IEEE P802.18
Radio Regulatory Technical Advisory Group (RR-TAG)

Draft Response Czech Spectrum Strategy Consultation

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Author(s):

Name	Company	Address	Phone	email
Benjamin Rolfe	BCA			ben.rolfe@ieee.org
Dries Neirynck	Ultra-Radio			dries.neirynck@ultra-radio.com
Edward Au	Huawei			edward.ks.au@gmail.com
Clint Powell	HID Global			cpowell@ieee.org
Hassan Yaghoobi	Intel			Hassan.yaghoobi@intel.com
Claudio da Silva	Meta			claudiodasilva@meta.com
David Goodall	Morse Micro			dave@morsemicro.com
David Halasz	Morse Micro			dave.halasz@ieee.org
Dorothy Stanley	HP Enterprise			dstanley@ieee.org

This contribution proposed a response to:

Czech Republic Czech Telecommunications Office (CTU)'s call for comments on the update of the Radio Spectrum Management Strategy consultation. See https://www.ctu.eu/call-comments-update-radio-spectrum-management-strategy.

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Re: Czech Republic CTU's call for comments on the update of the Radio Spectrum Management Strategy update.

Dear Chairman, CTU, Radio Department, Policy and Strategy Unit,

IEEE 802 LAN/MAN Standards Committee (LMSC) thanks Czech Republic Czech Telecommunications Office (CTU) for providing this opportunity to participate in the process of updating the current version of the Radio Spectrum Management Strategy ("report").

IEEE 802 LMSC is a leading consensus-based industry standards body, producing standards for wireless networking devices, including wireless local area networks ("WLANs"), wireless specialty networks ("WSNs"), wireless metropolitan area networks ("Wireless MANs"), and wireless regional area networks ("WRANs"). We also produce standards for wired Ethernet networks, and technologies produced by implementers of our standards are critical for all networked applications today.

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Please find below the comments of IEEE 802 LMSC to selected sections of the report.

Updates on UWB in Section 6.4.4.2: Short-range devices (SRD)

Section 6.4.4.2 of the report states: "*Applications using the ultra-wideband technology (UWB) met the expectations only to a very limited extent and tend to be used in industrial applications (cable detection, identification of vehicles and surveillance applications, support of safety in industry, etc.)*". IEEE 802 LMSC would like to inform the CTU that the application and deployment of UWB technology has changed dramatically since the publication of the report. Today, UWB technology based on IEEE Std 802.15.4 is included in mass market consumer devices, including smartphones, vehicles, and consumer accessories. UWB is a key technology in indoor location tracking, material sensing, and other industrial applications. Growth into consumer products, however, is a significant change.

<u>Current and future state of IEEE 802.15.4 UWB</u>

IEEE 802.15 standards specify UWB technology operation. IEEE Std 802.15.4-2020 [1] and IEEE Std 802.15.4z-2020 [2] are standards for precision ranging that support data communication, location discovery, and device ranging. The standards support operation in many frequency ranges including sub-1 GHz bands and 3.1 GHz to 10.6 GHz bands [3] and are increasingly used in many

[1] This document solely represents the views of IEEE 802 LMSC and does not necessarily represent a position of either the IEEE or the IEEE Standards Association.

high value applications. The capability of IEEE Std 802.15.4z-2020 to support secure ranging has led to a renewed interest in UWB from industry. The automotive industry was the driving force behind IEEE Std 802.15.4z-2020 and the first to include UWB in consumer products. Mobile handset makers have followed closely. This is generating significant economic and social value, attracting further interest in developing a robust and diverse industry ecosystem. For example, the UWB Alliance supports members in many application areas, including but not limited to agriculture, sensing, and radar; the FiRa Consortium is focused on precise (fine) ranging applications and localization; OmLox is supporting industrial localization; the Car Connectivity Consortium has been focused on automotive uses; while the Connectivity Standards Alliance is focused on secure premises access for, but not limited to corporate, hospitality, university, single-family homes, and multi-family homes. There is cooperation among these organizations to support the broad needs of the industry in complimentary ways.

The IEEE 802.15.4ab task group [4] is developing the next generation of UWB standard based on industry needs to fuel the next round of innovative products. The IEEE P802.15.4ab project is built on IEEE Std 802.15.4z-2020. New developments supported by the project include features to improve link budget and/or reduce air-time, sensing capabilities to support presence detection and environment mapping, improved accuracy, precision and reliability for high-integrity ranging, interference mitigation techniques to support greater device density and higher traffic use cases and to provide improved coexistence in the presence of other services in support of different regulatory requirements. Additional mechanisms are being defined to reduce complexity and power consumption, and to enhance support for ultra-low energy and low latency streaming, while ensuring compatibility with the deployed base of products.

