NXP Comments to TRAI Consultation Paper on Open and De-licensed use of Unused or Limited Used Spectrum Bands for Demand Generation for Limited Period in Tera Hertz Range

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Introduction.

Scope

This document provides comments on TRAI Consultation Paper No 21/2023 “Consultation Paper on Open and De-licensed use of Unused or Limited Used Spectrum Bands for Demand Generation for Limited Period in Tera Hertz Range” as issued by the Telecom Regulatory Authority of India, 27.09.2023 from NXP India. The questions in the above consultation paper are addressed in sequence.

Some specific background is provided on the future need for ultra wide band (UWB) short range device (SRD) applications in this spectrum as this is a common theme for the answers to some of the questions below.

NXP

NXP Semiconductors N.V. (NASDAQ: NXPI), an S&P500 company, enables a smarter, safer, and more sustainable world through innovation. As the world leader in secure connectivity solutions for embedded applications, NXP is pushing boundaries in the automotive, industrial & IoT, mobile, and communication infrastructure markets. Built on more than 60 years of combined experience and expertise, the company has ~31.000 employees including 11,000 engineers in R&D who created 9,500 patent families in more than 30 countries and posted revenue of $13.21 billion in 2022.

Based on the expertise in the field of high-performance mixed signal NXP drives innovation in the automotive, identification, and mobile electronics industries as well as in the fields of vehicle communication and automated driving. Core areas of the portfolio are sensors, microprocessors, (cyber-)security technology as well as wired and wireless communication. As a world leader in automotive semiconductors, NXP offers advanced solutions for vehicle sensor systems and driver assistance systems and short-range high-speed data communication solutions.

NXP India

NXP’s presence in India goes back more than 50 years and is one of NXP’s largest design centers. Our Center of Excellence functions from four sites across India with more than 2500 engineers and over 500 patents, and is focused on innovations for the Automotive, IoT, Industrial and Mobile markets.

Noida is one of NXP’s largest sites. It is a Center of Excellence for hardware and software design, validation and enablement specifically around edge processing and automotive processing. NXP Bengaluru is a hub of innovation for NXP’s connectivity, security, advanced analog and radio frequency products with the automotive and IoT markets as key drivers. The Pune site focuses on end-to-end solutions for Wireless LAN, and Bluetooth® connectivity. Established in 2007, it becomes part of NXP through the acquisition of Marvell’s wireless business in 2019. Our design center in Hyderabad is focused on NXP’s edge processing and advanced analog businesses.

NXP offer to provide further background

NXP would be glad to provide additional information to provide a deeper understanding of unlicensed ultrawideband and automotive radar.

Need for unlicensed UWB spectrum.

Introduction to sub THz UWB SRD applications

More and more SRD applications emerge making use of (low power) UWB allocations. These new applications provide enormous benefit for citizens, industry and in commercial applications.

Examples where citizens directly benefit are Wireless LAN, automotive radar and other radar applications and very short distance ultra high-speed connectivity.

More institutional and professional application examples are generic indoor surveillance, radiodetermination systems for industry automation, short-range assist and surrounding monitoring for vehicles and autonomous systems, ground based synthetic aperture radar, level probing radar, contour determination and acquisition, tank level probing radar, radiodetermination systems for industry automation in shielded environments. These applications require from 500 MHz to up to 40 GHz or more of bandwidth, sometimes in bands permitting multiple channels for concurrently operating devices.

Coexistence considerations for sub THz UWB applications

In general attention is required for higher power outdoor and air borne UWB SRD applications. There is also significant tension for allocating low power or shielded UWB SRDs in passive bands defined in ITU RR 5.340: 52.6-54.25 GHz, 86-92 GHz, 100-102 GHz, 109.5-111.8 GHz, 114.25-116 GHz, 148.5-151.5 GHz, 164-167 GHz, 182-185 GHz, 190-191.8 GHz, 200-209 GHz, 226-231.5 GHz and 250-252 GHz. Some new ultrawideband applications require a very wide spectrum but have a very modest power spectral density. The current ITU-R 5.340 bands form a significant obstacle. It would be useful to ensure such very low power UWB SRD applications are allocated in bands above 252 GHz.

Impact of existing allocations on UWB SRD applications

ITU has allocated of services in the 95-252 GHz band above 95 GHz up to 252 GHz. Almost none of the allocations are in practical use. Much spectrum is allocated for Fixed Services and IMT. SRD services are mostly assigned by countries on an underlying non-priority / non-interference status.

