Initiation to Research Methodologies project

1- Wifi connection

In this part of the project we propose to study a wireless connection between the Rasberry pi Pico W and a client (PC or Smartphone) by Wifi

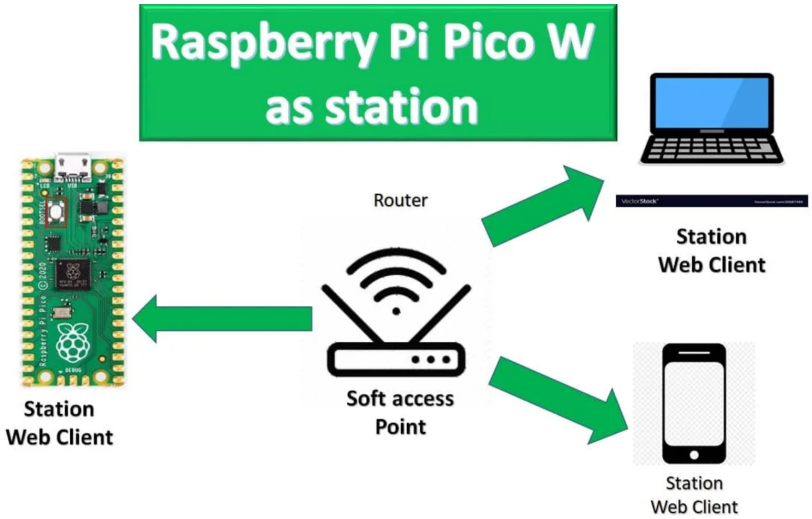


Figure 1: Raspberry Pico Pi use as a web server available on a WiFi network

a. Principle of exchange

Therefore, the medium of communication between the web client (web browser) and Raspberry Pi Pico W (web server) is the router. Raspberry Pi Pico W boards get the IP address from the Wi-Fi router. With this IP address, web clients can access the Web server through an existing TCP/IP local network.
The TCP/IP model is based on a four-layer model that divides network communications into four distinct categories or layers. The TCP/IP model, or Transmission Control Protocol/Internet Protocol model, is a foundational framework for how data is transmitted over networks, particularly the internet. It provides a structured approach to networking by breaking down the process into layers, each responsible for specific tasks.

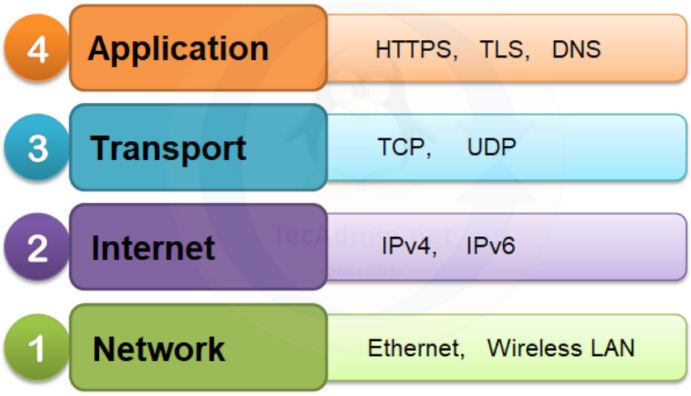


Figure 2: Model TCP/IP with 4 layers

b. Wifi standard

WiFi is a wireless technology largely used in the present data networks and based on the RF waves. This part introduces the advanced digital modulations used in this network protocol. The name « WiFi » is issued from « Wireless Fidelity ». «WiFi » has been used for the first time in 1999 in a commercial way. This name is more attractive than the protocol name IEEE 802.11 ». The IEEE 802.11 protocol is often reviewed in order to improve the data rate and the efficiency of the network connection. There are several protocol versions (802.11a, 802.11b, 802.11g et 802.11n).

