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

Draft Response Czech Spectrum Strategy Consultation

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4 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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5
6 Electronic filing

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7
8 Re: Czech Republic CTU's call for comments on the update of the Radio Spectrum Management
9 Strategy update.

10
11 Dear Chairman, CTU, Radio Department, Policy and Strategy Unit,

12
13 IEEE 802 LAN/MAN Standards Committee (LMSC) thanks Czech Republic Czech
14 Telecommunications Office (CTU) for providing this opportunity to participate in the process of
15 updating the current version of the Radio Spectrum Management Strategy ("report").

16
17 IEEE 802 LAN/MAN Standards Committee (IEEE 802 LMSC) is a leading consensus-based open
18 standards development committee for networking standards that are used by industry globally. It
19 produces standards for networking devices, including wired and wireless local area networks
20 ("LANs" and "WLANs"), wireless specialty networks ("WSNs"), wireless metropolitan area
21 networks ("Wireless MANs"), and wireless regional area networks ("WRANs"). Technologies
22 produced by implementers of our standards are a critical element for all networked applications
23 today.

24
25 IEEE 802 LMSC is a committee of the IEEE Standards Association and of Technical Activities,
26 two of the Major Organizational Units of the IEEE. IEEE has about 400,000 members in over 160
27 countries and its core purpose is to foster technological innovation and excellence for the benefit
28 of humanity. IEEE is also a major accredited standards development organization whose standards
29 are recognized world-wide. In submitting this document, IEEE 802 LMSC acknowledges and
30 respects that other components of IEEE Organizational Units may have perspectives that differ
31 from, or compete with, those of IEEE 802 LMSC. Therefore, this submission should not be
32 construed as representing the views of IEEE as a whole¹.

33
34 Please find below the comments of IEEE 802 LMSC to selected sections of the report.

35
36 **Updates on UWB in Section 6.4.4.2: Short-range devices (SRD)**

37
38 Section 6.4.4.2 of the report states: "*Applications using the ultra-wideband technology (UWB) met*
39 *the expectations only to a very limited extent and tend to be used in industrial applications (cable*
40 *detection, identification of vehicles and surveillance applications, support of safety in industry,*
41 *etc.)". IEEE 802 LMSC would like to inform the CTU that the application and deployment of*
42 *UWB technology has changed dramatically since the publication of the report. Today, UWB*
43 *technology based on IEEE Std 802.15.4 is included in mass market consumer devices, including*
44 *smartphones, vehicles, and consumer accessories. UWB is a key technology in indoor location*
45 *tracking, material sensing, and other industrial applications. Growth into consumer products,*
46 *however, is a significant change.*

47
48 **Current and future state of IEEE 802.15.4 UWB**

49
50 IEEE 802.15 standards specify UWB technology operation. IEEE Std 802.15.4-2020 [1] and IEEE
51 Std 802.15.4z-2020 [2] are standards for precision ranging that support data communication,

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.

52 location discovery, and device ranging. The standards support operation in many frequency ranges
53 including sub-1 GHz bands and 3.1 GHz to 10.6 GHz bands [3] and are increasingly used in many
54 high value applications. The capability of IEEE Std 802.15.4z-2020 to support secure ranging has
55 led to a renewed interest in UWB from industry. The automotive industry was the driving force
56 behind IEEE Std 802.15.4z-2020 and the first to include UWB in consumer products. Mobile
57 handset makers have followed closely. This is generating significant economic and social value,
58 attracting further interest in developing a robust and diverse industry ecosystem. For example, the
59 UWB Alliance supports members in many application areas, including but not limited to
60 agriculture, sensing, and radar; the FiRa Consortium is focused on precise (fine) ranging
61 applications and localization; OmLox is supporting industrial localization; the Car Connectivity
62 Consortium has been focused on automotive uses; while the Connectivity Standards Alliance is
63 focused on secure premises access for, but not limited to corporate, hospitality, university, single-
64 family homes, and multi-family homes. There is cooperation among these organizations to support
65 the broad needs of the industry in complimentary ways.

66
67 The IEEE 802.15.4ab task group [4] is developing the next generation of UWB standard based on
68 industry needs to fuel the next round of innovative products. The IEEE P802.15.4ab project is built
69 on IEEE Std 802.15.4z-2020. New developments supported by the project include features to
70 improve link budget and/or reduce air-time, sensing capabilities to support presence detection and
71 environment mapping, improved accuracy, precision and reliability for high-integrity ranging,
72 interference mitigation techniques to support greater device density and higher traffic use cases
73 and to provide improved coexistence in the presence of other services in support of different
74 regulatory requirements. Additional mechanisms are being defined to reduce complexity and
75 power consumption, and to enhance support for ultra-low energy and low latency streaming, while
76 ensuring compatibility with the deployed base of products.