<u>Expanded applications and massive growth</u>

It can be noted that the uses which the CTU identified in 2015 were, then and still today, critically important uses. UWB is still used for location tracking and material sensing in industrial environments extensively. The market has significantly expanded. Following completion of ECC Report 278 and IEEE Std 802.15.4z-2020, UWB has become ubiquitous and there are lots of active UWB development and deployments. For example, UWB is now used to secure passive keyless entry systems in many vehicles and for premises access. Mobile phone manufacturers have also been integrating UWB in their smart phones.

Sensing based upon UWB is another area of explosive growth. The ultra-low transmit power (at or below unintentional emissions limits) and very high dynamic response of impulse radio-UWB (IR-UWB) enables precise, fast, and accurate sensing for uses such as presence detection of children left in vehicles.

As another example of current market trends, UWB is emerging as a leading technology for ultra-low power, ultra-low latency moderate data rate communications such as real time audio and real-time ultra-low latency human interface devices for gaming.

In summary, while it may have appeared in 2015 that UWB had not lived up to original expectations, presently UWB deployments are numbering over a billion devices and are growing exponentially [5]. The UWB adoption timeline is consistent with that of the other popular license exempt technologies from first rulemaking to mass market adoption.

It is an appropriate time to develop a strategic plan for UWB

Given the increasing importance of UWB, IEEE 802 LMSC would like to encourage the CTU to include a strategy for UWB development in its radio spectrum management strategy.

Within CEPT, ECC Report 327 led to an update of ECC Decision (06)04 last year, removing the prohibition on fixed outdoor devices, simplifying the use of UWB in vehicular applications and enhancing the transmit power of indoor devices. IEEE 802 LMSC respectfully ask the CTU to include these measures in the Czech Republic's national regulations. Harmonization of regulations has many benefits, both technical and economic. In addition, CEPT ECC SE24 is beginning to revisit the UWB regulations in the 8.5 GHz to 10.6 GHz bands.

Furthermore, as the number and variety of applications of IEEE 802.15.4 UWB devices continue to grow, radio spectrum policies and spectrum regulations can help combat climate change by creating conditions conducive to lowering power usage. For example, with the constraint of -41.3 dBm/1 MHz power spectral density, or in other terms, 37 nJ/ms, the IEEE 802.15.4 UWB radios cause very little or no interference to other users of the same spectrum (e.g., there are defined restrictions for UWB radios to operate from 3.1 GHz to 10.6 GHz bands), but the IEEE 802.15.4 radios themselves may become blocked by strong nearby signals. While regulations do not protect IEEE 802.15.4 radios from interference, spectrum policies can keep parts of the spectrum suitable for energy efficient low power device use.

Additional information that the CTU may find helpful in updating its spectrum strategy, including potential updates to current rules for UWB, can be found in the references [6] [7].

Updates on IEEE 802.11/Wi-Fi to Section 6.4.4.1: WiFi radio access networks

IEEE 802.11 technologies provide significant economic value

IEEE 802.11 technologies are integral to the modern communications infrastructure and vital for sustaining social and economic progress of citizens, enterprises, and governments in the Czech Republic and worldwide.

IEEE 802.11 technologies directly support quality communication services, spur economic development, and foster innovation, benefiting established and developing communities alike. For example, Wi-Fi technology, which is based on the IEEE 802.11 standard, serves as an important platform for offering free internet access, fostering educational and business opportunities in underserved communities. IEEE 802.11 technologies are a key enabler of emerging applications such as augmented and virtual reality (AR/VR), industrial IoT, and dense deployment scenarios such as stadiums. With a global device estimate of 18 billion and an annual addition of 4 billion devices [8], IEEE 802.11 technologies drive economic growth and innovation. As shown in [9], the number of Wi-Fi hotspots was expected to grow fourfold from 2018 to 2023, resulting in about 628 million public Wi-Fi hotspots by the end of 2023. As shown in an industry consortia report [10], Wi-Fi contributes USD $458 billion in European Union's economic value in 2021, and the economic value is expected to increase to USD $637 billion by 2025.

Current and future state of IEEE 802.11

Today, Wi-Fi networks based on IEEE 802.11 standards are found in residential, office, and industrial environments, in public and private settings. Users in an array of industries rely on these cost effective, energy efficient technologies. Each new generation of IEEE 802.11 technologies continues to improve efficiency, reliability, latency, throughput, and determinism. IEEE 802.11 standards support operation in several frequency bands, including the sub-1 GHz, 2.4 GHz, 5 GHz, 6 GHz (5925 MHz to 7125 MHz), and 60 GHz (57 GHz to 71 GHz) bands, with significant global deployments.