In many cases UWB SRD applications can coexist with existing primary and secondary allocations. However, it is likely to be hard to co-allocate unlicensed UWB bands with IMT bands since IMT is likely to interfere with the UWB SRD applications. Vice versa, low power UWB SRD applications may create only slightly elevated noise floor for IMT receivers (i.e., there may be some, but always a very modest impact).

References to UWB SRD studies, standards and applications

Existing relevant work on SRDs in sub THz frequencies including compatibility studies can be found in:

- **ECC report 334**: https://docdb.cept.org/download/4289 (28.01.2022) identifies conditions under which UWB SRD applications generic indoor surveillance, radiodetermination systems for industry automation, short-range assist and surrounding monitoring for vehicles and autonomous systems, ground based synthetic aperture radar, level probing radar, contour determination and acquisition, tank level probing radar, radiodetermination systems for industry automation in shielded environments are compatible with Radio Astronomy Service, Fixed Service, Earth Exploration Satellite Service (passive) and Amateur Service. The band examined depends on the UWB application but ranges from 114.25 GHz to 260 GHz. The ECC report provided the basis for ECC Decision 22(03): https://docdb.cept.org/document/28577.

- **ECC report 351**: https://docdb.cept.org/document/28588 (03.02.2023) extends ECC report 334 with conditions under which exterior and in-cabin vehicular radars are compatible with Radio Astronomy Service, Fixed Service, Earth Exploration Satellite Service (passive) and Amateur Service in the 122.25-130 GHz and 134-148.5 GHz bands. The revision of ECC DEC 22(03) to accommodate these applications is in process.

- ITU is studying the frequency band from 275-450 GHz. This link provides and overview: https://www.itu.int/hub/2020/01/studies-on-the-use-of-frequency-bands-above-275-ghz-by-land-mobile-and-fixed-service-applications/. Applications mentioned are short range (kiosk downloading and ticket gate downloading mobile systems) and very short range (inter-chip communication systems, intra-device communications and wireless links for data centers). Key study report are ITU-R SM.2450 and ITU-R M.2517-0. In particular the band between 252 and 296 GHz could be a prime candidate for extremely wide band SRD applications. License free operation should be permitted.

- **IEEE 802.15 WSN SCTHz Terahertz Standing Committee** is studying communication applications from 300 GHz to 3 THz. There is considerable interest in middle-distance, short distance and very short distance communication applications.

- **IEEE Std 802.15.3d™-2017,** an amendment to IEEE Std 802.15.3™-2016, which defines physical layer (PHY) at the frequency range between 252 GHz and 325 GHz for switched point-to-point links and defines two PHY modes that enables data rates of up to 100 Gb/s using eight different bandwidths between 2.16 GHz and 69.12 GHz.

  Applications targeted with this standard comprise wireless backhaul/fronthaul links, wireless links in data centers as well as short-range applications such as kiosk downloading, intra-device and close-proximity communication. An extension of the channel plan up 450 GHz covering the spectrum, that has been identified by World Radiocommunications Conference (WRC) 2019 in Radio Regulation (RR) No. 5.564A.

- **ETSI ISG THz** https://www.etsi.org/technologies/terahertz-thz is studying 275 – 450GHz. See here for a public domain presentation: https://mentor.ieee.org/802.15/dcn/23/15-23-0354-00-0thz-presentation-of-etsi-isg-thz.pdf. Short distance applications with very high channel bandwidths play a prominent role. A collaboration is envisaged with IEEE 802.15 WSN SCTHz.

Questions in Consultation

Question 1: About the need to permit license-exempt operations in 116-123, 174.8-182, 185-190 and 244-246 GHz.

The 116 – 122.25 GHz band has a co-primary allocation for the EESS passive which is in active use. This consideration has led to the band being excluded for consideration for a higher power outdoor application: vehicular radars in ECC Report 351. Also see section 0.8 of ECC Report 334 for the permissible power of an extremely wide band application in this band: RDI-S.

The proposed unlicensed bands do not appear to be broadly useful considering ECC Report 334 and ECC report 351 for a number of realistic early day UWB SRD applications. On that basis there does not appear to be a clear application for UWB SRDs in this band at this point in time. It is for note that many countries have a 7 GHz or larger unlicensed band in 57-64 GHz (with minor national variations) which is still largely undeveloped at this stage.

Question 2: What should be the terms and conditions including technical parameters for permitting license-exempt operations in 116-123 GHz, 174.8-182 GHz, 185-190 GHz, and 244-246 GHz?

In view of the lack of specific interest of NXP no proposal is offered.

Question 3: Is there a need for permitting license-exempt operations in any other bands in the 95 GHz to 3 THz frequency range?

