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UPDATE ON COMMERCIAL AND REGULATORY DEVELOPMENTS FROM INDUSTRY ON LICENSE-EXEMPT USE IN THE 5925-7125 MHz FREQUENCY BAND

(Item on the Agenda: 3.2)

(Informative document submitted by the Dynamic Spectrum Alliance, DSA)

Impact on the sector:

Since the World Radiocommunication Conference 2003 decision to open spectrum in the 5 GHz range to license-exempt wireless access systems and radio local area networks (WAS/RLAN), of which Wi-Fi is an example, there have been revolutionary changes in technology, use cases, and demand. Wi-Fi has moved from an amenity that helps make broadband connectivity more useful to an essential part of broadband delivery and an essential element in enabling businesses to get work done and people to get online in urban, suburban, and rural areas. New Wi-Fi standards such as Wi-Fi 6E and future Wi-Fi 7, need access to the full 1200 MHz of the 6 GHz band to support current and emerging innovative use cases, now and in the future. Opening only 500 MHz of the 6 GHz band would limit Wi-Fi networks' ability to support high-bandwidth dense deployments use cases as it would have to continue to employ small channel bandwidths.

Executive Summary:

The momentum for the deployment of license-exempt Wi-Fi 6E devices continue to grow. As of July 2022, there were a total of 792 different device models spanning laptop and desktop PCs, mobile phones, tablets, routers, access points, gateways, smart TVs, etc. available commercially. Some recent large-scale Wi-Fi 6E deployments have been at universities and public venues where there is a high-density of high-bandwidth users. There are multiple trials in progress utilizing pre-commercial license-exempt devices using Wi-Fi 7 technology, which is based on 320 MHz wide channels.

Introduction

The Dynamic Spectrum Alliance (DSA) is a global, cross-industry, not for profit organization advocating for laws, regulations, and economic best practices that will lead to more efficient utilization of spectrum, fostering innovation and affordable connectivity for all. Its membership spans multinationals, small-and medium-sized enterprises, as well as academic, research and other organizations from around the world all working to create innovative solutions that will benefit consumers and businesses alike by making spectrum abundant through dynamic spectrum sharing. A full list of DSA members is available on the DSA's website at www.dynamicspectrumalliance.org/members.

The DSA has long advocated for license-exempt devices, such as Wi-Fi devices, to share the entire 5925-7125 MHz (6 GHz) with incumbent operations. Wi-Fi must protect incumbent operations from receiving harmful interference. Incumbent operations in the 6 GHz band can grow alongside growing Wi-Fi operations. Incumbents would not need to be relocated to other spectrum bands, which is likely the case if certain other technologies were authorized to operate in the upper portion of the 6 GHz band.

Three categories of license-exempt devices that have been authorized to date. They are very low power devices that can operate indoors and outdoors, low-power indoor devices and standard power devices that can operate indoors and outdoors under control of an Automated Frequency Coordination (AFC) system. Administrations that have adopted rules to authorize license-exempt devices to date, have authorized one or more categories of devices.

The technical conditions to protect incumbents from receiving harmful interference varies by category of device. For example, by establishing strict power spectral density requirements, very low power and low power indoor devices can coexist with incumbents. In contrast, high-power standard-power devices may not be able to operate in portions of the 6 GHz band in administrations where there are mobile incumbent operations. Additionally, and of great interest to DSA, standard power devices must be under the control of a cloud-based AFC system, to protect outdoor fixed link operations in the band.

