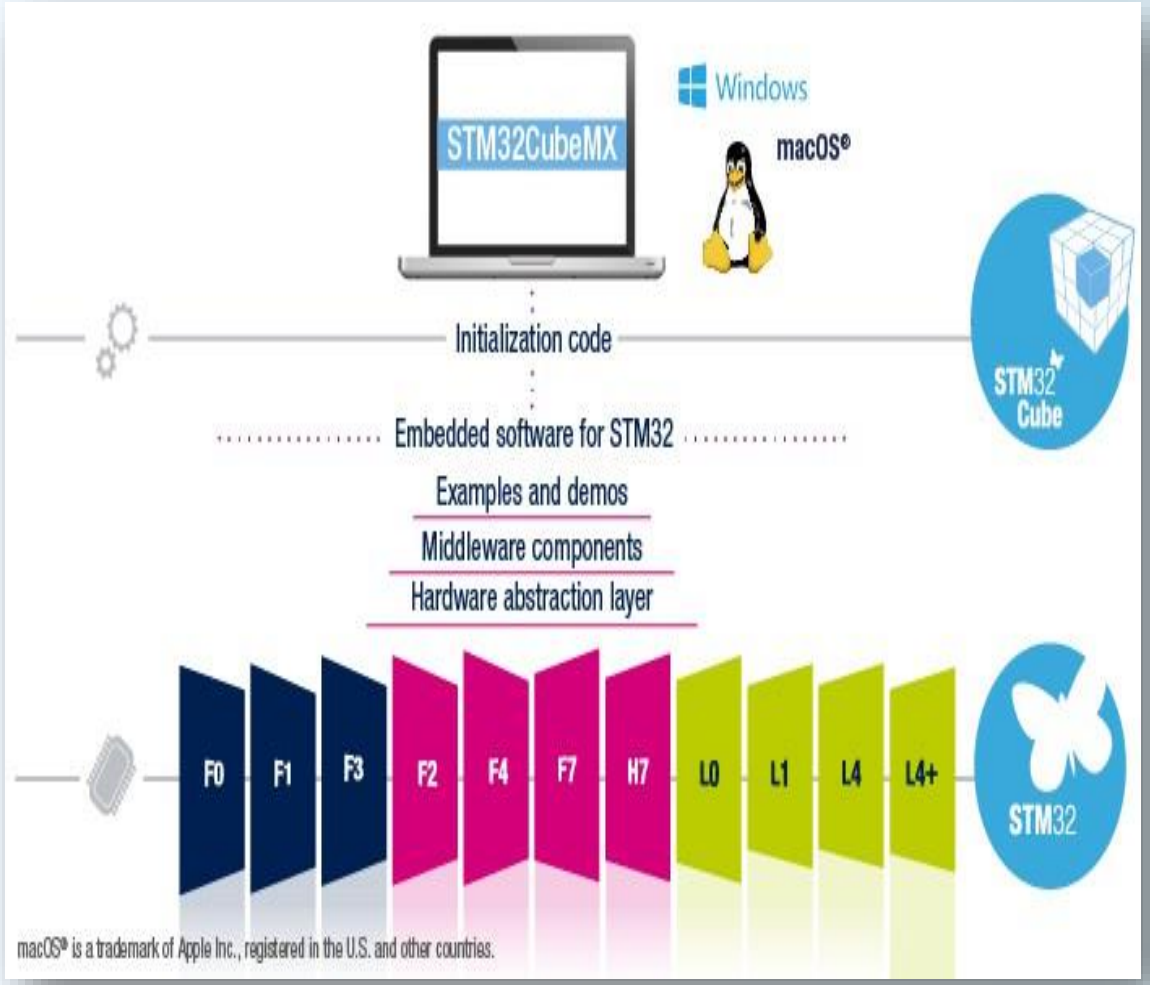
ELECTRO CLUB



STM32 Software Toolkit

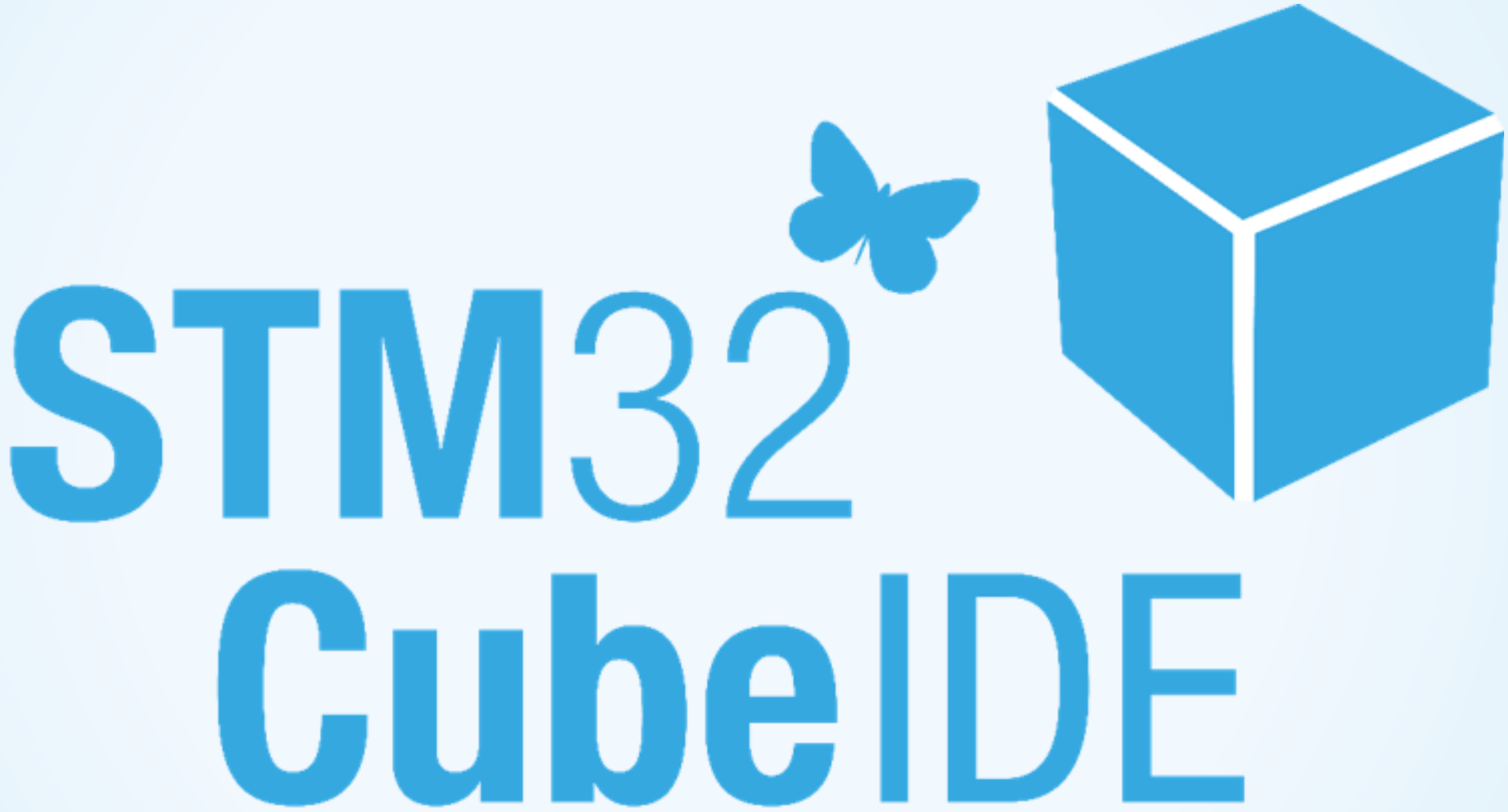
STM32 Software Toolkit





STM32 Software Toolkit

ELECTRO CLUB



STM32 Software Toolkit

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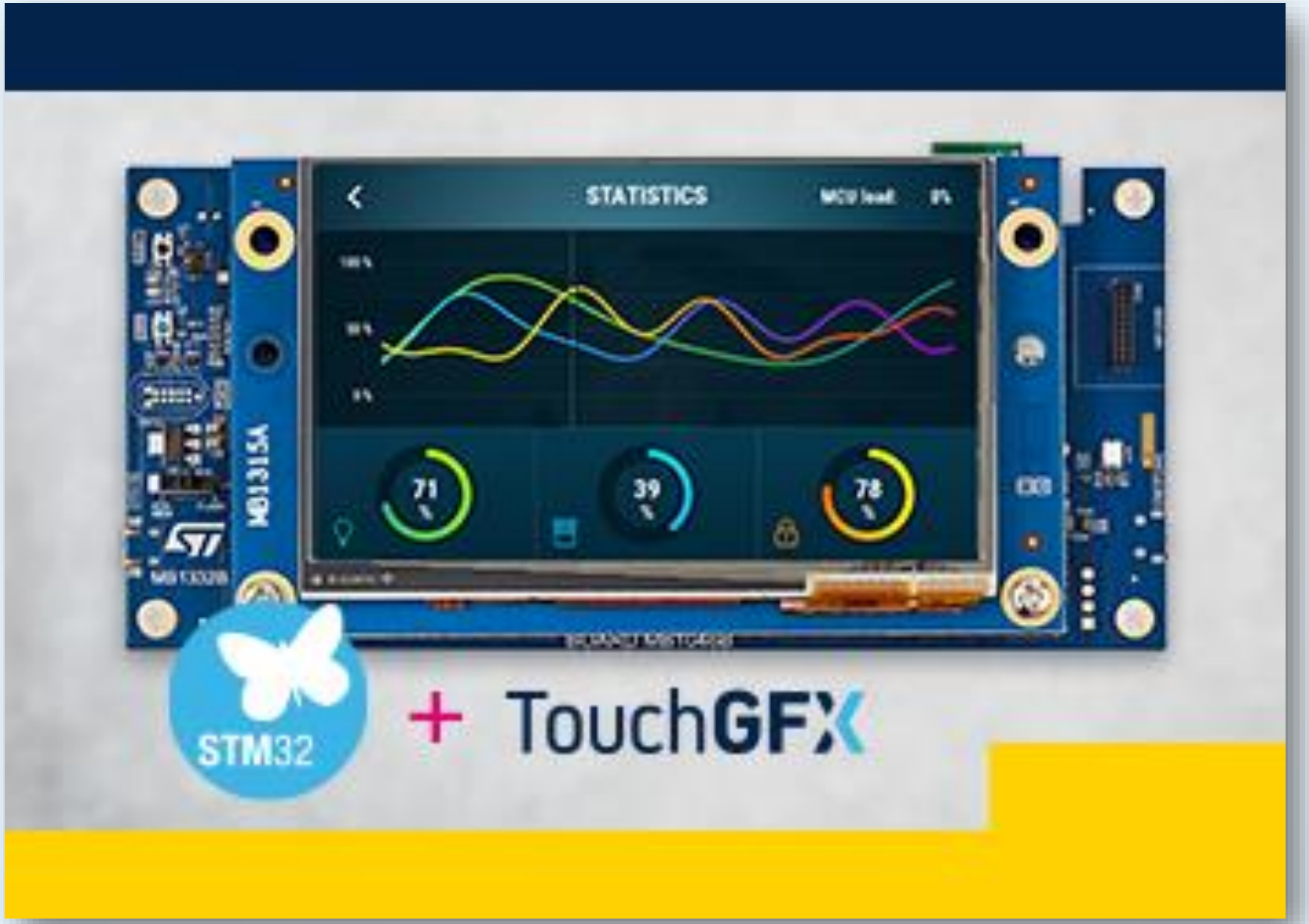
Runtime monitoring tool for STM32

helps visualize any application behavior

STM32 CubeMonitor

STM32 Software Toolkit



Other MCUs

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MPLAB X IDE

mikroC

Other MCUs

ELECTRO CLUB

Atmel Studio

Softopc com

Other MCUs

Code Composed Studio

Other MCUs

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ESPRESSIF

