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Radio Regulatory Technical Advisory Group (RR-TAG)

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| Proposed response to EU RSPG’s questionnaire |
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This document drafts a proposed response to EU RSPG’s questionnaire on the Role of Radio Spectrum Policy to help combat Climate Change.

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Electronic filing April 12, 2023

Re: Questionnaire on the Role of Radio Spectrum Policy to help combat Climate Change

Dear RSPG,

IEEE 802 LAN/MAN Standards Committee (LMSC) thanks Radio Spectrum Policy Group (RSPG) for issuing the questionnaire on the role of radio spectrum policy to help combat climate change and for the opportunity to provide feedback on this topic.

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.

IEEE 802 LMSC is a committee of the IEEE Standards Association and Technical Activities, two of the Major Organizational Units of the Institute of Electrical and Electronics Engineers (IEEE). IEEE has about 400,000 members in over 160 countries. IEEE’s core purpose is to foster technological innovation and excellence for the benefit of humanity. In submitting this document, IEEE 802 LMSC acknowledges and respects that other components of IEEE Organizational Units may have perspectives that differ from, or compete with, those of IEEE 802 LMSC. Therefore, this submission should not be construed as representing the views of IEEE as a whole[[1]](#footnote-1).

IEEE 802 LMSC supports RSPG’s ongoing activities on sustainability and climate change, and encourage RSPG to consider IEEE 802 technologies as playing an important role in providing energy-efficient wireless broadband connectivity to EU citizens. Please find below the responses of IEEE 802 LMSC to selected questions of this questionnaire.

***Introduction: the lesson IEEE 802 wireless technologies learnt from Ethernet***

IEEE 802 wireless technologies use, for most part, license-exempt spectrum to operate. The technologies specified by the IEEE 802 LMSC are used in a range of scenarios where energy-efficiency is of utmost important. For instance, the IEEE 802.15 family of standards provide specifications for technologies that are often energy-constrained or have "bursty" transmission patterns (e.g., a need to transmit or receive data only rarely, but over a long total product life-span), such as sensor or IoT networks. The IEEE 802.11 standard is incorporated in a large set of battery-driven devices (such as laptops and smartphones) used by individuals on a daily basis in professional and private settings that require a high level of energy efficiency to maximize utility of the devices for users, and also contains features to support bursty transmissions.

This contribution focuses on features and metrics for energy efficiency that have been guiding the development of IEEE 802 wireless technologies in the last 15 years. First we introduce an early contribution of the IEEE 802.3 Ethernet Working Group to energy efficiency in networking, and then we exemplify how learnings from that contribution progressed into wireless technologies, making them the highly efficient technologies they are today.

IEEE 802.3az-2010 was an early network standard that considered energy efficiency parameters suitable for standardisation. Low Power Idle feature has two components. The first is disabling the transmitter, except for necessary intermittent refresh signalling, during the Low Power idle state. This provides an energy saving compared to a continuous idle signal that was used on most links until then. The second is a 'sleep' and 'wake' signal that is sent before the link enters and before the link exits the Low Power Idle state, respectively.

The longer the wake time, the greater the potential energy savings in the receive device. This however comes at the cost of more buffering in the transmitting device, the transmitter must wait longer for the receiver to accept packets, and therefore greater latency. Since the latency a system can tolerate may vary over time, IEEE 802.3az-2010 defines Link Layer Discovery Protocol (LLDP) messages that allow the default latency to be changed through negotiation between the two ends of the link, enabling the wake time to be changed dynamically. As an example, while a personal computer (PC) is running a voice application, the latency can be set low at the price of potentially lower energy savings. When use of the voice application is complete, and the PC is just web browsing, the latency and therefore the energy savings can potentially be increased.

Since there is both a latency and energy overhead in bringing a link out of the Low Power Idle state, at low utilisation, it may be more energy efficient to bring a link out of the state once, rather than multiple times, to send multiple packets. It might even be possible that a constant low rate of packets will prevent a link from entering the Low Power Idle state. This is where the approach of buffering then bursting packets comes from, assuming the resultant increase in latency can be tolerated.