77 **Expanded applications and massive growth**

78
79
80 It can be noted that the uses which the CTU identified in 2015 were, then and still today, critically
81 important uses. UWB is still used for location tracking and material sensing in industrial
82 environments extensively. The market has significantly expanded. Following completion of ECC
83 Report 278 and IEEE Std 802.15.4z-2020, UWB has become ubiquitous and there are lots of active
84 UWB development and deployments. For example, UWB is now used to secure passive keyless
85 entry systems in many vehicles and for premises access. Mobile phone manufacturers have also
86 been integrating UWB in their smart phones.

87
88 Sensing based upon UWB is another area of explosive growth. The ultra-low transmit power (at
89 or below unintentional emissions limits) and very high dynamic response of impulse radio-UWB
90 (IR-UWB) enables precise, fast, and accurate sensing for uses such as presence detection of
91 children left in vehicles.

92
93 As another example of current market trends, UWB is emerging as a leading technology for ultra-
94 low power, ultra-low latency moderate data rate communications such as real time audio and real-
95 time ultra-low latency human interface devices for gaming.

96
97 In summary, while it may have appeared in 2015 that UWB had not lived up to original
98 expectations, presently UWB deployments are numbering over a billion devices and are growing
99 exponentially [5]. The UWB adoption timeline is consistent with that of the other popular license
100 exempt technologies from first rulemaking to mass market adoption.

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

103
104 Given the increasing importance of UWB, IEEE 802 LMSC would like to encourage the CTU to
105 include a strategy for UWB development in its radio spectrum management strategy.

106
107 Within CEPT, ECC Report 327 led to an update of ECC Decision (06)04 last year, removing the
108 prohibition on fixed outdoor devices, simplifying the use of UWB in vehicular applications and
109 enhancing the transmit power of indoor devices. IEEE 802 LMSC respectfully ask the CTU to
110 include these measures in the Czech Republic's national regulations. Harmonization of regulations
111 has many benefits, both technical and economic. In addition, CEPT ECC SE24 is beginning to
112 revisit the UWB regulations in the 8.5 GHz to 10.6 GHz bands.

113
114 Furthermore, as the number and variety of applications of IEEE 802.15.4 UWB devices continue
115 to grow, radio spectrum policies and spectrum regulations can help combat climate change by
116 creating conditions conducive to lowering power usage. For example, with the constraint of -41.3
117 dBm/1 MHz power spectral density, or in other terms, 37 nJ/ms, the IEEE 802.15.4 UWB radios
118 cause very little or no interference to other users of the same spectrum (e.g., there are defined
119 restrictions for UWB radios to operate from 3.1 GHz to 10.6 GHz bands), but the IEEE 802.15.4
120 radios themselves may become blocked by strong nearby signals. While regulations do not protect
121 IEEE 802.15.4 radios from interference, spectrum policies can keep parts of the spectrum suitable
122 for energy efficient low power device use.

123
124 Additional information that the CTU may find helpful in updating its spectrum strategy, including
125 potential updates to current rules for UWB, can be found in the references [6] [7].

126
127 **Updates on IEEE 802.11/Wi-Fi to Section 6.4.4.1: WiFi radio access networks**

128
129 **IEEE 802.11 technologies provide significant economic value**

130
131 IEEE 802.11 technologies are integral to the modern communications infrastructure and vital for
132 sustaining social and economic progress of citizens, enterprises, and governments in the Czech
133 Republic and worldwide.

134
135 IEEE 802.11 technologies directly support quality communication services, spur economic
136 development, and foster innovation, benefiting established and developing communities alike. For
137 example, Wi-Fi technology, which is based on the IEEE 802.11 standard, serves as an important
138 platform for offering free internet access, fostering educational and business opportunities in
139 underserved communities. IEEE 802.11 technologies are a key enabler of emerging applications
140 such as augmented and virtual reality (AR/VR), industrial IoT, and dense deployment scenarios
141 such as stadiums. With a global device estimate of 18 billion and an annual addition of 4 billion
142 devices [8], IEEE 802.11 technologies drive economic growth and innovation. As shown in [9],
143 the number of Wi-Fi hotspots was expected to grow fourfold from 2018 to 2023, resulting in about
144 628 million public Wi-Fi hotspots by the end of 2023. As shown in an industry consortia report
145 [10], Wi-Fi contributes USD \$458 billion in European Union's economic value in 2021, and the
146 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 underline (to add new material).