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Questions

Legenda

Slides including following brain symbol are purely theoretical ones

Optional steps during development in Labs are marked with a grey bar

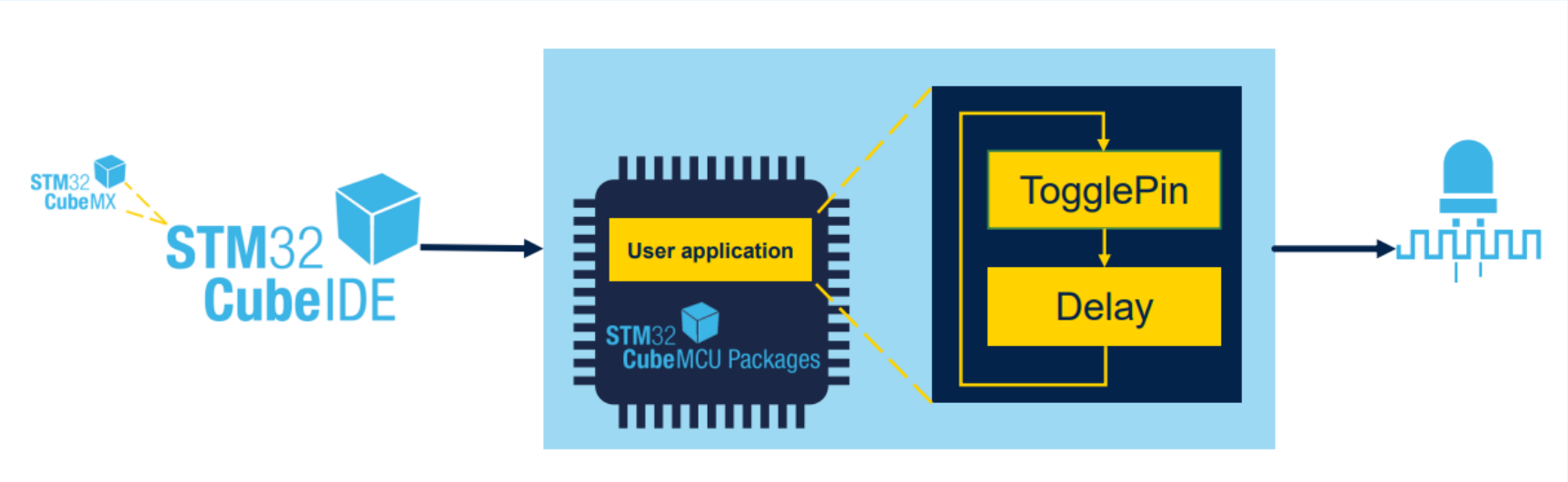
Yellow bar in Lab#2 show differences vs STM8 microcontrollers STM32F103RCT6

Source code for development is included inside pink boxes

```
HAL_Delay(1000);
```

LAB#1 LED Blinking in 6 Clicks

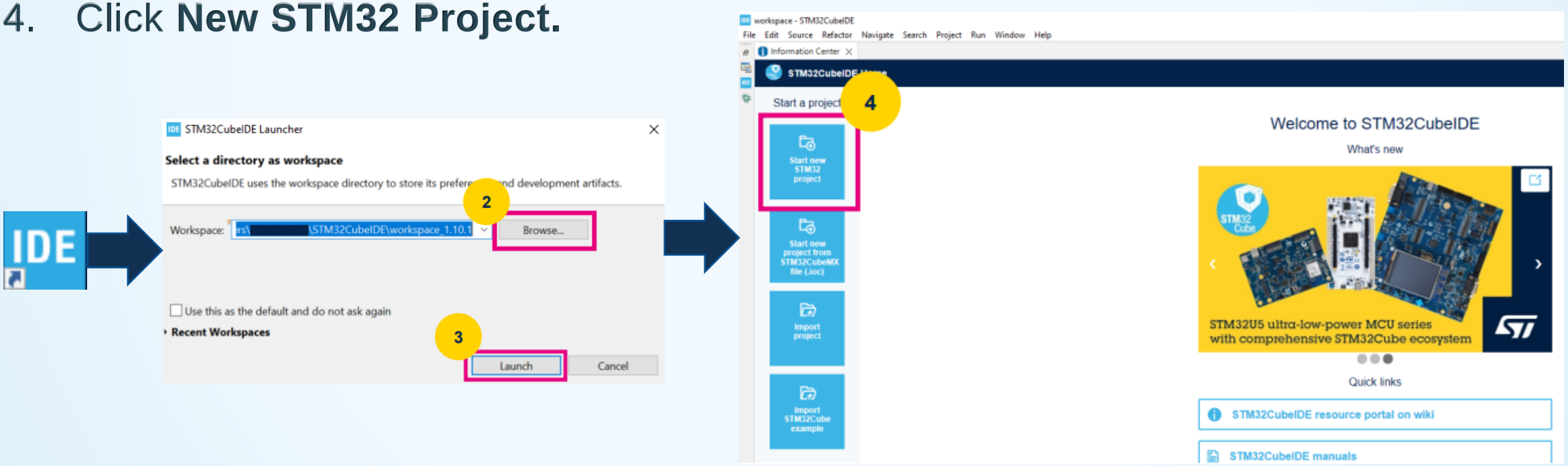
- This short hands-on will show you how to start a project for STM32 kit from scratch using only STM32CubeIDE
- The target is to get a running blinking LED in a few clicks



LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

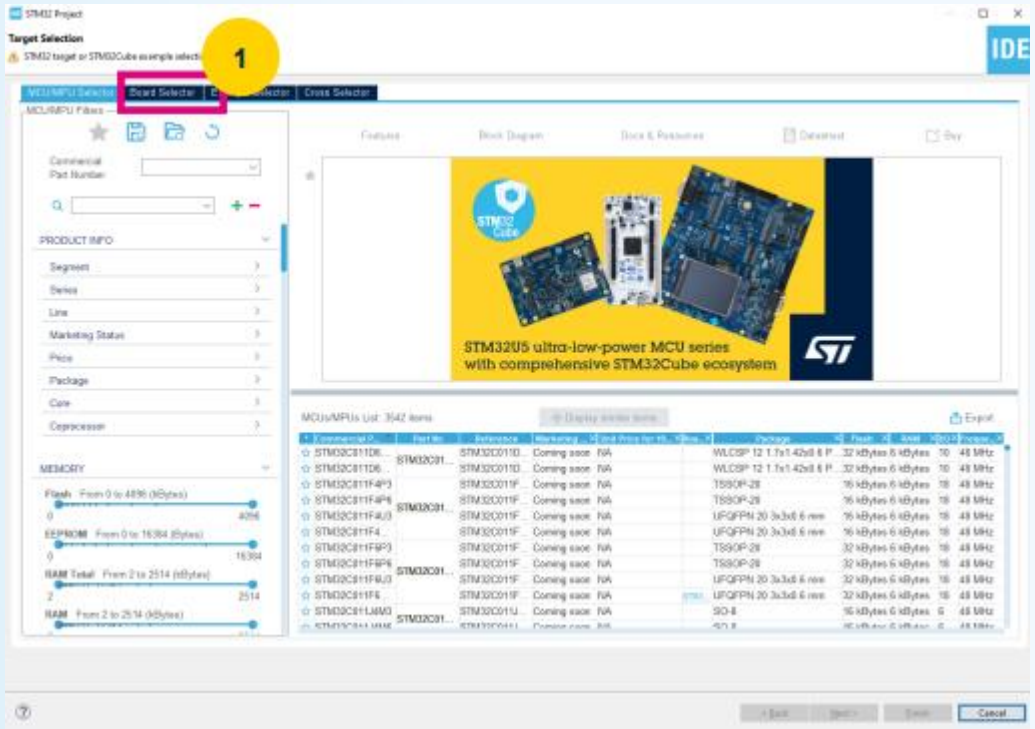
1. Launch STM32CubeIDE.
2. Select a new workspace.
3. Click **Launch.**
   - Steps 2 and 3 are usually optional: only needed after new workspace creation.
4. Click **New STM32 Project.**

