

# Telecomunicazioni

## WiFi and BT

**Roberto Verdone**  
[www.robertoverdone.org](http://www.robertoverdone.org)

---

# Short Range Systems

Communication technologies covering, in real world environments, typical ranges up to about 100 m, or less.

Multi-hop topologies are needed to cover larger distances, if allowed by the technology.

Reference standards / technologies for IoT solutions:

- **IEEE 802.11 (WiFi) family**



- **Bluetooth family**



- **IEEE 802.15.4 family**



- (others not mentioned)

# WiFi



Since 1997.

IEEE/IETF Standard.

802.11

802.11b

802.11a

802.11g

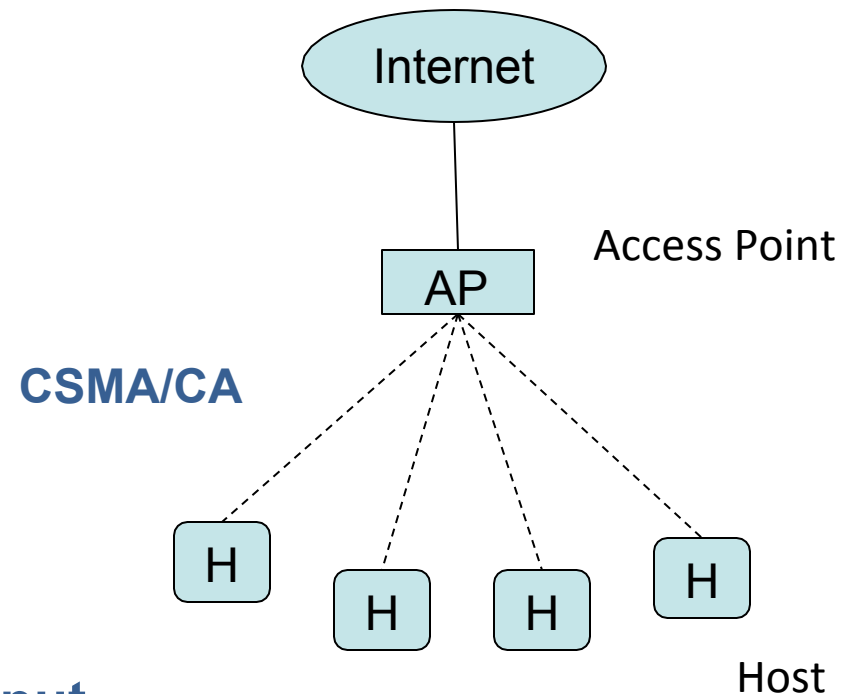
802.11n      WiFi 4

802.11ac      WiFi 5

802.11ax      WiFi 6

- **(Much) Above-Mbit/s user throughput**
- **Not optimised for energy consumption**
- **Mostly oriented to Local Area Networks (no multi-hop)**