The last performing of the WiFi signals is based on the Orthogonal Frequency Division Multiplexing (OFDM). This kind of data keying is now largely used for the new communication standards (for example, the 802.11a/g versions or Data Broadcast as the DVB). The frequency carrier spreading of the OFDM allows transmitting the data over a large number of carriers which are regularly set with an accurate bandwidth between them. This bandwidth permits to limit the data mixing between different sub-carriers. This propriety is relied to the orthogonality principle. The OFDM advantages are the spectral spreading efficiency, low RF interference influence and moderate distortion due to multiple routes. This last propriety is useful in terrestrial radio broadcasting. The radio signal comes in the receiver through several paths with different lengths (reflexion on obstacles, …). Time shift signals on the receiver induce intersymbol interference (ISI). The data keying technology over several
sub-carriers allow limiting the multi paths influence. The frequency bandwidth used by the radio waves protocol Wifi comes from 2.5GHz to 2.483GHz corresponding to a bandwidth of 83MHz. This bandwidth is divided in 13 transmission channels numbered from 1 to 13. Each channel uses a bandwidth of 22MHz (with a bandwidth of 20MHz for the signal separated by a bandwidth of 1MHz). The 13 channel frequency carriers are shift successively by 5MHz. That induces a superposition of some power spectral densities of the different channels as shown on figure below.

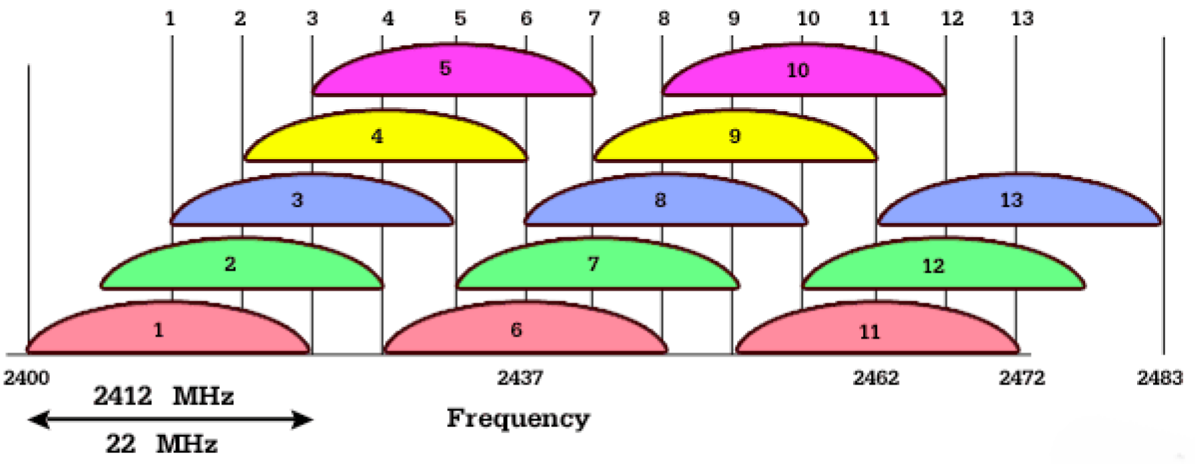


Figure 3 : Spectral repartition of the WiFi2 channels

Each channel is divided in 52 sub-channels with 48 carriers used for the data and 4 other channels for the "driver carriers" (Transmission channel identification). These carriers are separated by a bandwidth of 300 kHz.