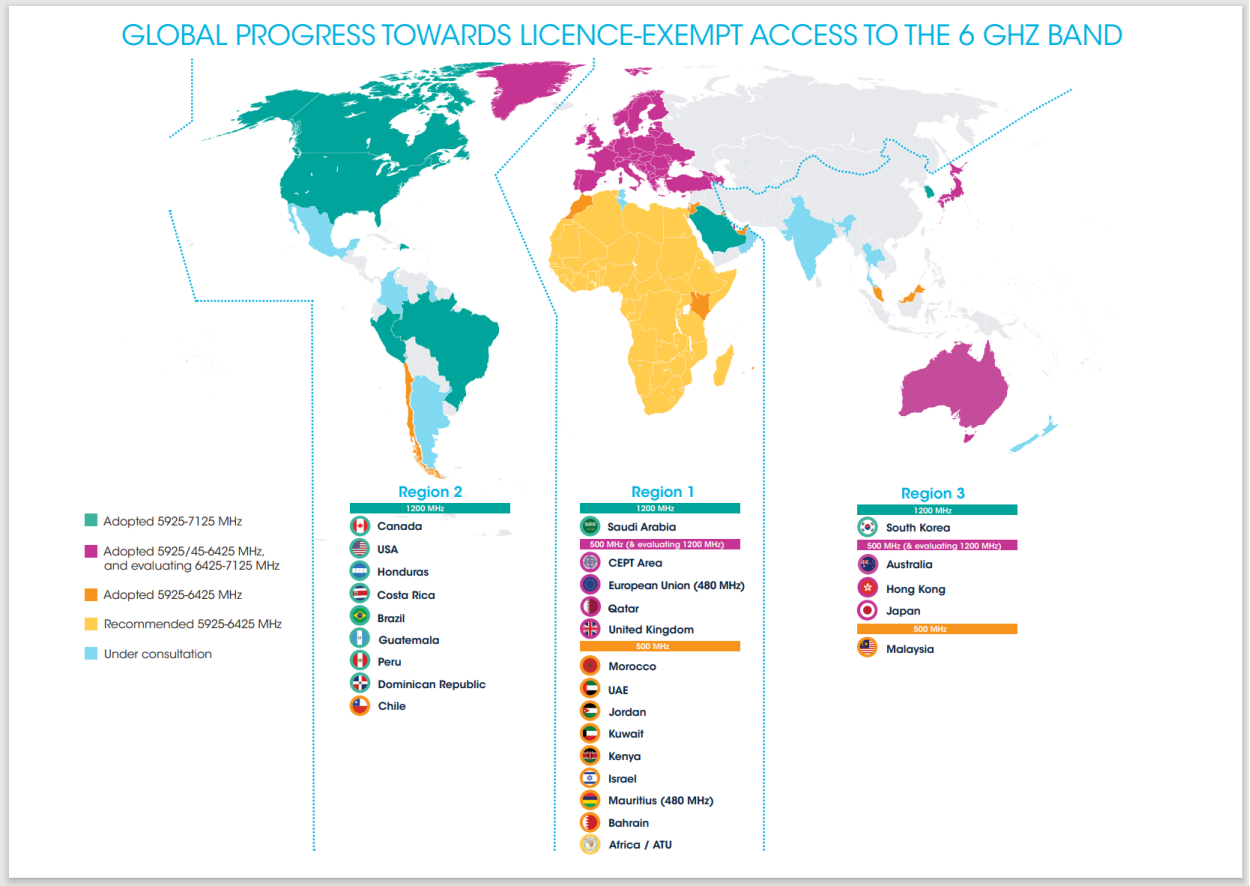
Regulatory Update on License-Exempt Use in the 6 GHz Band

The image below shows the global progress toward license-exempt access to the 6 GHz band.[1] It shows countries that have adopted rules for license-exempt use in all 1200 MHz of the 6 GHz band and those countries that have only authorized use in the lower 500 MHz of the band.

Countries representing more than 40% of the global gross domestic product (GDP) have opened, or have proposed opening, the full 6 GHz band for licence-exempt use. A more detailed breakdown by country can be found on the Wi-Fi Alliance web site.[2]

In the Americas region, Brazil, Canada, Costa Rica, the Dominican Republic, Guatemala, Honduras, the United States, and Peru have already decided to designate the 1200 MHz of the 6 GHz band for unlicensed access.