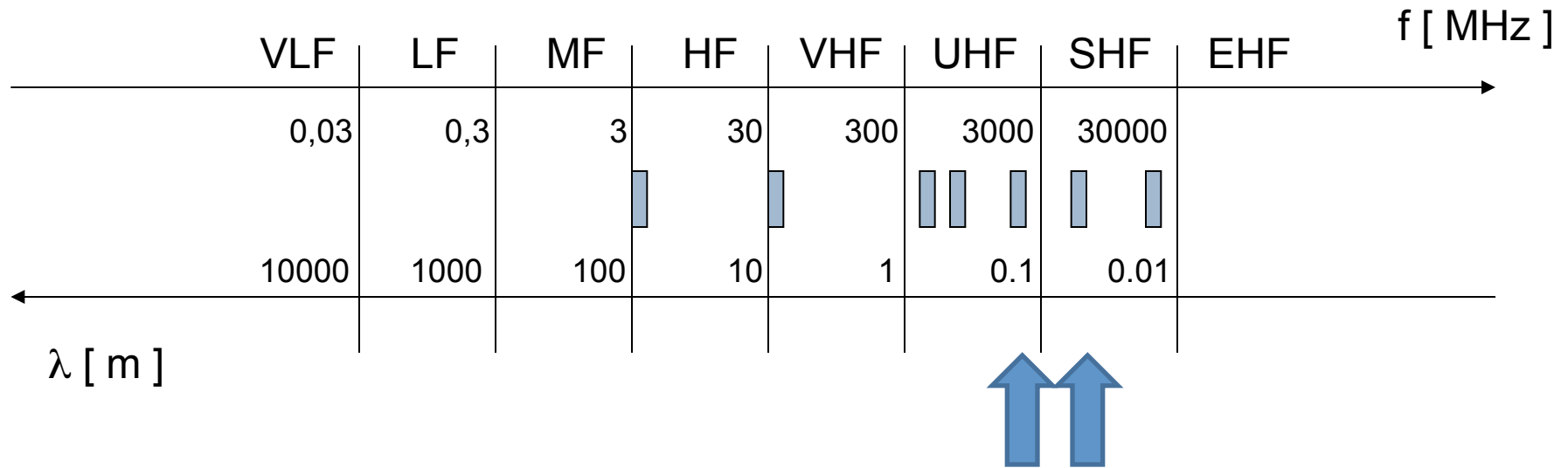
## Network Architecture



# WiFi



## ISM Bands: Licence - Exempt in Most Countries



13.553 – 13.567 MHz

**RFid**

40.66 – 40.70 MHz

**RFid**

433 – 464 MHz

**Proprietary Radios**

867 – 870 MHz

**Proprietary Radios, LoRa, ...**

**2.4 – 2.48 GHz**

**Proprietary Radios, Bluetooth, WiFi, Zigbee, ...**

**5.725 – 5.875 GHz**

**WiFi, ...**

# WiFi



Since 1997.

IEEE/IETF Standard.

- 802.11
- 802.11b      2.4 GHz ISM band
- 802.11a
- 802.11g      2.4 GHz ISM band
- 802.11n      2.4 GHz ISM band
- 802.11ac
- 802.11ax      (2.4 GHz ISM band)

Channel	Frequency	US	Japan	Europe
1	2412	Yes	Yes	Yes
2	2417	Yes	Yes	Yes
3	2422	Yes	Yes	Yes
4	2427	Yes	Yes	Yes
5	2432	Yes	Yes	Yes
6	2437	Yes	Yes	Yes
7	2442	Yes	Yes	Yes
8	2447	Yes	Yes	Yes
9	2452	Yes	Yes	Yes
10	2457	Yes	Yes	Yes
11	2462	Yes	Yes	Yes
12	2467	No <sup>B</sup> except CAN	Yes	Yes
13	2472	No <sup>B</sup>	Yes	Yes

# WiFi



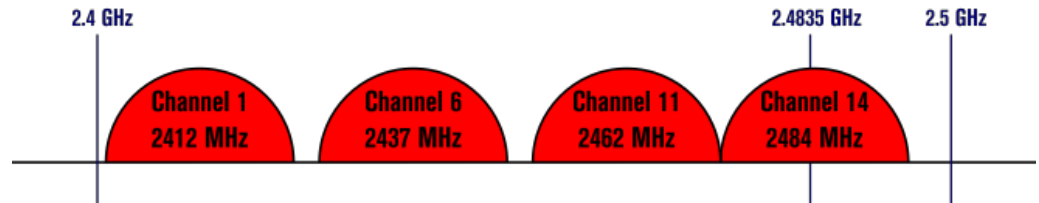
Since 1997.

IEEE/IETF Standard.

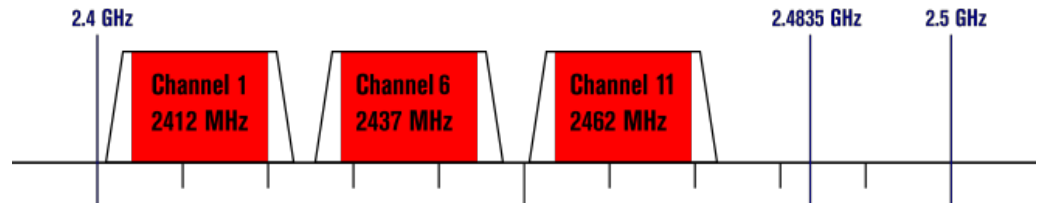
- 802.11
- 802.11b      2.4 GHz ISM band
- 802.11a
- 802.11g      2.4 GHz ISM band
- 802.11n      2.4 GHz ISM band
- 802.11ac
- 802.11ax      (2.4 GHz ISM band)