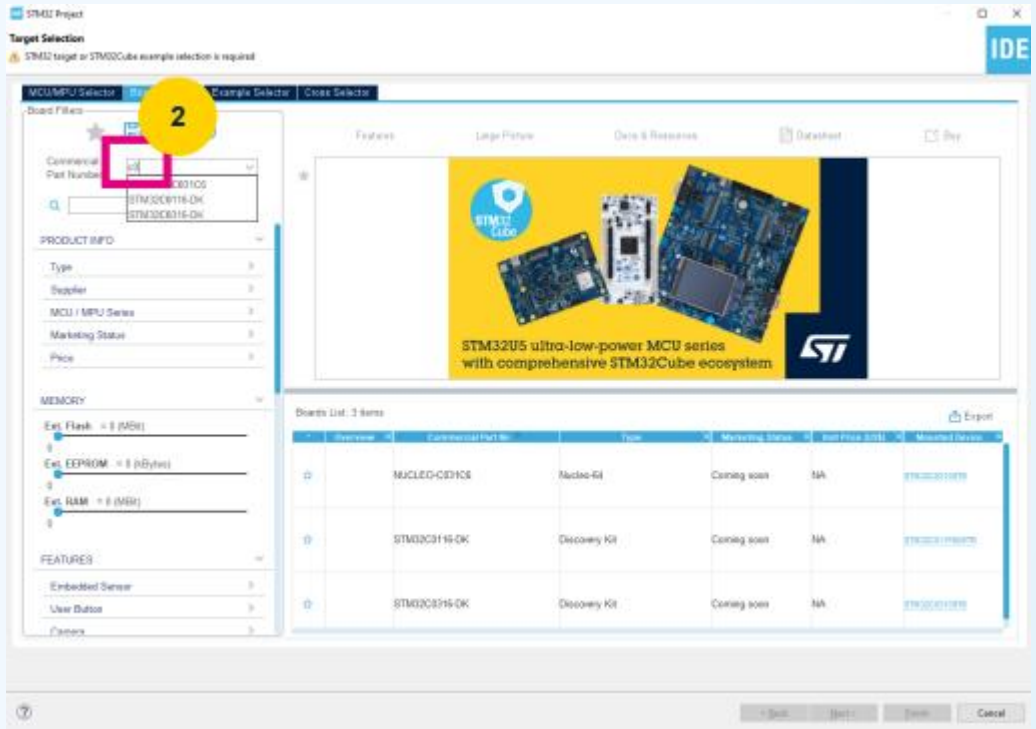


LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

1. Click on Board Selector.
2. Type your board name in Commercial Part Number search box.

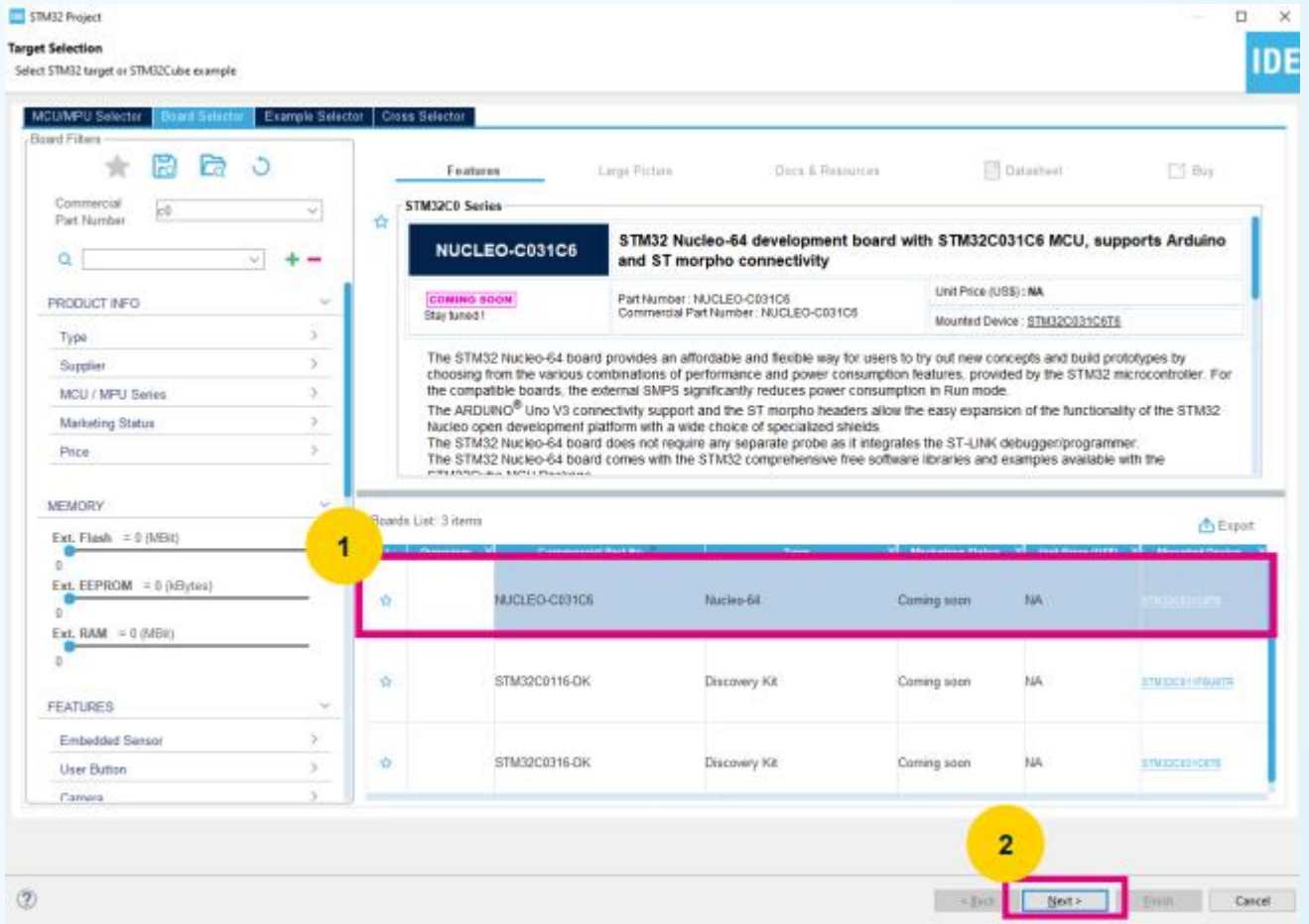




LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

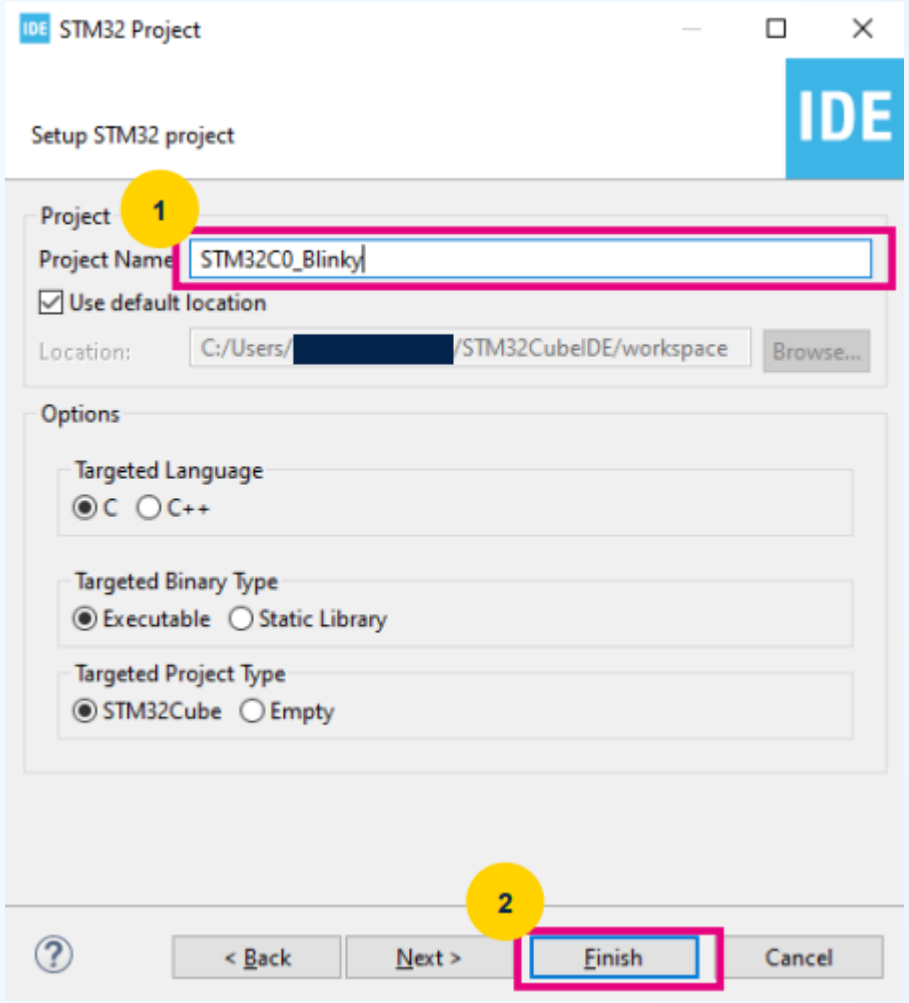
1. Select you board or your chip.
2. Click **Next**.



LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

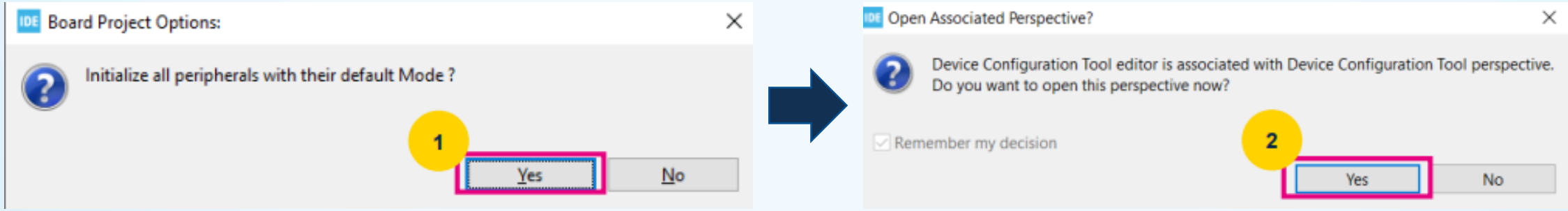
1. Give a name to your project.
   - Here “STM32C0_Blinky.
2. Click **Finish.**



LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

1. Click **Yes** in pop-up asking of peripherals initialization.
   - This will setup all STM32C0 GPIOs to work with the NUCLEO-C031C6 (LED, Button, etc).
2. Click **Yes** in pop-up asking to open device configuration perspective.
   - This will create your project structure with all needed files and open the STM32CubeMX embedded in STM32CubeIDE.
   - This pop-up may not appear if already acknowledged with “Remember my decision” flag.



LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

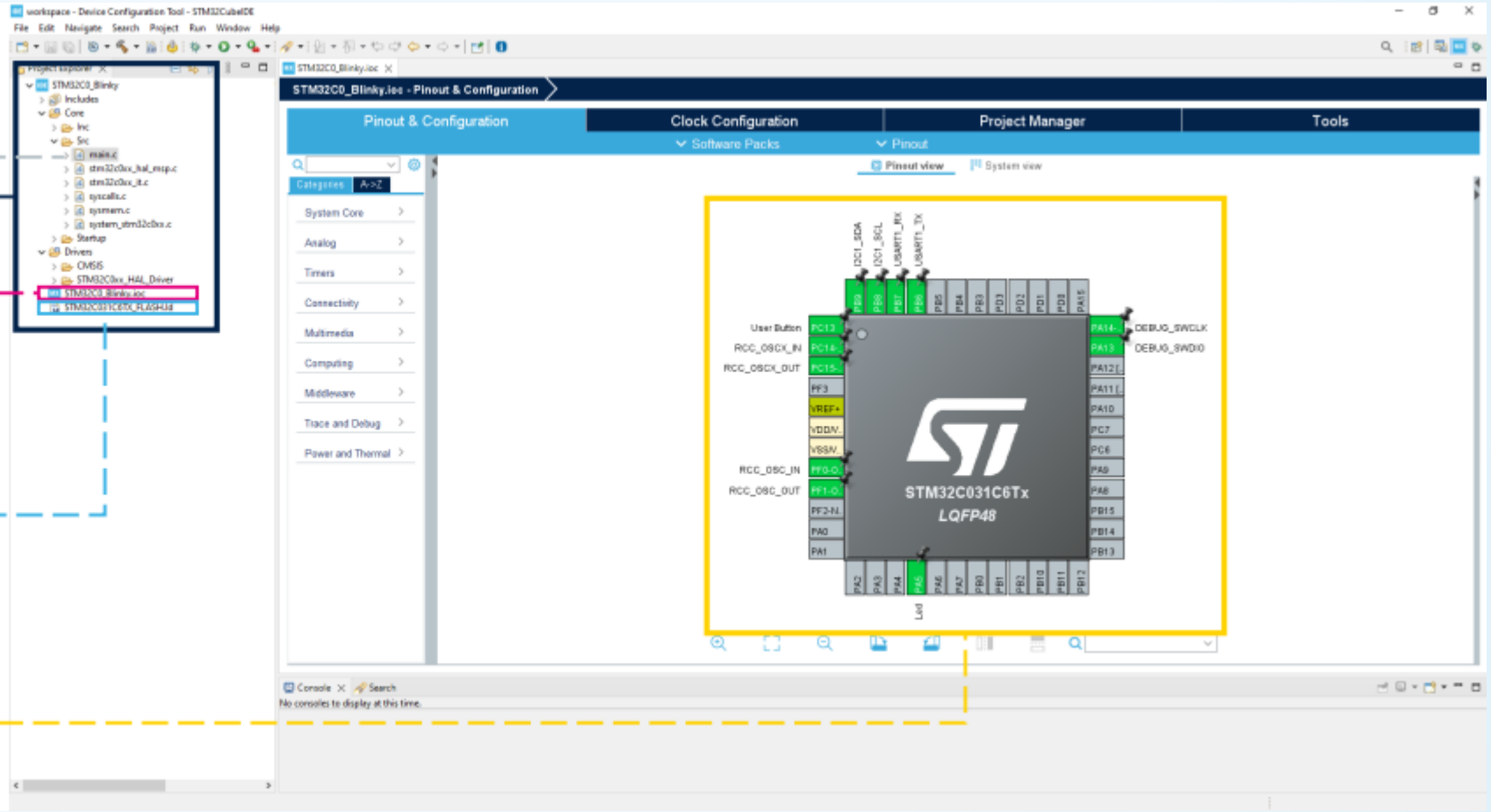
What you got after 6 clicks

Project Structure
- Core (Src, Inc & Startup)
  - User's application inside
  - We will work with main.c
- Drivers (CMSIS & HAL)

IOC File
- Already open at startup
- STM32CubeMX plugin into STM32CubeIDE

Linker File
- Handles placement in STM32C0 memories

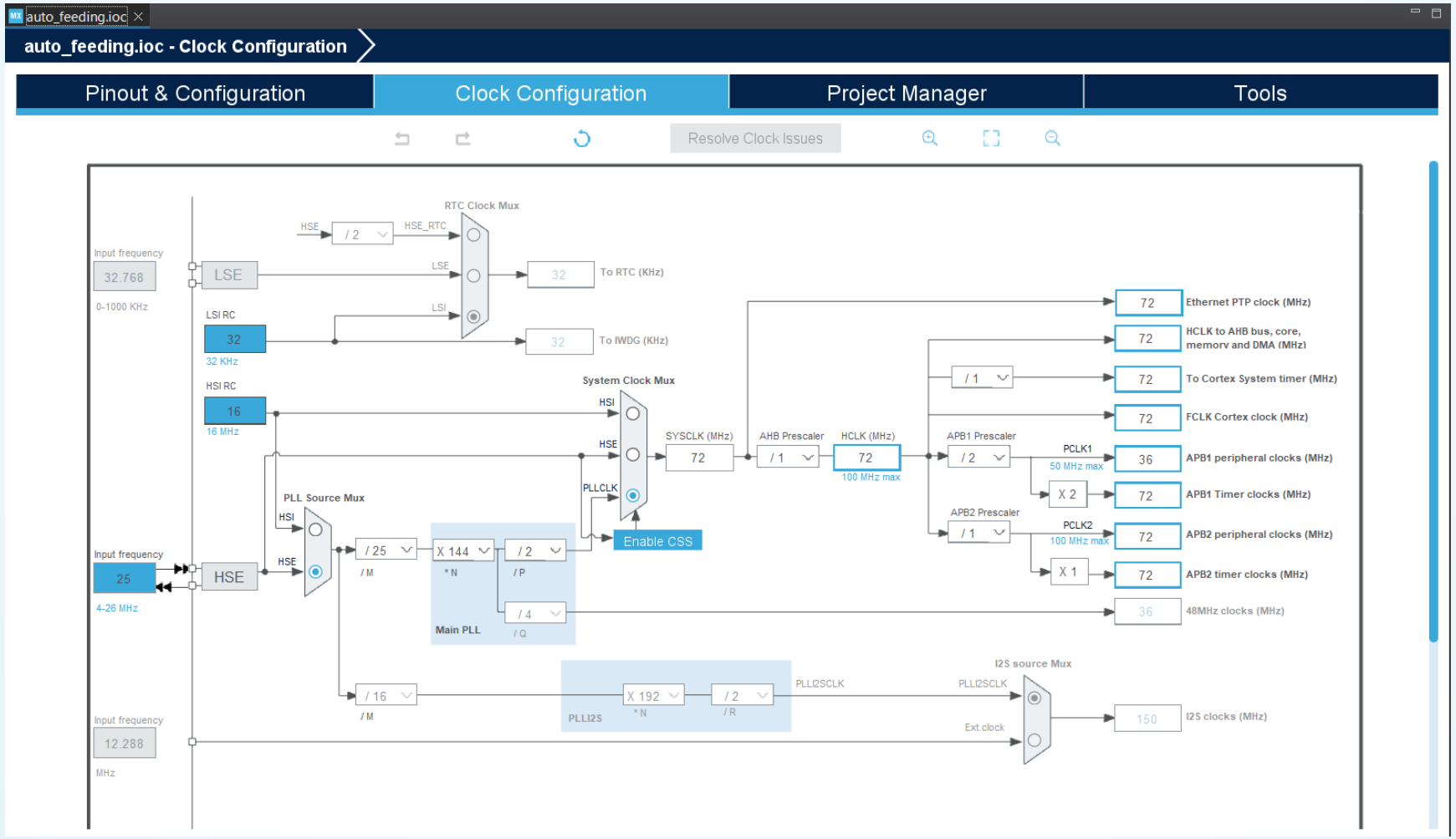
STM32C0 Pinout
- LED and Push-Button
- HSE and LSE Oscillators
- UART and SWD



LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

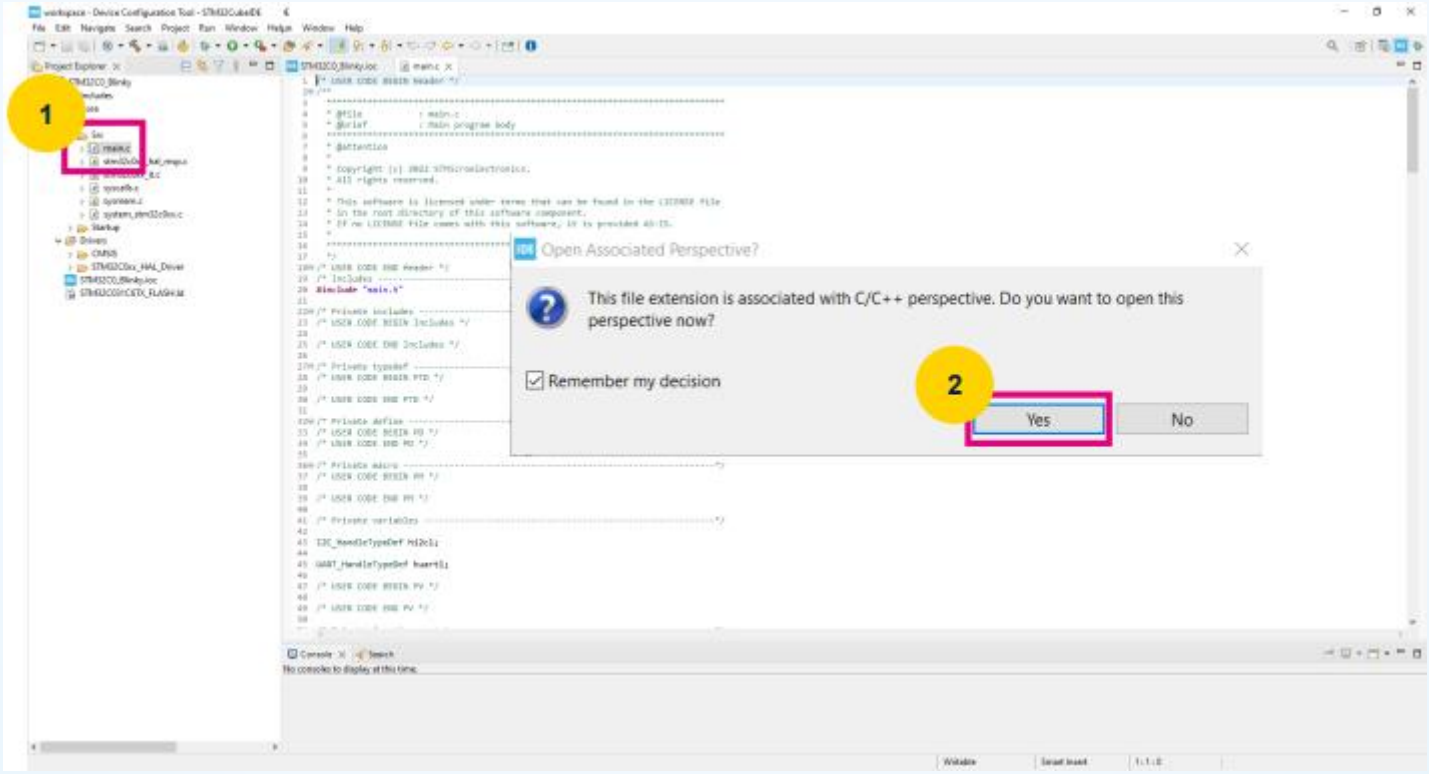
Clock configuration



LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

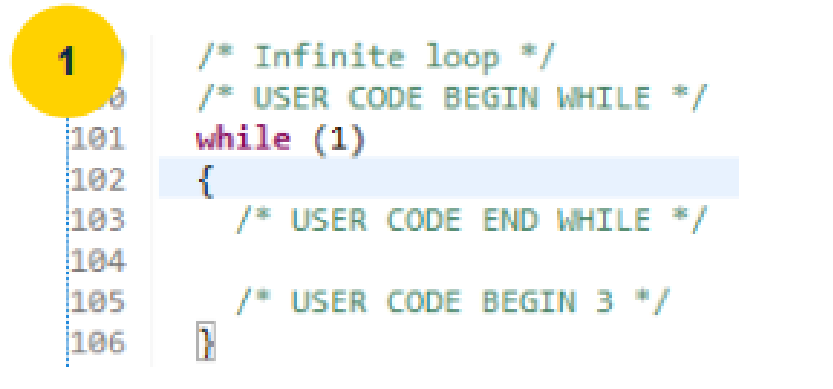
1. Double Click on **main.c**
2. Click **Yes** in pop-up asking to change perspective.
   - This pop-up may not appear if already acknowledged with “Remember my decision” flag

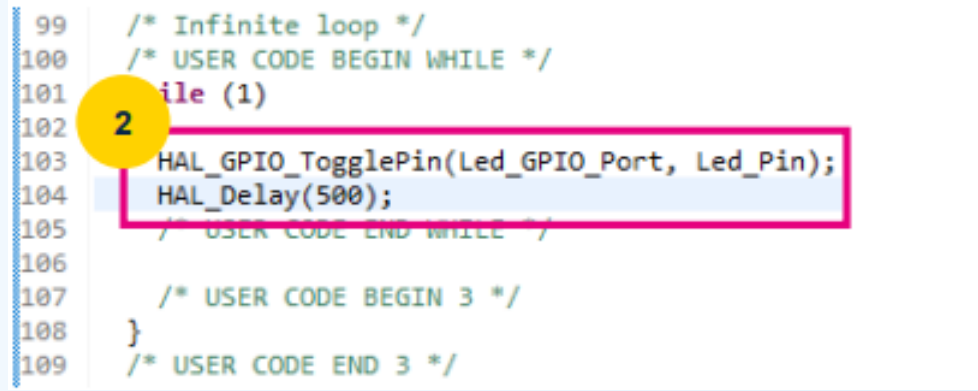


LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

1. Scroll the main.c file till the USER CODE BEGIN/END WHILE section.
   - Source code **within** “USER CODE BEGIN WHILE” and “USER CODE END WHILE” section **will be preserved** after regeneration.
2. Add code inside the USER CODE BEGIN/END WHILE section.
   - HAL_Delay uses STM32C0 SysTick peripheral, which is enabled to fire every 1s.
   - **Without** a delay, it’s impossible to see GPIO toggle in run mode: only in debug stepping mode