[1] Home - 6 GHz for Licence-Exempt Access (visited on October 14, 2022).
[2] Countries Enabling Wi-Fi in 6 GHz (Wi-Fi 6E) | Wi-Fi Alliance (visited on October 14, 2022).



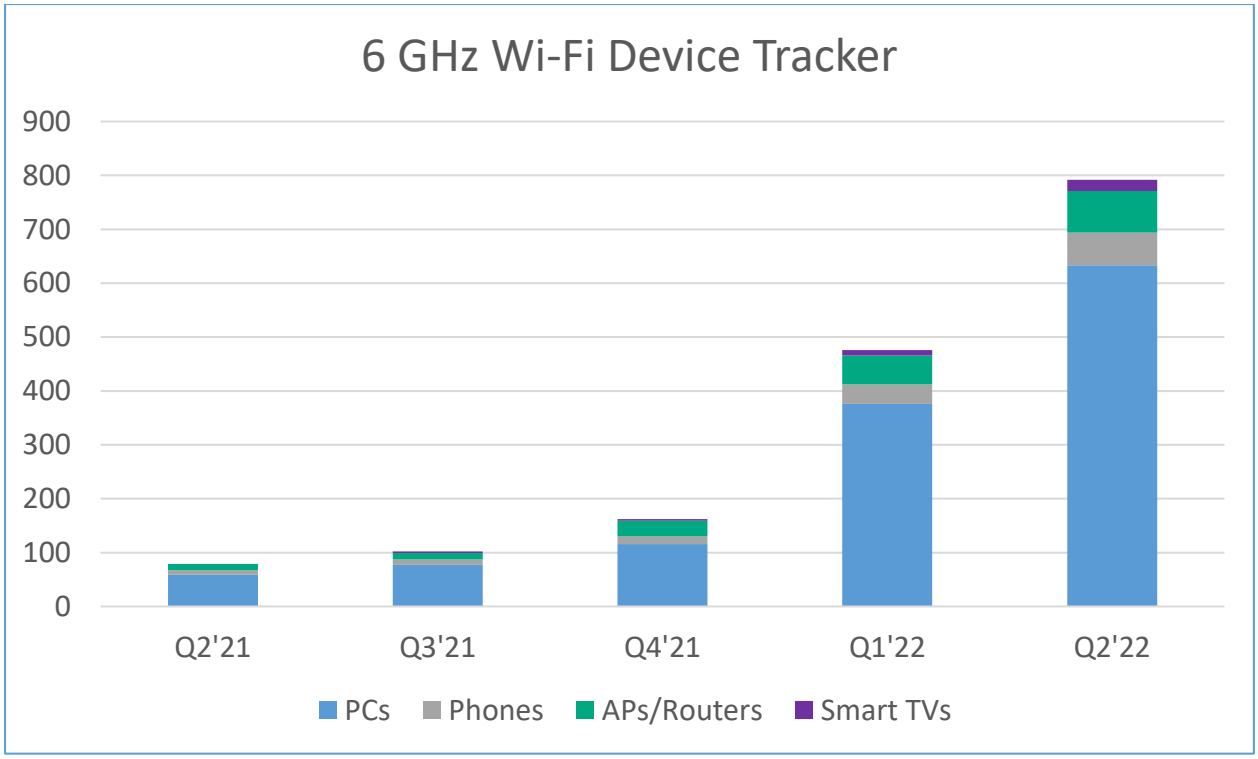
Wi-Fi 6E Device Update

As of the beginning of July 2022, there were **792 license-exempt devices** capable of operating across the entire 6 GHz band.[3] These include **633** PC device models, **61** mobile phone models, **77** routers / access points / gateways, and **21** Wi-Fi enabled television receivers.