The applications investigated in ECC Report 334 and 351 should be considered for license exempt operation in the thereto assigned bands. NXP's specific interest is vehicular radars (both in-cabin and exterior radars) and very short distance communication. Vehicular radars can be deployed in the 122.25-130 GHz and 134-141 GHz and 141-148.5 GHz band. The regulations as proposed in the public consultation for Draft Revision of ECC Decision 22(03) Annex A2.7 can be used for this purpose: https://cept.org/files/9522/Draft%20ECC%20Recommendation%20(23)03_v1.docx. In summary:

For exterior vehicular radars:

Designated frequency band	Front radars		Corner and short/ultra-short range radars	
	Maximum mean e.i.r.p. (Note)	Maximum peak e.i.r.p.	Maximum mean e.i.r.p. (Note)	Maximum peak e.i.r.p.
122.25-130 GHz	32 dBm		9 dBm	
134-141 GHz	32 dBm		9 dBm	
141-148.5 GHz	-6 dBm within 1 GHz	-1 dBm within 1 GHz	-6 dBm within 1 GHz	-1 dBm within 1 GHz

For in-cabin vehicular radar:

Designated frequency band	Maximum mean e.i.r.p. density	Maximum mean e.i.r.p. over the bandwidth	Maximum peak e.i.r.p. over the bandwidth
122.25-130 GHz	-30 dBm/MHz	3 dBm	16 dBm
134-148.5 GHz	-30 dBm/MHz	3 dBm	16 dBm

In addition, a contiguous band of at least 25 GHz should be available for very short distance communication application below 350 GHz, e.g. the 252-296 GHz band as identified by ITU-R 5.564A, and as studied in ITU-R M.2517-0, or the 252-325 GHz band as identified by IEEE Std 802.15.3d™ 2017. IN case of allocation of IMT to this band there is a high likelihood of interference from IMT to such applications. Vice versa: IMT may suffer mild service degradation in dense co-deployments. Therefore it is for consideration to not allocate IMT in this band. These should also be an abundance of bands for IMT on lower frequencies that are still unused. Services other than IMT are likely be compatible with such very short distance communication applications.

Examples of applications can be found in the ETSI ISG THZ presentation referenced above and in the applications examples for IEEE Std 802.15.3d™, with due note of NXP's specific interest in short distance wireless interconnect.

Question 4 and 5: Need for permitting license-exempt operation in 77-81 GHz band for automotive radar applications and conditions for access?

As indicated in the TRAI consultation paper the 76 GHz band and the 77-81 GHz bands have been assigned for use by exterior vehicular radars in many countries, including USA, Europe, China. Almost all countries that have not assigned the band for exterior vehicular radar are in process to make such an assignment. ITU recognises vehicular radar as part of the ITU radio regulations https://www.itu.int/pub/R-REG-RR/en, specifically ITU RR 5.559 and 5.559B. The car radar industry is actively standardizing exterior radar based on available regulations for this band.

The assignment of this band to exterior vehicular radar in India is paramount for developing state-of-the-art traffic safety.

The suggestion from NXP for regulations in the 77-81 GHz band is to adopt the same technical conditions as are currently in use in India for the 76 GHz band, as listed in “The Gazetta of India : Extraordinary Part II – Sec. 3(i) dated September 16, 2015:

Frequency Band	Maximum RMS Effective Radiated Power Limits
77 to 81 GHz	5W (37dBm)

Question 6, 7: The need to open the frequency spectrum between 95 GHz to 3 THz for experiment and demonstration of equipment designed to operate on any frequency above 95 GHz through a separate experimental license and further details?
NXP has no contribution for this item.

Question 8: Other issues or inputs in respect of the frequency spectrum in Tera Hertz bands?
Spectrum management in the Tera Hertz bands should permit the assignment of very wide bands. New communication applications are eying 100 Gbit/s and higher speeds. Sensor/radar applications require wide bands for high accuracy. It is suggested not to adopt an early and relatively conventional service assignment plan with relatively small bands, as is case for 100-252 GHz spectrum in ITU. It is likely the final need for spectrum for applications that will flourish in this band will substantially differ from the applications vying for spectrum today. Breaking up the band early may create an impediment to Ultra and Extremely Wide Band applications.

It is for specific consideration to provide for unlicensed extreme wide band applications, larger than 25 GHz. The 252-296 GHz band as identified by ITU-R 5.564A, and as studied in ITU-R M.2517-0, or the 252-325 GHz band as identified by IEEE Std 802.15.3d™-2017 could be an excellent start.