## Non-Overlapping Channels for 2.4 GHz WLAN

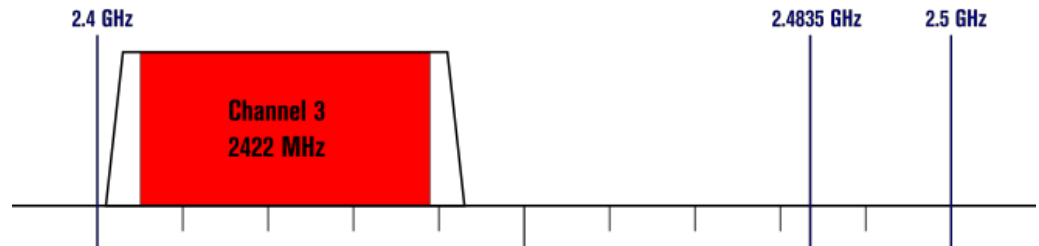
802.11b (DSSS) channel width 22 MHz



802.11g/n (OFDM) 20 MHz ch. width - 16.25 MHz used by sub-carriers



802.11n (OFDM) 40 MHz ch. width - 33.75 MHz used by sub-carriers



## WiFi



Since 1997.

IEEE/IETF Standard.

802.11

802.11b

802.11a          5.8 GHz ISM band

802.11g

802.11n

802.11ac          5.8 GHz ISM band

802.11ax          5.8 GHz ISM band

---

# Bluetooth



Since 1994.

BT SIG Standard.

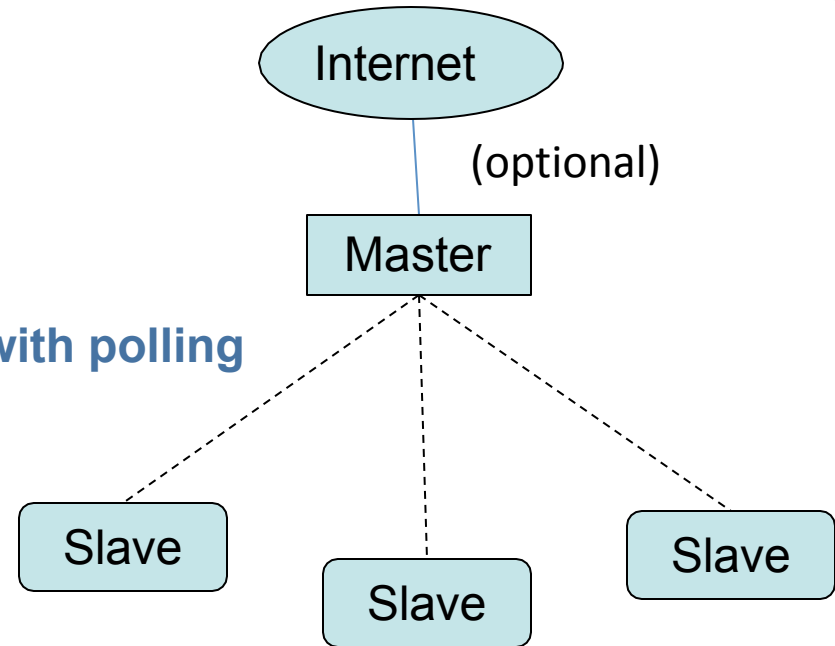
BT 1.0  
BT 2.0 EDR  
BT 3.0  
BT 4.0 LE  
BT 5.0

2.4 GHz ISM band

... 40/80 channels on 2.4 GHz ISM band  
Frequency Hopping

TDMA with polling

## Network Architecture



Piconet: max 7 slaves

- **Around-Mbit/s user throughput**
- **Low energy consumption**
- **Mostly oriented to Personal Area Networks (few nodes)**



# 802.15.4 – Zigbee vs WiFi

