# ESPHome component development
# Part 1: Introduction

## Presentation

ESPHome's primary vocation is to enable users with *no computer skills* to create electronic **modules**. To do this, it calls on a library of **components** which it assembles according to the user's requirements, automatically generating the code needed to realize the desired function. The user then simply assembles the various components required on an electronic board. Then connect it to a computer to load the code generated by ESPHome.

Clarification of the terminology used:

- A "**module**" (**device**) designates a set of **components** grouped together by a user to perform a function. In ESPHome, the description of a module is defined in a yaml file. For example, you could define a module to measure room temperature. To do this, we'll use an ESP32 microcontroller connected via an I²C bus to a temperature sensor.
- A "**component**" is a basic element of the ESPHome library. Components can be physical, such as a sensor, or logical, such as an I²C bus. A component is defined by a set of files in C++ and Python.

A normal ESPHome **user** creates new **modules.** The modules are described in a Yaml configuration file, and from this description the ESPHome program automatically generates C++ code. This code is compiled and an executable is generated. The resulting firmware is loaded into the microcontroller's memory and run.

A **developer** for ESPHome will create new **components** for the library. This is a much more complex operation, as it requires the developer to describe how the component works, using both C++ and Python. This requires a good knowledge of C++, and basic notions of Python.

I was faced with the problem of creating an ESPHome **module** that used **components** that didn'*t exist* in the ESPHome **library**. So I wondered what procedure and tools I should use to create this new component.

To my knowledge, there are many tutorials on creating modules in ESPHome, but very few on creating new components. So I went through a process of trial and error, with the help of other users, and eventually defined an environment and a process to follow. As I learned quite a lot along the way, I thought it would be interesting to share this experience. I'd like to make it clear that this is how I do things, but of course there are other ways of doing things.

## ESPHome's high-level vision

I'll start by explaining how ESPHome works at a high level of abstraction, as I understand it.

To create a new **module** in ESPHome, you need to define all the components you wish to use and how they are interconnected.

For example, to create a "room temperature measurement" module, you'll specify that you want to use: an ESP32 microcontroller installed on an esp32dev development board, connected to a BMP085 sensor via an I²C bus.

The sensor measures the temperature and sends it back to Home Assistant via ESPHome's native Wifi API.

The Yaml file will look like this:

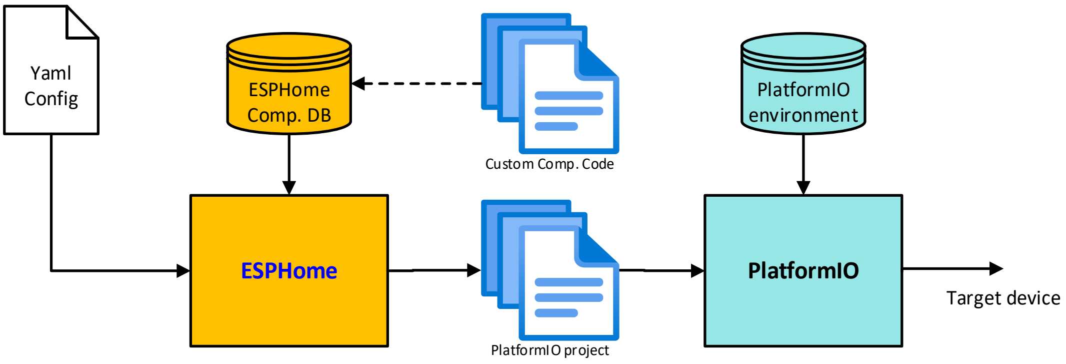
```
esphoma:
  name: test-bmp085
  platform : esp32
  board: esp32dev

api :

wifi :
  ssid: !secret wifi_ssid
  password: !secret wifi_password

i2c:
  sda: 21
  scl: 22
  id: bus_i2c_id

sensor:
  - platform: bmp085
    i2c_id : bus_i2c
    address: 0x77
    temperature:
      name: "Outside Temperature"
```

In this file, we indicate that we're creating a new ESPHome module called "test-bpm085", that the microprocessor used is an "ESP32", which is mounted on an "esp32dev" development board, that the module connects to your "Wi-Fi" network, that it communicates with Home Assistant using the "native api protocol", that it uses an "I2C" bus, and that a "BMP085 sensor" connected to the I²C bus returns the temperature.

Based on this description, ESPHome works its *magic* by performing the following tasks:

- First, ESPHome reads the Yaml file. This enables it to list all the components used and to know all the interconnections (internal creation of a netlist). During this phase, the syntax and semantics of the Yaml file are checked. This is the preparation and verification phase.
- Secondly, ESPHome will search its library for all the components used in this module. For example: a wifi component, an I2C component, an Api component, a BMP085 component, a sensor component, etc. It then copies the source code of these components into a directory created specifically for the module being assembled. To "instantiate" and "connect" the components to each other, he uses the netlist to generate a C++ file (main.cpp). This is the code generation phase. During this phase, ESPHome also generates all the necessary environment for PlatformIO. It then launches PlatformIO, which will create, download and run the resulting firmware on the hardware target.

This diagram describes the process:



So, to summarize, once the configuration file has been validated, the source files for the various components used are copied into the PlatformIO project, a main.cpp file and the plaformio.ini file are generated, and control is passed to PlatformIO.

PlatformIO checks that the necessary development environment, such as compilers, libraries, programming utilities, etc., is present and up-to-date. This environment is specified in the `platformio.ini` configuration file generated by ESPHome. PlatformIO will then compile and download the resulting code to the target device.

*In this series of presentations, we're going to focus not on use, but on the creation of components that can then be used to create new modules.*

The process begins with :

- writing documentation to show users how to use our new component.
- writing Python files to validate the module and generate C++ code from the user configuration.
- Writing C++ files to "model" the component. This part of the development is the longest and most complex, since it requires detailed analysis of the component specifications, a minimum understanding of ESPHome's internal architecture, and writing the code that functionally models the component.
- Submitting your new component to the ESPHome library. This can be a long and difficult phase, as the code and documentation for ESPHome components must comply with very strict constraints. This phase requires dialogue with the person in charge of validating your component...
- Although it's not mentioned anywhere, I think that when you add a new component to ESPHome it's implicitly understood that you're committed to maintaining that component (bug-fix and enhancement). For this, your GitHub developer name is associated with the component.

But first you need to install the development environment...