The lesson from the research work that led to the IEEE 802.3az-2010 and that followed on real-world deployments of this standard in networks in different environments, is that there are energy gains to be made from being able to schedule traffic, being able to transmit large amount of data in bursts rather than transmit smaller amounts of data continuously over a long time and being able to idle receivers. These lessons also apply for wireless technologies, and features supporting such behaviour are integrated through various features in IEEE 802 wireless technologies for a long time.

Questions 1)-3) target the sort of monitoring activity already initiated by ARCEP that is exemplified e.g. here: https://www.arcep.fr/cartes-et-donnees/nos-publications-chiffrees/impact-environnemental/derniers-chiffres.html Even though it's in French, the pictures are already very descriptive.

***Question 4. In your analyses related to energy consumption and/or energy efficiency, what are your reflections on the influence of parameters such as frequency band, type of radio access technology, coverage addressing different areas (urban, suburban, rural)?***

Ubiquitous deployments of wireless communications based on IEEE 802 technologies are essential to enable the EU’s sustainable development goals and achieve its Digital Decade vision. It has been remarked in several studies produced by or for European institutions that networks using IEEE 802 wireless technologies, in combination with wired backhaul over long distances, are the current leaders in terms of energy efficient networks.

As has been remarked by the RSPG’s opinion on Spectrum Policy in Climate Change published in November 2021, access to large, contiguous frequency blocks reduces the consumption associated with the support of multiple carriers and carrier aggregation. IEEE Std 802.11ax-2021 and IEEE P802.11be, for instance, introduce capability to operate in the entire 6 GHz band (i.e., 5925 MHz to 7250 MHz) with multiple concurrent 320 MHz channels. Regulatory conditions are likely to determine whether maximal energy-efficiency can be achieved for the intended applications of this technology. Extending the license-exempt operation to the upper 6 GHz band (specifically, 6425 MHz to 7125 MHz) in Europe is aligned with the RSPG’s opinion and make the maximization of energy efficiency possible.

In addition, as the RSPG recognises in its opinion that the current EU framework facilitates the roll-out of indoor networks, which in turn contributes to combat climate change, it is important for the RSPG to anticipate reflections on the future of the sub 1 GHz bands to enable wider deployment of IEEE 802 technologies especially for indoor settings. For instance, IEEE 802.15.4 technologies are often deployed in scenarios where a sensor device might sporadically need to transmit or receive low volumes data. For these technologies, transmission can be scheduled and devices remain dormant between transmissions. A design-goal is long life-span of each battery-powered device, often tens of years.

***Question 5. Is the energy efficiency of the wireless ECN not only measured / calculated but also subject to regulations in your country? If so, by which entity and for which purpose or objective? If so, please describe the provisions in place, including how these provisions are enforced and controlled (if applicable), and the experiences with these provisions so far.***

***Question 6. Taking into account the scope of the work of the RSPG above, do you wish to share other thoughts or ideas which could be helpful to the RSPG to identify the role radio spectrum policy can play to help combat climate change and mitigate other adverse environmental impacts?***

IEEE 802 wireless technologies are typically designed in a way such that they can be either primary or secondary users of a frequency band. The majority of extant deployments of IEEE 802 wireless technologies operate in license-exempt bands or bands where an incumbent user has priority access to the band. This has the advantages of enabling IEEE 802 wireless technologies to be flexible over time, as well as allowing IEEE 802 wireless technologies to co-exist with pre-existing priority services in different bands. We would like to highlight the observation by RSPG in its 2021 Opinion on Spectrum Policy in Climate Change that spectrum needs and demands to help combat against climate change can change over time. License-exempt designations provide flexibility to the regulator and to technology developers in terms of changing and adapting features to the current needs of society and the economy.

***Question 7. What information on energy consumption of the wireless ECNs does your company / the Members of your stakeholders' association collect? Which methodology/ methodologies are being used? Please name any standards that are being used.***

IEEE 802 wireless standards specify mechanisms that can be incorporated by implementers in products in the way that the implementers prefer and choose. The specific set of mechanisms chosen by implementers for a product and the use of those implemented mechanisms has a large impact on the energy use of the product.

