LANCOM White Paper

Wi-Fi 6E

With the numbers of end devices growing steadily and the increasing density of IoT devices, the load on the available Wi-Fi frequencies has made communication hardly possible without collisions. For this reason and for almost 15 years of no changes within the spectrum usages, the Wi-Fi industry actively requested the National Regulatory Agencies for new frequencies. The American regulatory authority FCC has already allocated the full spectrum of 1,200 MHz for Wi-Fi in the 6-GHz band. In Europe, at least the first half of the spectrum (500 MHz) is expected to be allocated by the summer of 2021; the so-called lower-band of 6 GHz. The Wi-Fi Alliance generally extends Wi-Fi 6 by the 6-GHz band, calling it "Wi-Fi 6E". A new era for wireless LAN has begun!

Focusing on high density

The advantages of Wi-Fi 6 are most apparent in what are known as high-density environments, where very large numbers of Wi-Fi end devices or IoT devices all operate at the same time. Examples are football stadiums, concert venues, convention centers, trade fairs, airports or universities, schools or hospitals and the like.

Wi-Fi 6 thus sets new benchmarks and leads to a significant increase in performance. However, this is quickly offset by the exponential growth in the amount of data transmitted per client. Wi-Fi 6E remedies this by opening up additional spectrum for WLAN access points and clients. This is because the currently available spectrum often represents a bottleneck. For example, the 2.4 GHz frequency band is generally crowded with a high number of clients. And the number of users in the 5 GHz band is also rising steadily, with DFS (radar detection) also posing a problem there.

In Europe, two frequency bands are currently available for Wi-Fi: the 2.4-GHz band (2400–2483.5 MHz, channels 1–13) and the 5-GHz band (5150–5350 MHz, channels 36–64 and 5470–5725 MHz, channels 100–140 as well as 5735-5875 MHz, channels 149-173, yet the latter with a lower transmission power). Operating on the 5-GHz band requires the use of Dynamic Frequency Selection (DFS) on channels 52 to 140. This restricts access points to those channels that are currently free, since channels may be occupied by various systems such as weather radar.

In Europe, for example, the 2.4-GHz band provides a maximum of just three non-overlapping channels with a bandwidth of 22 MHz or four overlap-free channels with a bandwidth of 20 MHz each, whereas the 5-GHz band supports up to 27 of these channels, although not all of them can be used all the time due to the restrictions mentioned above. The recent Wi-Fi standards Wi-Fi 4 (IEEE 802.11n), Wi-Fi 5 (IEEE 802.11ac), and Wi-Fi 6 (IEEE 802.11ax) bundle these channels in order to increase data transfer rates. This decreases the number of usable channels accordingly. Permitted, and even required by some standards, are channel widths of 40, 80, and optionally 160 MHz.

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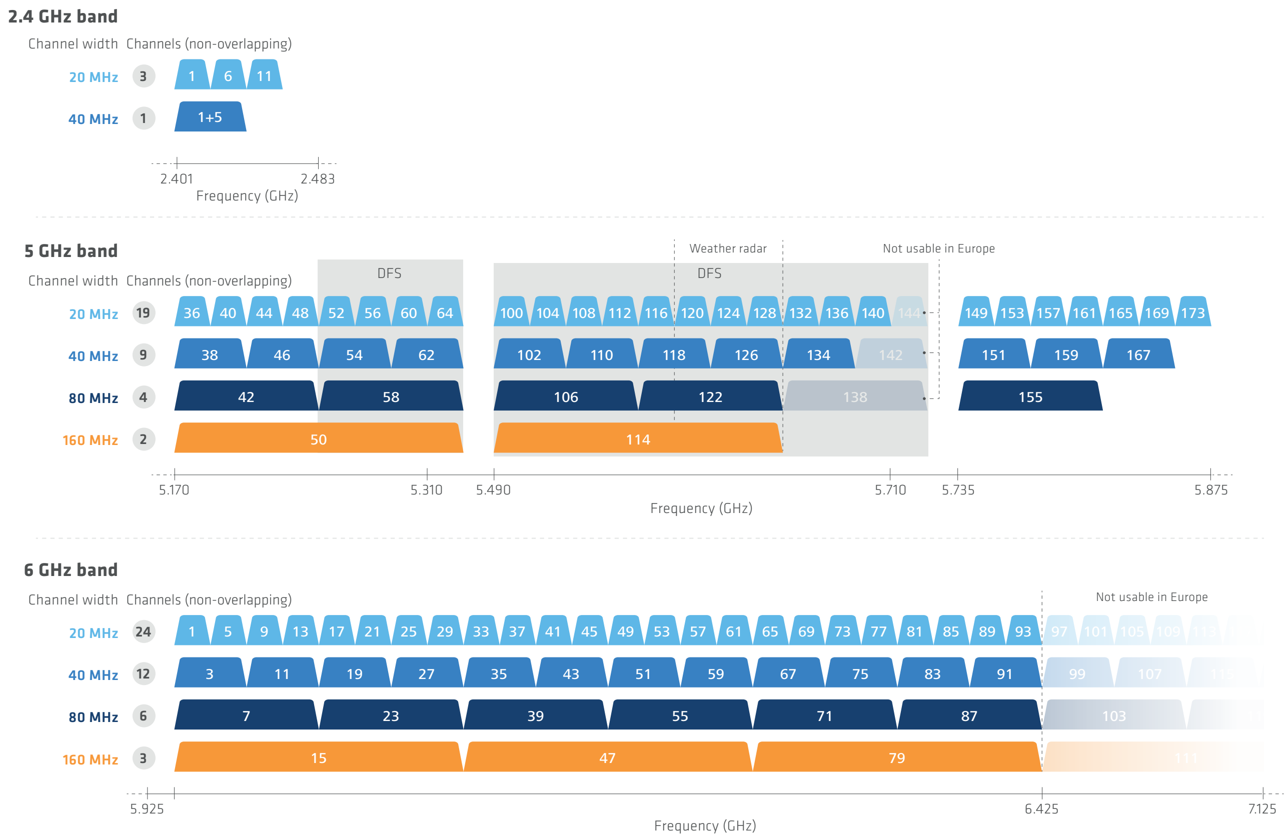