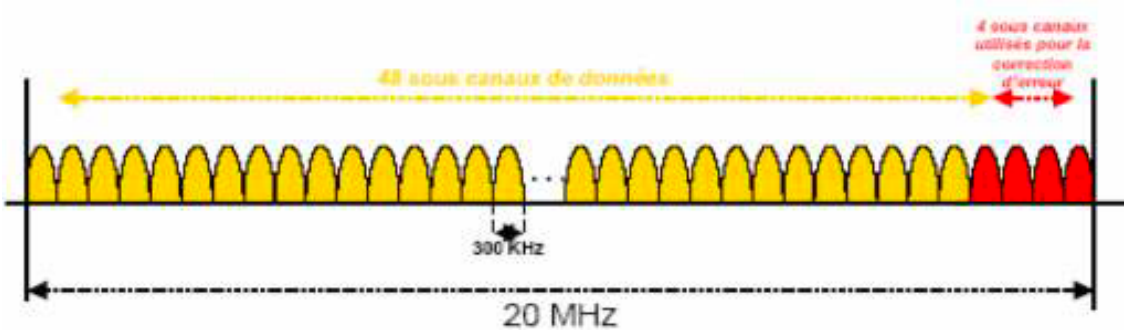


Figure 4 : 48 (data) + 4 (driver) sub carriers composing a channel WiFi

The main advantage of this protocol is to be able to modify the data rate for keeping the same spectral power density. Indeed, the adjustment of the maximum data rate is done through a change keying from QPSK for low signal to noise (S/N) ratio to QAM64 then the S/N is sufficient. The time parameter used in this radio wave channel is also a specificity of the protocol WiFi. The propriety which permits to share the radio source access is managed by the method « CSMA/CA (« Carrier Sense Multiple Access »/ « Collision Avoidance »).

The method is the same for the two versions 802.11b and 802.11g. The CSMA/CA principle consists in supervising the free radio channel activity. If the channel is free, the transmission is available. Nevertheless, the radio device is not full duplex (emission and reception simultaneously). Then two devices can emit simultaneously on the same channel inducing collision. These collisions are detected on the MAC layer and the packets not acquired are emitted again. If there is no activity detected during a specific time equal to DIFS, the frame is emitted instantaneously else when the channel becomes available, it is possible to differ the emission (or the re-emission in the case of a collision) using a random delay.

- **With an application on computer or smartphone (WiFi analyzer) scan the available WiFi networks around you.**

- **Try to identify the channel used, the power RSSI power (Received Signal Strength Indicator)**

c. Your first program to connect Raspberry to WiFi

First step is to realize a Wifi connection with an acces point. MicroPython in Raspberry Pi Pico W provides network interface module. This network module provides two types of Wi-Fi interfaces. One for the station, when the Raspberry Pi Pico W connects to a router. Similarly, one for the access point that is for other devices to connect to SSID broadcasted by Raspberry Pi Pico W.

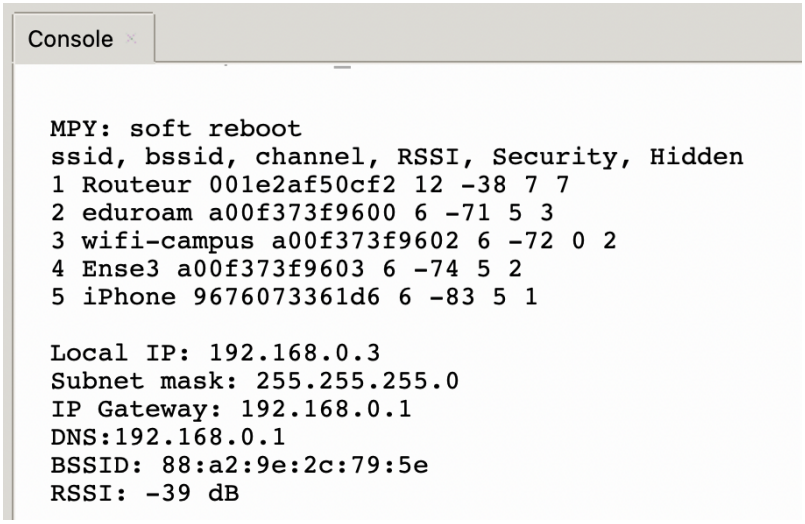
Several sources propose Wifi connection example python programs for Raspberry Pico

https://docs.micropython.org/en/latest/library/network.WLAN.html

https://arduino103.blogspot.com/2022/07/pico-wireless-micropython-et-le-wifi.html

https://www.gcworks.fr/tutoriel/pico/ConfigurationWifi.html

- **with these sources write a python program that connect your Raspberry Pi Pico W to an Wifi access point with a ssid = 'Routeur' and the connection password = '12345678'**
- **Your program could scan available acces points (not mandatory) and give the connection information on the Wifi network as follow**



- **When your Raspberry is connected make a ping with your computer connected on the same Wifi same SSID("Routeur")**

d. Your first program to create a web server on Raspberry to WiFi