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

199

200 6.4.4.1. WiFi radio access networks

201

202 From economic point of view, the use of WiFi technology is among the most important ones. WiFi
203 technology is used for wireless access networks as well as for offloading of 3G/4G/5G data traffic
204 terminals (data off-loading¹⁰⁹). Bands 2400 – 2483.5 MHz (frequency band 2.4 GHz), ~~and~~ 5150 –
205 5350 MHz and 5470 – 5725 MHz (frequency band of 5 GHz), ~~and~~ 5945 – 6425 MHz (frequency
206 band 6 GHz) are harmonised in Europe for WiFi technology¹⁴⁴ and are used by computers, tablet
207 PCs, smart phones and other devices designed for connection to public and private networks. It is
208 estimated¹⁴⁵ that WiFi connection is used by 75 % of the users of smart phones. In most regions
209 of the world WiFi is understood as a key component of development of Internet connection.
210 Standard IEEE 802.11n practically enables speed over 100 Mbit/s, ~~and standards IEEE 802.11ac~~
211 ~~and IEEE 802.11ax enable speeds of over 1000 Mbit/s and 802.11ac gigabit speed.~~

212

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

219

220 The new generation of IEEE 802.11 technologies, currently under development in the IEEE
221 P802.11be amendment, will continue to improve performance and enhance spectrum coexistence
222 capacities. To achieve the targeted performance improvements, IEEE P802.11be introduces
223 advanced features including channel bandwidths of up to 320 MHz, multiple resource units to a
224 single station, multi-link operation, enhanced quality of service (QoS), improved TWT (for
225 improved battery life for IoT or other applications), and improved punctured
226 transmission/subchannels to accommodate coexistence with incumbents more effectively and
227 efficiently. The P802.11be amendment currently supports carrier frequency operation between
228 1000 MHz and 7125 MHz with extension to 7250 MHz under consideration.

229

230 For the Wi-Fi 6 generation of products, IEEE 802.11ax introduced a trigger mechanism where the
231 Wi-Fi AP can schedule uplink transmissions of a client, enabling predictability of access.
232 Moreover, if a Wi-Fi 6 AP knows the QoS (throughput, latency) requirement of a client, the AP
233 can schedule the clients accordingly. IEEE P802.11be, known as Wi-Fi 7 in the marketplace,
234 further enhances the ability to control the medium (e.g., through restricted target wake time service
235 periods, a.k.a. rTWT, advertised in Beacon frames). These scheduling mechanisms introduced in
236 IEEE 802.11ax and IEEE P802.11be work well to deliver predictable QoS in environments where
237 the spectrum environment is controlled by a network manager, e.g., in industrial and
238 manufacturing sites and stadiums. Additionally, IEEE P802.11be defines multi-link operation to
239 further support high determinism and QoS and wide channel bandwidths up to 320 MHz to support
240 increased throughput and capacity.

241

242 The related standards IEEE 802.11ad ~~and~~ IEEE 802.11ay (WiGig), approved in 2013 ~~and~~ 2021,
243 ~~respectively,~~ will enable multi-gigabit communication at short distance in the bands 57 – 7166
244 GHz. In addition, the IEEE 802.11ah (HaLow) standard provides connectivity to beyond 1 km for
245 low power, long range IoT devices in the sub-1 GHz band.

246

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

250

251 Popularity and development of WiFi will be also supported by the development of 4G and 5G
 252 networks which, in a certain phase of development, envisage offloading of the traffic by means of
 253 WiFi. WiFi networks ~~could become~~ are an integral part of mobile communication networks (e.g.,
 254 by means of the WiFi hotspots). ~~The decision on the expansion, if any, of additional frequencies~~
 255 ~~for mobile access networks in the frequency band of 5 GHz will be made by the international~~
 256 ~~conference WRC-15. In this context, the European Commission issued mandate to CEPT in 2013~~
 257 ~~to prepare a study of utilisation of the sections 5350 – 5470 MHz and 5725 – 5925 MHz by FWA~~
 258 ~~networks designated for provision of broadband services of electronic communications~~¹⁴⁶.

259

260

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



262

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

264

265 The expansion of bands pro FWA is conditional upon compatibility with other civil and non-civil
 266 use of the bands, in particular the radiolocation service, scientific services¹⁴⁷ and intelligent
 267 transport systems ITS¹⁴⁸ which are or will be important for ensuring security, fluency and economy
 268 of road traffic. The expansion of the bands would enable homogenous use of the spectrum by
 269 BWA/FWA/WiFi systems using channel width up to ~~320~~160 MHz which enable gigabit data
 270 throughput for enterprise and dense usages of innovative applications such as AR/VR. In some
 271 countries, the frequency band 5.725 – 5.825 GHz is now used¹⁴⁹ under the so-called light license
 272 usually in rural areas for wireless access. The preliminary internal analysis of the Office prepared
 273 according to the measurement results suggests compatibility of the existing ITS systems with
 274 BWA/FWA/WiFi systems. In the frequency band of 5350 – 5470 MHz the facilitation of mutual
 275 coexistence is significantly more complicated and it would require sophisticated procedures
 276 preventing mutual interference (e.g., geo-location databases).

277

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

286

287 **Conclusion**

288

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

293

294 Respectfully submitted

295

296 By: /ss/.

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300

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302

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