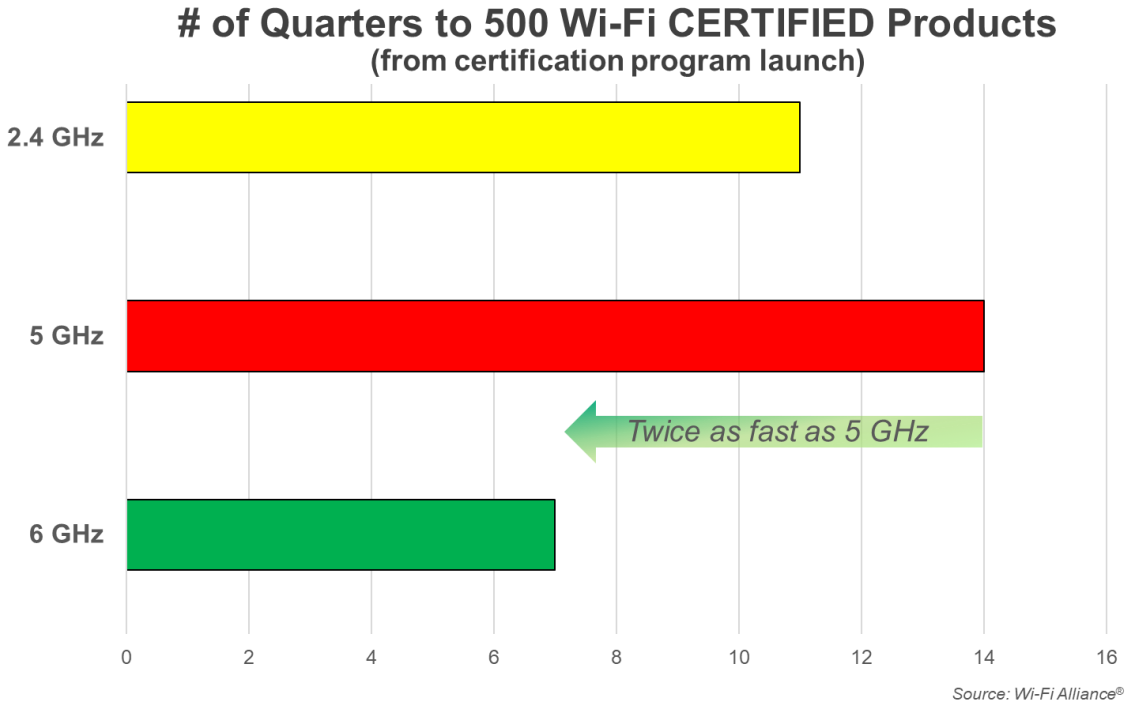
Annex A provides a detailed breakdown by category and manufacturer. Additional devices in each category are expected to be introduced during the second half of the year. Once an administrator puts in place rules to authorize license-exempt use across the entire 6 GHz band and updates its homologation process accordingly, its residents and businesses can take advantage of the increasing economies of scale.

The image below shows that the Wi-Fi Ecosystem in the 6 GHz band is diverse and is growing rapidly.

[3] Source: Intel. Wi-Fi 6E device tracking summary is public information compiled by Intel from vendor websites, press releases, and third-party device reviews. Intel provides this assessment for informational purposes only, does not guarantee its accuracy, and it is subject to change without notice



The next figure illustrates the Wi-Fi unprecedented ecosystem development in the 6 GHz band, comparing the time it took to reach the limit of 500 Wi-Fi Certified products in the 2.4 and 5 GHz bands.[4]



[4] Source: HPE Aruba analysis.

Notable Recent Wi-Fi 6E Deployments

Commercial Low Power Indoor 6 GHz Devices Support High-Bandwidth Dense Deployments at Universities and other Educational Institutions

More than 250 educational institutions — including colleges, universities, and K-12 districts — are using Wi-Fi 6E access points.[5] In July, the University of Michigan in the United States announced that it replaced more than 16,000 legacy Wi-Fi access points deployed across 225 buildings and outdoor areas at its Ann Arbor and Dearborn campuses with Wi-Fi 6 and Wi-Fi 6E.[6] The University of Michigan network serves more than 63,000 students and supports a maximum of 70,000 concurrent Wi-Fi connections. These upgrades will substantially benefit the university community. Download speeds on the Wi-Fi 6E LPI networks can reach up to 750 megabits per second. In large classrooms that accommodate up to 500 students at a time, the Wi-Fi 6E network will enable all personal devices to receive an HD-quality video stream even in the busiest and most densely populated areas. These large classrooms with high density use require sufficient Wi-Fi channel diversity to ensure each student can receive her/his HD-quality video stream. This requires that the entire 1200 MHz in the 6 GHz band be made available for free use devices.