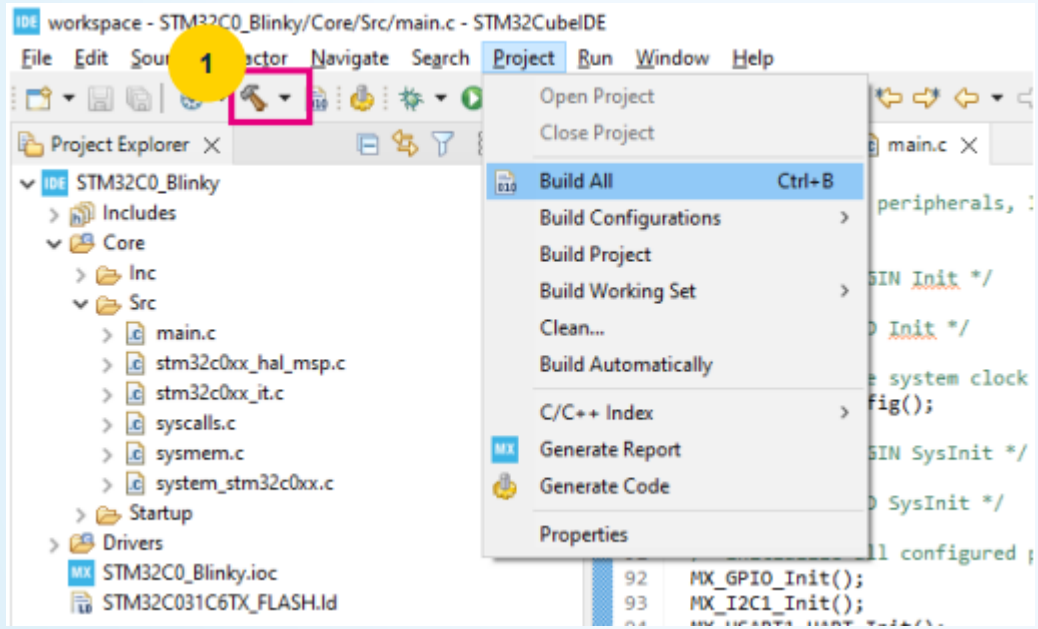


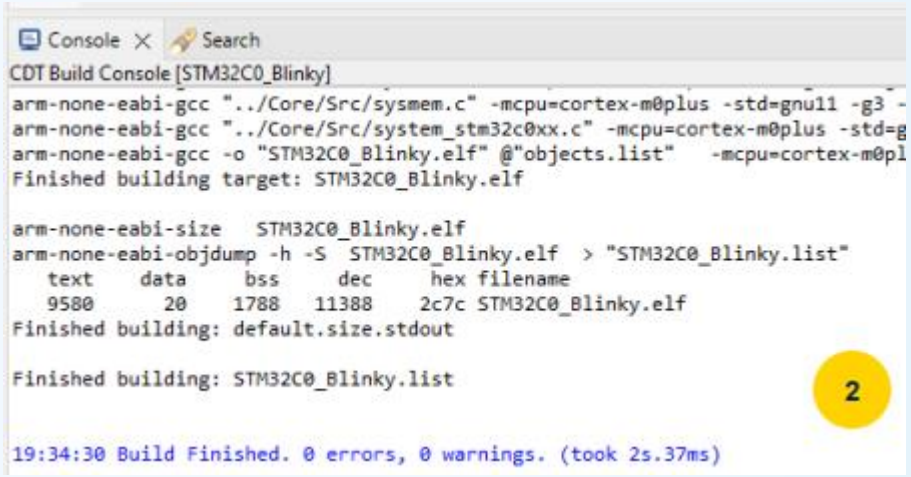


LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

1. Click on Hammer icon, **or** press Ctrl + B, navigate to project → Build All.
2. Check no error on Console.

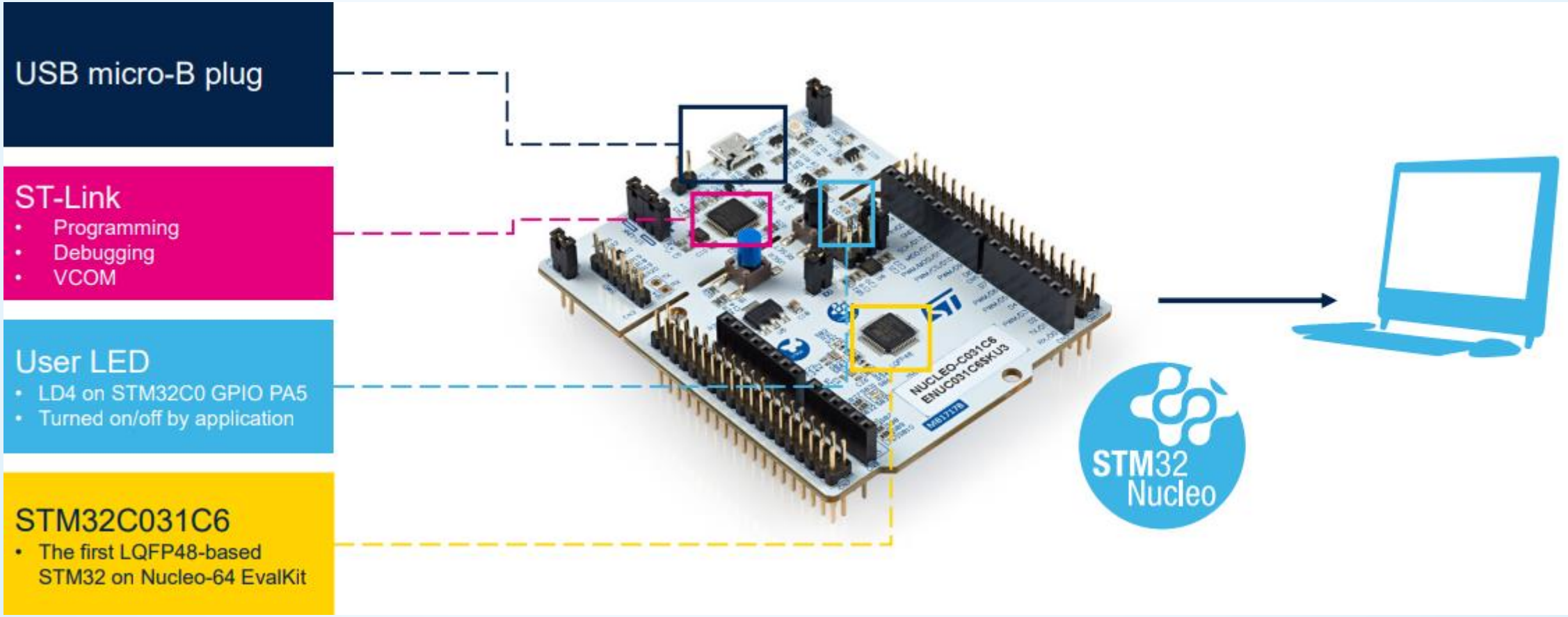




LAB#1 LED Blinking in 6 Clicks

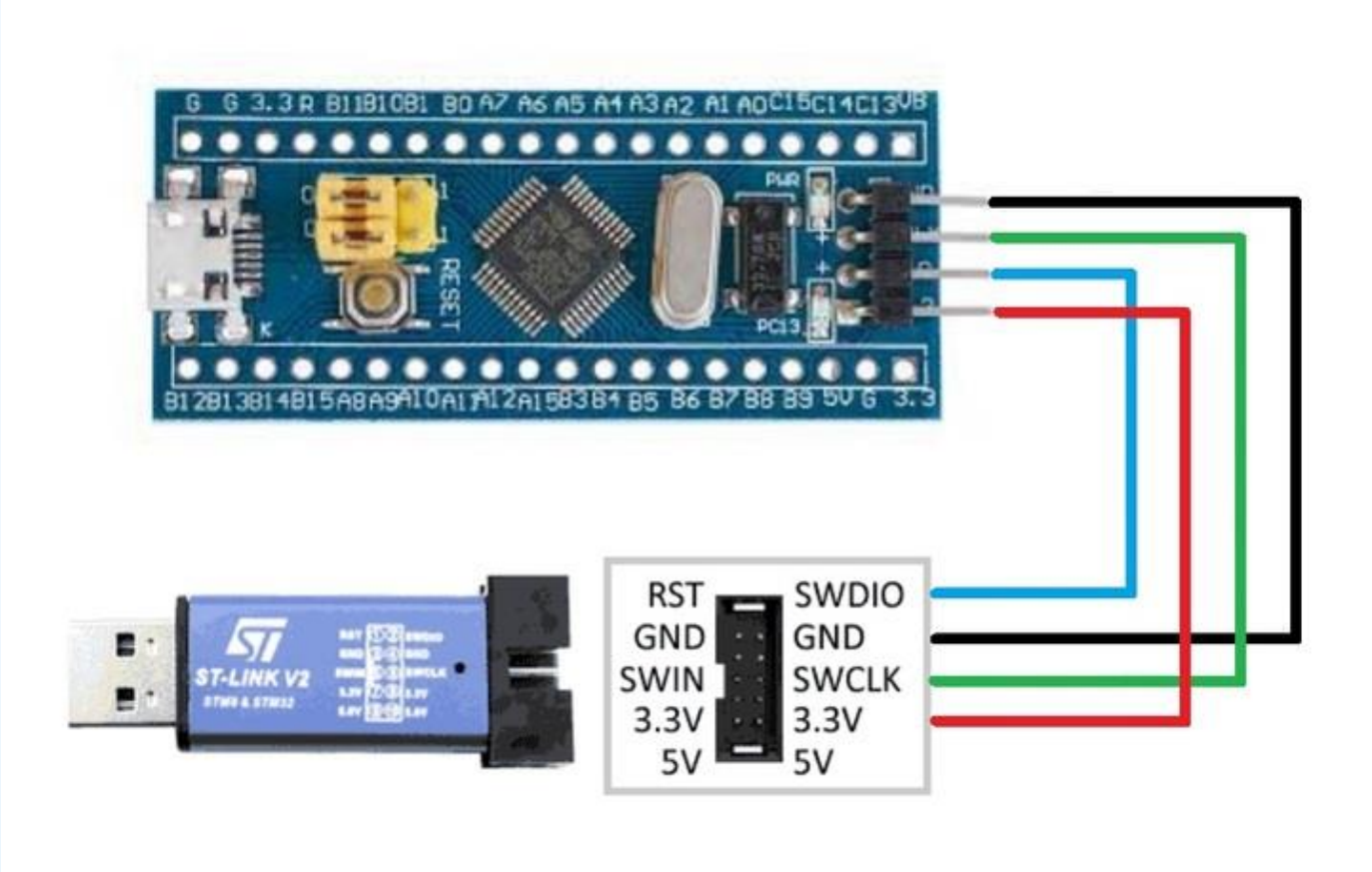
ELECTRO CLUB

Connect your board to your laptop.