For this reason, the IEEE 802 wireless groups do not themselves perform energy consumption benchmarking. Industry consortia that oversee particular uses of IEEE 802 wireless standards may, however, gather metrics on the energy consumption of implementations destined for those particular use-cases. We can highlight:

The Wi-Fi Alliance Sustainability information package , TBD

***Question 8. Does your company / the Members of your stakeholders' association measure or calculate energy efficiency of wireless ECNs? Which methodology/ methodologies are being used? Please name any standards that are being used.***

***Question 9. For the items described in Questions 7) and 8) above, which data breakdowns are available to your company / association: e.g., by operator (if applicable), by service, by frequency band, by technology (e.g., 2G/3G/4G/5G), by region, by site, by network element, etc.? Please mention also the cases for which incomplete breakdowns are available.***

***Question 10. Are you considering collecting any additional information that you could collect with reasonable effort?***

***Question 11. Which actions is your company / the Members of your association taking to improve the energy efficient use of radio spectrum (e.g. switching to new technologies, advertisements to make energy efficient technologies more attractive, sleep mode for base stations, or other actions)?***

IEEE 802 wireless standards already and continue to provide a rich toolbox of energy-saving features.

IEEE 802.11ah-2010 is an amendment to the IEEE 802.11 standard that specifies mechanisms for operation of WAS/RLAN in sub-1 GHz bands. It was developed with sensor and IoT networks in mind, and contains an 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.

The IEEE 802.11ax-2021 amendment to the IEEE 802.11 standard specifies (broadcast) Target Wake Time, which is a scheduling mechanism for transmissions between an AP and a non-AP. It has the advantage of allowing larger through-put while lowering latency since both devices will be aware of when transmissions will be made, but also enables energy-efficiency since the devices can be idle or quiet when transmissions do not need to be made.

The IEEE 802.11be amendment to the IEEE 802.11 standard, which was recently made accessible to a broader public, specifies multi-link operation - a way for multiple APs in a single device to coordinate traffic management over several bands. One mechanism provided for in multi-link operation is for the logical controlling entity of the multi-link device to quiet channels which are not necessary given the total data traffic load. In practice, if a multi-link device is capable of simultaneously sending traffic on 2,4 GHz, 5 GHz and 6 GHz links, but the current load on the network is such that only one or two of these links are necessary to provide a robust service level, the other one or two links can be quieted dynamically. The links can be un-quieted once the load on the network increases, with the result that the radios consume only the amount of energy they need for a given traffic load.

In the next major project of the IEEE 802.11 Working Group, namely the Ultra-High Reliability, the project description explicitly lists AP Power Save mechanisms as a target.

***Question 12. What were the triggers for these actions (e.g. legal requirement, economic interests, consumer expectations, competitiveness, etc.)?***

IEEE 802 wireless technologies are developed to satisfy market and society needs. Energy-efficient features are expected by consumers, enterprise and industrial users of IEEE 802 wireless technologies.

***Question 13. Were there any difficulties when you attempted to introduce or perform these actions? Please specify.***

No.

***Question 14. What further actions would enable you to foster (a more) energy efficient spectrum use, if any? Should such an activity be done by national spectrum regulators / ministries / European entities? Please specify and explain.***

***Question 15. Would some kind of spectrum regulation facilitate your motivation to use radio spectrum in a (more) energy efficient way?***

***Question 16. Taking into account the scope of the work of the RSPG above, do you wish to share other thoughts or ideas which could be helpful to the RSPG to identify the role radio spectrum policy can play to help combat climate change and mitigate other adverse environmental impacts?***

**Conclusion**

IEEE 802 LMSC thanks the RSPG for the opportunity to provide this submission and kindly requests the RSPG to take into account our responses in its decision towards the role of radio spectrum policy to combat climate change.

Respectfully submitted

By: /ss/.

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References:

[1] “IEEE Standard for Information Technology - Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks - Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Enhancements for High-Efficiency WLAN,” in *IEEE Std 802.11ax-2021 (Amendment to IEEE Std 802.11-2020)*, vol., no., pp.1-767, 19 May 2021, doi: 10.1109/IEEESTD.2021.9442429.

[2] Wi-Fi Alliance: Wi-Fi 6E momentum underscores need for entire 6 GHz band, November 2022. [Available online](https://www.wi-fi.org/news-events/newsroom/wi-fi-6e-momentum-underscores-need-for-entire-6-ghz-band) [accessed: 20 February 2023].

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. [↑](#footnote-ref-1)