In September, Texas A&M University in College Station, Texas and Doane University in Crete, Nebraska each began the process to replace their installed base of Wi-Fi access points with Wi-Fi 6E. On the Texas A&M campus network, there are roughly 120,000 unique devices on any given day. According to the Texas A&M Chief Information Officer "Our focus is on building a smart campus of tomorrow and that requires a secure, reliable, high-performance network".[7] Doane University made the decision to deploy Wi-Fi on campus to accommodate increasing numbers of student devices and campus-owned "internet of things" devices.[8]

Experimental License Shows Promise of Standard Power Devices for Broadband Access

Earlier this year, in the United States, there was a project conducted under experimental license that showed the potential of Standard Power devices to help close the digital divide. In May, Nextlink Internet, a United States-based Wireless Internet Service Provider, announced the results of field tests using a Standard Power 6 GHz prototype standard power device under an experimental license that incorporated a Qualcomm radio operating in the portions of the 6 GHz band authorized for license-exempt use. Nextlink Internet demonstrated throughput of over 1 Gbps download speed and 500 Mbps upload speed to each subscriber module under a full load, utilizing a 160 MHz channel at distance of 3.2 kilometers. Once an AFC has been approved by the FCC, Nextlink Internet will have the ability to deploy the technology broadly throughout its service areas, providing affordable broadband to rural and exurban communities.

Wi-Fi 7 Developments

Wi-Fi 7 is the Wi-Fi Alliance label for the IEEE 802.11be amendment to the IEEE 802.11 standard. Earlier this year, Wi-Fi Alliance finalized Draft 2.0 of the Wi-Fi 7 specification. The most significant changes Wi-Fi 7 will enable include support for wider channels, multi-link operation, and 4K Quadrature Amplitude Modulation (QAM). The new, larger 320 MHz channels will increase data throughput. Through multi-link

[5] Jake Williams, "Two more universities upgrade to 6E networks", EDSCOOP, September 22, 2022, Two more universities upgrade to 6E networks (edscoop.com).
[6] Annaliese Gottschalk, "U-M first in nation to offer WiFi 6E; university wide accomplishment is an investment in the future", University of Michigan IT News, 28 June 2022. U-M first in nation to offer WiFi 6E; university wide accomplishment is an investment in the future – Michigan IT News (umich.edu)
Claus Hetting, "University of Michigan deploys colossal Wi-Fi 6E campus network", Wi-Fi NOW, 15 July 2022. University of Michigan deploys colossal Wi-Fi 6E campus network - Wi-Fi NOW Global (wifinowglobal.com).
[7] Jake Williams, "Two more universities upgrade to 6E networks", EDSCOOP, September 22, 2022, Two more universities upgrade to 6E networks (edscoop.com).
[8] *Id.*

operation, Wi-Fi enabled devices will be able to send and receive data combined over three frequency bands (2.4 GHz, 5 GHz, or 6 GHz), with the mix of channels shifting at any time based on data traffic and other factors. Multi-link operations will result in reduced latency, greater reliability, and more rapid data transmission, while 4K QAM will allow each Wi-Fi 7 transmission to carry more data than the current generation of technology, speeding downloads significantly.