IEEE 802.11 technologies include a number of mechanisms that lead to efficient and sustainable utilization of the radio spectrum. IEEE 802.11 technologies, for example, adopt a Listen-Before-Talk (LBT)-based interference avoidance procedure and incorporate power saving mechanisms such as Target Wake Time (TWT). As discussed below, the new generation of IEEE 802.11 technologies, currently under development in the IEEE P802.11be amendment, will continue to improve performance and enhance spectrum coexistence capacities.

Of note, the IEEE Std 802.11ax-2021 [11] standard supports operation in the upper 6 GHz band (6425 MHz to 7125 MHz), and products based on this standard are seeing significant adoption where regulatory rules permit deployment [12]. The significance of unlocking the upper 6 GHz band for Wi-Fi radio access networks cannot be overstated, as access to larger, contiguous bandwidths in the 6 GHz band reduces the potential for harmful interference [13] and allows for IEEE 802.11 technologies to support more effectively emerging delay-sensitive residential, enterprise, and industrial applications. A new generation of IEEE 802.11 technologies, currently under development in the IEEE P802.11be amendment, will continue to enhance coexistence strategies and provide even more effective spectrum sharing and sustainable utilization in these bands. Moreover, the Wi-Fi industry is taking the lead in specifying coexistence strategies for bands with incumbent users, such as automated frequency coordination [14], [15], [16] and other coexistence mechanisms supported by different regulatory methods in the 6 GHz band [17].

The IEEE 802.11ah-2016 standard [18], known as Wi-Fi HaLow in the marketplace, is an amendment to the IEEE 802.11 standard that specifies mechanisms for operation of Wi-Fi in sub 1 GHz bands. It was developed with sensor and IoT networks in mind and agriculture is one of the potential applications [19]. IEEE 802.11ah-2016 standard includes an access point (AP) Power Save Mode. In this mode, the AP can signal to non-AP devices in the network that it is going to be in a "doze mode" for a period of time. By negotiating the length of the doze mode in advance, the AP and the non-AP devices can both conserve energy. This amendment introduced many features to increase energy efficiency. These include reducing overhead and relaxing timing for energy limited clients that typically operate from a coin cell. It also introduced TWT, which allows long sleeping devices to negotiate a time for the device to be active. This enables optimizing power consumption per device.

Suggested modifications to Section 6.4.4.1. WiFi radio access networks

Note: The text that follows suggests modifications to Section 6.4.4.1 as it appears in the report. The suggested modifications describe what is proposed to be changed by using ~~strikethrough~~ (to remove text from the current Radio Spectrum Management Strategy) and underscore (to add new material).

Note: IEEE 802 LMSC respectfully asks the CTU to consider replacing “WiFi” with “Wi-Fi” throughout the report.

6.4.4.1. WiFi radio access networks

From economic point of view, the use of WiFi technology is among the most important ones. WiFi technology is used for wireless access networks as well as for offloading of 3G/4G/5G data traffic terminals (data off-loading[109]). Bands 2400 – 2483.5 MHz (frequency band 2.4 GHz), ~~and~~ 5150 – 5350 MHz and 5470 – 5725 MHz (frequency band of 5 GHz), and 5945 – 6425 MHz (frequency band 6 GHz) are harmonised in Europe for WiFi technology[144] and are used by computers, tablet PCs, smart phones and other devices designed for connection to public and private networks. It is estimated[145] that WiFi connection is used by 75 % of the users of smart phones. In most regions of the world WiFi is understood as a key component of development of Internet connection. Standard IEEE 802.11n practically enables speed over 100 Mbit/s, and standards IEEE 802.11ac and IEEE 802.11ax enable speeds of over 1000 Mbit/s ~~and 802.11ac gigabit speed~~.

The IEEE Std 802.11ax-2021 [11] standard supports operation in the 6425 MHz to 7125 MHz bands with channel bandwidth of up to 160 MHz, and products based on this standard are seeing significant adoption where regulatory rules permit deployment [12]. IEEE 802 technologies are designed not to cause interference with other users in these bands. The Wi-Fi industry is taking the lead in specifying a number of co-existence strategies for bands with incumbent users, such as automated frequency coordination [14], [15], [16].

The new generation of IEEE 802.11 technologies, currently under development in the IEEE P802.11be amendment, will continue to improve performance and enhance spectrum coexistence capacities. To achieve the targeted performance improvements, IEEE P802.11be introduces advanced features including channel bandwidths of up to 320 MHz, multiple resource units to a single station, multi-link operation, enhanced quality of service (QoS), improved TWT (for improved battery life for IoT or other applications), and improved punctured transmission/subchannels to accommodate coexistence with incumbents more effectively and efficiently. The P802.11be amendment currently supports carrier frequency operation between 1000 MHz and 7125 MHz with extension to 7250 MHz under consideration.