LAB#1 LED Blinking in 6 Clicks

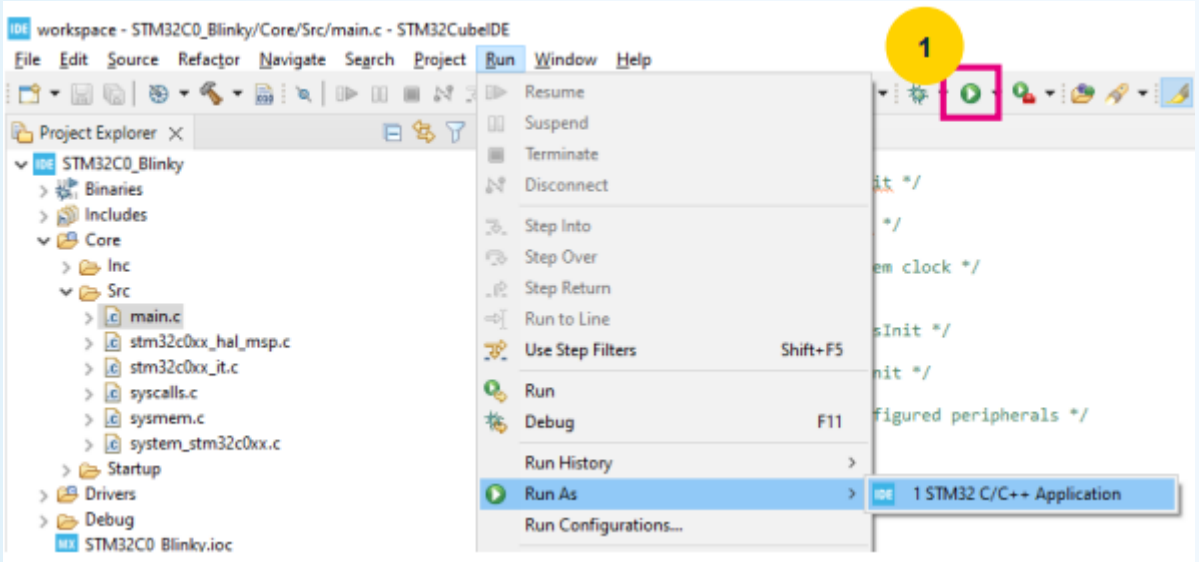
1. Connect the SWD pins to the STM32 board.
2. Connect the STLink to your lapyop.

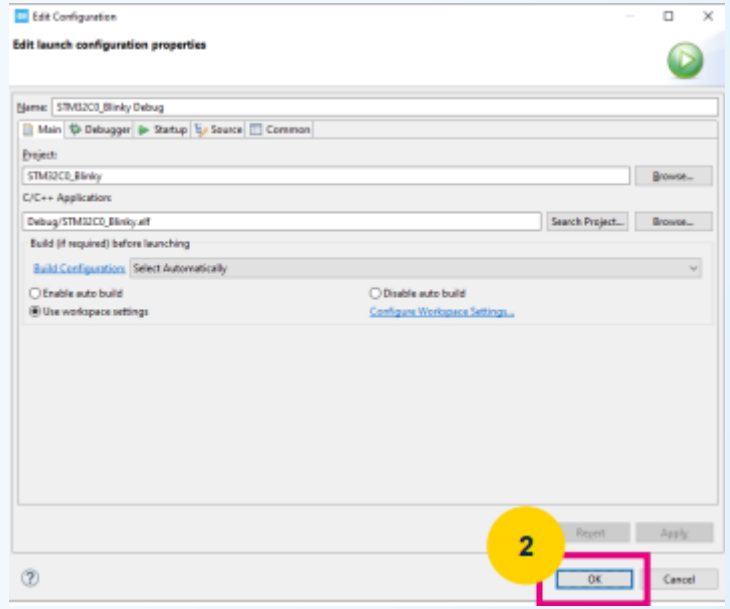


LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

1. Click on Play icon, **or** navigate to Run → Run as → STM32 C/C++ Application.
2. Click **OK** in Edit Configuration window.
   - This window will not appear in the future for same project.
   - To change project configuration in the future, click on down arrow, or navigate Run menu.

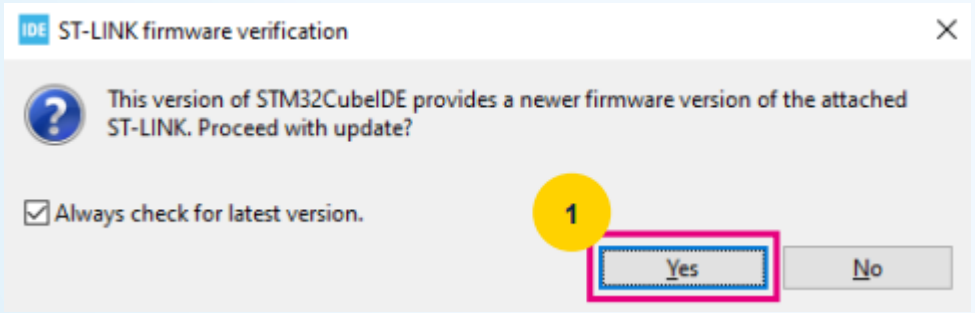


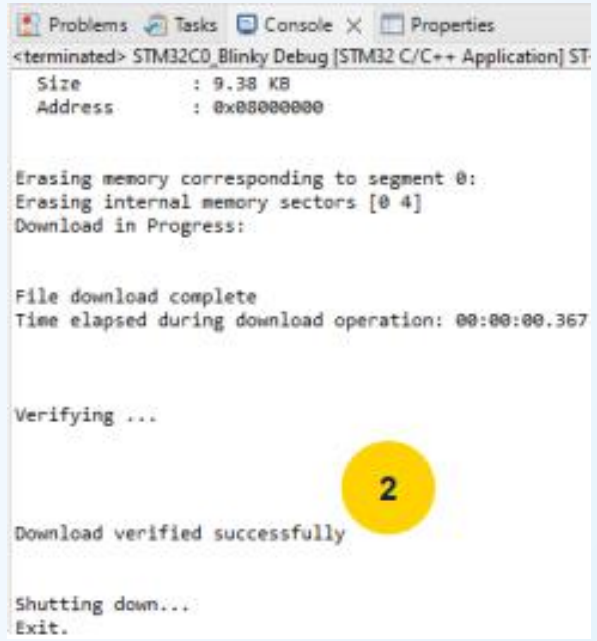


LAB#1 LED Blinking in 6 Clicks

ELECTRO CLUB

1. Click Yes in pop-up asking to upgrade the ST-Link FW. This pop-up may not appear if “Always check…” flag is not set, or ST-Link FW is already updated.
   - Follow instructions:
     1. Click **Open in upgrade mode**
     2. Click **Upgrade.**
     3. Click the pop-up.
     4. Get back to previous slide to start again the Download process.
2. Check no errors on Console.





LAB#1 LED Blinking in 6 Clicks

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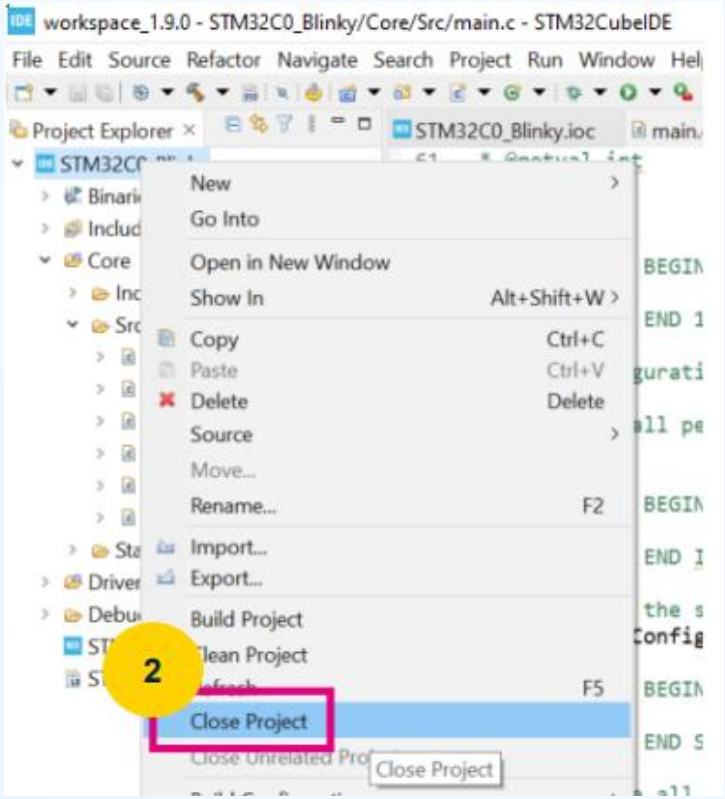
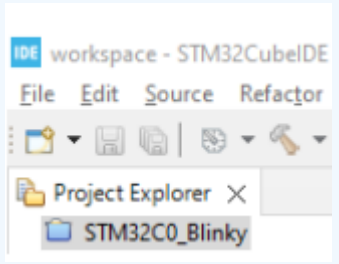
1. Right click on your project name in Project Explore, and click on Close Project
   - Let's move to the LAB#2





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