With three 320 MHz-wide channels, Wi-Fi 7 will support throughputs of 30 gigabits per second (Gbps), which is more than three times as fast as the 9.6 Gbps maximum of Wi-Fi 6. Making three 320 MHz-wide channels available for Wi-Fi 7 will necessitate access to the entire 1200 MHz of the 6 GHz band (5925-7125 MHz). 6 GHz is the only frequency band where there is sufficient spectrum for consumers and enterprises to take full advantage of Wi-Fi 7. Were only the lower half of the band (5945-6425 MHz) available for license-exempt use, then only a single 320 MHz-wide Wi-Fi 7 channel could be supported.

Wi-Fi equipment manufacturers have already started the process for building Wi-Fi 7 compatible products even while the standards development process is underway. For example, at the recent DSA Global Summit held in Paris last month, Broadcom Inc. demonstrated the improved capabilities of its Wi-Fi 7 chipset. Qualcomm, Intel and MediaTek are also working on their own Wi-Fi 7 chips.[9] While some early Wi-Fi 7 products may be available in late 2023, widespread availability is expected to begin in 2024 once the standard is finalized.

[9] Qualcomm, Broadcom, Intel and MediaTek Are Working On 6nm Wi-Fi 7 SoCs (techlog360.com)

Annex A - Wi-Fi 6E / 6 GHz Band Equipment Availability as of July 2022[10]

792 – Total Device Models

- **633 – PC Device Models**
  - *Laptop PCs* (393) – Acer (23), Asus (45), Captiva (1), Casper (1), Colorful (1), Consair (1), Croab (1), Dell (60), Dynabook (5), Elsa (1), Framework (2), Fujitsu (6), Getec (1), Gigabyte (7), Honor (1), HP (52), Huawei (1), Kubunto (1), Lenovo (83), LG (9), MSI (58), Razer (9), Saget/Clevo (2), Samsung (13), Valo (4), Xiaomi (1), XMG (3), Xotic (3).
  - *Tablets* (20) –, Asus (1), AyaNeo (6), AYNTEC (1), Fujitsu (1), GPD (1), HTC (1), Pimax (1), Samsung (3), Zebra (5).
  - *Desktop PC* (124) – Acer (12), Asrock (3), Asus (5), Beelink (2), Colorful (1), Corsair (1), Dell (22), Fujitsu (9), Gigabyte (4), HP (16), Intel (2), Lenovo (13), Minisforum (2), MSI (27), Toshiba (1), Zotac (4).
  - *Desktop Motherboards* (94) - Asrock (15), Asus (19), Gigabyte (27), iCraft (1), MSI (31), , NZXT (3).

- **61 – Mobile Phones**
  - Asus (8), Google (3), Lenovo (1), Motorola (9), Nubia (2), OnePlus (2), Oppo (5), Realme (2), Samsung (5), Sony (1), Vivo (1), Xiaomi (13), ZTE (9).

- **77 – Routers/Access Points/Gateways**
  - *Router Manufacturers* (30) – Amazon (1), Asus (5), H3C (1), Linksys (2) Motorola (1), MSI (1), Netgear (5), Plume (2), TP-Link (9), Zinwell (3).
  - *Access Points* (36) – Airspan (1), Alcatel-Lucent Enterprise (1), Arista (1), Arris (1), Astronics (1), Calix (4), Cambium Networks (2), Cisco (6), Commscope (1), EnGenius (1), Extreme Networks (2), Huawei (1), Juniper (1), Lanner (1), Netgear (1), Nokia (2), Prism (1), Ubiquiti (1), Verizon (1), Zyxel (3).
  - *Gateways* (11) – Bouygues (1), Comcast (1), Deutsche Glasfaser (1), Free (1), Frontier (1), Orange (1), Plume (1), Technicolor (1), Verizon (1), ZTE (2).

- **21 – Televisions**
  - Hisense (8), LG (1), Samsung (9), Vizio (3).

[10] Source: Intel. Wi-Fi 6E device tracking summary is public information compiled by Intel from vendor websites, press releases, and third-party device reviews. Intel provides this assessment for informational purposes only, does not guarantee its accuracy, and it is subject to change without notice.