For the Wi-Fi 6 generation of products, IEEE 802.11ax introduced a trigger mechanism where the Wi-Fi AP can schedule uplink transmissions of a client, enabling predictability of access. Moreover, if a Wi-Fi 6 AP knows the QoS (throughput, latency) requirement of a client, the AP can schedule the clients accordingly. IEEE 802.11be, known as Wi-Fi 7 in the marketplace, further enhances the ability to control the medium (e.g., through restricted target wake time service periods, a.k.a. rTWT, advertised in Beacon frames). These scheduling mechanisms introduced in IEEE 802.11ax and IEEE 802.11be work well to deliver predictable QoS in environments where the spectrum environment is controlled by a network manager, e.g., in industrial and manufacturing sites and stadiums. Additionally, IEEE 802.11be defines multi-link operation to further support high determinism and QoS and wide channel bandwidths up to 320 MHz to support increased throughput and capacity.

The related standards IEEE 802.11ad and IEEE 802.11ay (WiGig), approved in 2013 and 2021, respectively, ~~will~~ enable multi-gigabit communication at short distance in the bands 57 – 71~~66~~ GHz. In addition, the IEEE 802.11ah (HaLow) standard provides connectivity to beyond 1 km for low power, long range IoT devices in the sub-1 GHz band.

The potential of WiFi is based on the possibility of license-free operation and on continuous innovation – relative to the first specification of devices with speed 11 Mbit/s today's standards have exceeded the achievable speed almost by ~~two~~ three orders.

Popularity and development of WiFi will be also supported by the development of 4G and 5G networks which, in a certain phase of development, envisage offloading of the traffic by means of WiFi. WiFi networks ~~could become~~ are an integral part of mobile communication networks (e.g., by means of the WiFi hotspots). ~~The decision on the expansion, if any, of additional frequencies for mobile access networks in the frequency band of 5 GHz will be made by the international conference WRC-15. In this context, the European Commission issued mandate to CEPT in 2013 to prepare a *study of utilisation of the sections 5350 – 5470 MHz and 5725 – 5925 MHz by FWA networks* designated for provision of broadband services of electronic communications146.~~

Figure No. 3 – Current and possible future configuration of the band of 5 GHz for FWA/WiFi

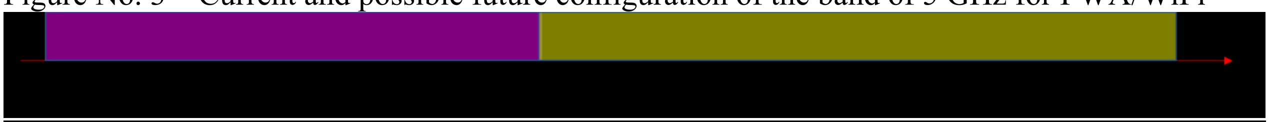

Figure No. 3a – Current and possible future configuration of the band of 6 GHz for FWA/WiFi

The expansion of bands pro FWA is conditional upon compatibility with other civil and non-civil use of the bands, in particular the radiolocation service, scientific services[147] and intelligent transport systems ITS[148] which are or will be important for ensuring security, fluency and economy of road traffic. The expansion of the bands would enable homogenous use of the spectrum by BWA/FWA/WiFi systems using channel width up to 320~~160~~ MHz which enable gigabit data throughput for enterprise and dense usages of innovative applications such as AR/VR. In some countries, the frequency band 5.725 – 5.825 GHz is now used[149] under the so-called light license usually in rural areas for wireless access. The preliminary internal analysis of the Office prepared according to the measurement results suggests compatibility of the existing ITS systems with BWA/FWA/WiFi systems. In the frequency band of 5350 – 5470 MHz the facilitation of mutual coexistence is significantly more complicated and it would require sophisticated procedures preventing mutual interference (e.g., geo-location databases).

Consequences of utilisation of the spectrum by WiFi networks: In both frequency bands of 2.4 GHz and 5 GHz designated for the operation of WiFi networks there have been cases of mutual local interference of the networks and other signs indicating quite high load on the band. In a part of the 5GHz band designated for the operation of outdoor networks there are instances of interference with meteorological radars due to WiFi operators' failure to comply with the operating conditions. Since this phenomenon has very adverse implications for the quality of the services using the information from the meteorological radars the problem is dealt with both on international level and on national level (see Article 3.6).

Conclusion

IEEE 802 LMSC thanks the CTU for the opportunity to provide this submission. We encourage the CTU in future version of the Radio Spectrum Management Strategy to take into account the latest development of IEEE 802.11 and IEEE 802.15 technologies and consider a strategic plan for UWB.

Respectfully submitted

By: /ss/.
Paul Nikolich
IEEE 802 LAN/MAN Standards Committee Chairman
em: p.nikolich@ieee.org

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