Fig. 1: Frequency scheme 2.4 GHz, 5 GHz, and 6 GHz

Evidently, current Wi-Fi standards fully exploit the Wi-Fi spectrum made available so far and, with the number of Wi-Fi-enabled devices growing fast, capacities are exhausted.

A major step for Wi-Fi

The American regulatory authority FCC is planning to expand the Wi-Fi spectrum by a further 1,200 MHz in the 6-GHz band (5925-7125 MHz), which effectively multiplies the spectrum available for Wi-Fi. This will provide an additional 59 channels of 20-MHz bandwidth. Similarly, the number of the frequently used 40- and 80-MHz bandwidth channels increases by 29 and 14, respectively. Even at the extreme of 160-MHz bandwidth channels, the available spectrum allows the use of seven additional channels. On top of that, the available spectrum is a preparation for the upcoming wireless LAN standard Wi-Fi 7, which will be able to create 320 MHz channel widths.

Europe is planning to approve the 6-GHz frequencies available exclusively to license-exempt technologies such as Wi-Fi by 500 MHz (5925–6425 MHz) in 2021 (for Low Power Indoor and Very Low Power Portable, see info box). So far there has been no agreement on more continuous exclusive spectrum. Nevertheless, the Wi-Fi industry is striving to be able to use the spectrum above 6.425 GHz for wireless LAN one day. Nonetheless, for Europe this additional 500 MHz is the first expansion of the Wi-Fi frequency range in over 15 years. It more than doubles the spectrum available to Wi-Fi. The number of 20-MHz bandwidth channels exclusively for Wi-Fi increases by 24; accordingly, bundling these channels results in 12 additional 40-MHz channels, six 80-MHz channels and, potentially, three extremely wide 160-MHz channels.

Device classes for the 6 GHz band

Low Power Indoor

Currently, the global Wi-Fi industry anticipates two different classes of devices for the 6 GHz band. The best-known class is “Low Power Indoor” (LPI). These are devices that may be operated indoors and can use a maximum of 200 mW (23 dBm) EIRP transmission power. In addition, an access point must be operated via a power plug or PoE in Europe, and the use of batteries is prohibited. This is to prevent indoor access points from being operated outdoors in large numbers. There is no such restriction on the client side. It is assumed that the requirement that access points are only to be operated indoors will lead to low outdoor use of clients in 6 GHz. After all, a smartphone is perfectly capable of getting outside and still maintaining a connection to an indoor access point, e.g. in the garden or on the balcony.

Very Low Power

The other class is called “Very Low Power” (VLP) and describes devices that are usually worn close to the body and span a so-called “Personal Area Network” (PAN). A well-known example of this is AR/VR headsets, which could be wirelessly paired with a smartphone or tablet. Since these devices are portable and can be used outdoors, there is a restriction on transmit power here to only 25 mW (14 dBm). Another use case would be head-up displays in car windows, which also receive their data from an on-board computer or smartphone via Wi-Fi 6E from an on-board computer or smartphone.

Summary

The release of the 6-GHz band will be a huge boost to Wi-Fi over the next few years. Exclusive use of Wi-Fi 6 means that Wi-Fi connections are more stable, and the significantly greater bandwidth and very low latency times make room for an exponential growth in users of Wi-Fi 6E networks.

Wi-Fi 6E transfers existing Wi-Fi 6 features to the 6 GHz band, including orthogonal frequency division multiple access (OFDMA), target wake time (TWT), and multi-user multiple input, multiple output (MU-MIMO). It also enforces the use of the latest security standards, WPA3, for home and corporate networks, and Enhanced Open for open networks such as Wi-Fi hotspots. With the use of the current latest and best Wi-Fi encryption standards, the networks and users should be even better protected.

Initial tests with pre-production models from well-known manufacturers of chipsets and radio modules indicate that we can expect clients such as notebooks and smartphones to achieve transfer rates of up to 2 Gbps with latency times of less than one millisecond. The advantages of Wi-Fi 6E are most apparent in in high-density environments, with very large numbers of Wi-Fi end devices or IoT devices all operating at the same time. Furthermore, Wi-Fi 6E achieves performance levels so far available only to local industrial networks based on the latest cellular standard 5G—however, the investment costs are just a fraction. This way, state-of-the-art IoT or VR applications will become cost-effective.