Protocols for Wireless Networking

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Overview

Wireless Networking Protocols

- Wi-fi and its many standards
- Bluetooth
- NFC
- RFID

There Is More Than One Wireless Protocol

We often call anything wireless “Wi-fi”

There are multiple ways of wireless communication

Different protocols have different advantages

- **Battery savings**
- **Speed**
- **Range**

Wi-Fi

Wi-Fi

All devices with the Wi-Fi trademark use an IEEE standard

- Institute of Electrical and Electronics Engineers

802.11a - First wireless standard (1999)

- 5 GHz
- 54 Mbps
- Low range
- Not really used anymore

802.11**b**

2.4 Ghz

11 Mbps

Better range

Interference from household devices

Microwave ovens | Baby monitors

Cordless telephones

802.11**g**

2.4 GHz

54 Mbps

Backward compatible with 802.11b

Same interference issues as 802.11b

802.11**n**

October 2009

Works on both 2.4GHz and 5GHz

600 Mbps

Multiple-Input
Multiple-Output antennas

MIMO

802.11**ac** (WiFi 5)

January 2014

5GHz

7 Gb/s

802.11**ax** (WiFi 6)

August 2019

Works on both 2.4GHz and 5GHz

14Gbps

802.11ax-2021 (Wi-Fi **6E**)

Certified in January 2021

Uses the 6GHz band

Only 802.11ax devices supported on 6GHz

Not Available in All Countries Yet

A Note On Wireless Regulations

Two types of frequencies

- **Licensed**
  - **A company needs to buy a license to transmit in that frequency**
- **Unlicensed**
  - **Everyone can use this frequency to transmit data**
    - **There are still rules you need to follow!**

Wi-Fi frequencies are unlicensed

- **You don’t need to apply for a license for the wi-fi in your home!**
- **The regulations are *usually* hardcoded by the wireless router**
  - **Ex: Signal Power**

Example Regulation for Unlicensed Bands

Regulations depend per country

- **I will use US (FCC) numbers**

Wi-Fi 6E routers can transmit with up to 36 dBm of equivalent isotropic radiated power (EIRP)

- **Total radiated power from a transmitter antenna times the numerical directivity of the antenna**

2.4 GHz / 5GHz / 6GHz all have different regulations

- **For both transmitter and clients**

Wi-Fi Frequencies & Channels

2.4 GHz - everything between 2.4 - 2.5 GHz

5GHz - 5.1 - 5.8 GHz

- **The 5.9 Ghz frequency is called the Safety Band**
  - **Reserved for transportation-related communication**
- **In 2020 – FCC split this between unlicensed and its original purpose**

2.4 GHz includes 14 channels

- **Only 11 used in North America**
- **14 used in Japan**

Every channel is a different sub-frequency range on which communication is done

2.4 GHz Wi-Fi Channels

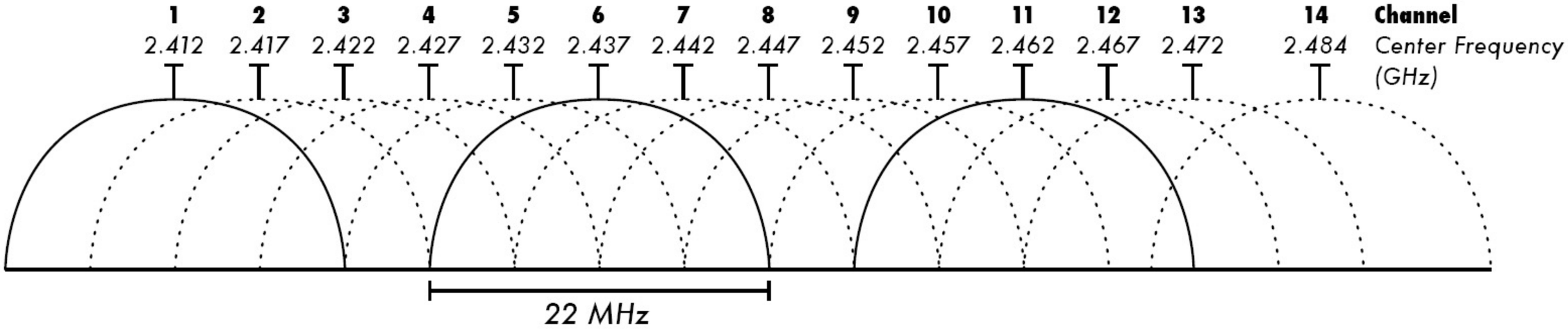
Each transmission channel takes 20-22 MHz

Each channel is separated by 16-22 MHz

Communication channel can be set on your router and different Wi-Fi devices

99% of the time it's done automatically when setting up devices

Only channels 1, 6, 11 are non-overlapping



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5GHz and 6GHz

5 GHz

24 x 20MHz non-overlapping channels!

Ability to have 40, 80 or even 160 MHz channels

6 GHz

7 x 160 MHz channels!

Wi-Fi – Summary Cheat Sheet

802.11a
5GHz / 54 Mbps

802.11b
2.4GHz / 11 Mbps

802.11g
2.4GHz / 54 Mbps

802.11n
2.4Ghz or/and 5Ghz / 600 Mbps

802.11ac (Wi-Fi 5)
5GHz / 7 Gbps

802.11ax (Wi-Fi 6)
2.4Ghz or/and 5Ghz / 14Gbps

802.11ax (Wi-Fi 6E)
6 GHz

Other Wireless Networking Protocols

Bluetooth

Wireless standard for exchanging data over short distances

- 800 feet in Bluetooth 5.0 (theoretical)

Operates at 2.4 GHz

Very low battery consumption in Bluetooth “Classic” compared to WiFi

- Bluetooth Low Energy (BLE) is a version of Bluetooth with even lower consumption

Lower maximum speed than WiFi

- WiFi 6E = 1Gbps+
- Bluetooth = 1-3 Mbps

NFC

Near Field Communication

Very low range

- Under 10 centimeters

Passive or active

- Passive: bus card, credit cards
- Active: phone, card reader

RFID

Radio-Frequency Identification

Similar purpose as barcode

- Does not need direct line-of-sight

Used in many industries to track items

- Progress of a car through the assembly line
- Track pharmaceuticals through warehouses

Can be implanted under skin

- Tracking livestock

Conclusion

Wireless Networking Protocols

Wi-fi

- 802.11a
- 802.11b
- 802.11g
- 802.11n
- 802.11ac (Wi-Fi 5)
- 802.11ax (Wi-Fi 6)
- 802.11ax-2021 (Wi-Fi 6E)

Bluetooth

NFC

RFID

Up Next:
Networked Hosts and Their Services