6 GHz License Exempt: Why the full 1200 MHz and why now?

Apple Inc.

Broadcom Inc.

Cisco Systems Inc.

Dynamic Spectrum Alliance

Facebook Inc.

Google LLC

Hewlett-Packard Enterprise

Intel Corporation

Microsoft Corporation

Qualcomm Incorporated

SUMMARY

Apple, Inc., Broadcom, Inc., Cisco Systems, Inc., Dynamic Spectrum Alliance, Facebook, Inc., Google LLC, Hewlett-Packard Enterprise, Intel Corporation, Microsoft Corporation, and Qualcomm Incorporated

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I. **INTRODUCTION** AND **SUMMARY**

In the almost two decades since countries globally implemented the World Radio Conference 2003 decision to open new spectrum in the 5 GHz range to license-exempt devices, there have been revolutionary changes in Wi-Fi technology, use cases, and demand. In a relatively short amount of time, Wi-Fi technology 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 -driven in part by the rise to dominance of mobile devices and the expectation of near-ubiquitous wireless connectivity. In the home, Wi-Fi enables multiple users to simultaneously access the Internet, fuels video streaming to smart TVs, connects appliances to enable remote diagnostics and repair, and powers security systems, thermostats, sprinkler controllers, and more. At work, Wi-Fi supports access to enterprise networks for a range of applications, supports a variety of data communications, and connects all types of devices including robots, autonomous vehicles in warehouses, factory equipment, screens and whiteboards. At play, there is not a stadium being constructed today that does not have extensive Wi-Fi capability for fans, vendors, and administrative and team support. New uses for Wi-Fi have also appeared to address rural or disadvantaged populations, stemming from the need for low-cost infrastructure to help expand services to the unserved. By any measure, Wi-Fi is a massive success story that helps policymakers achieve critical objectives in broadband policy as well as in economic and social policy areas.

Wi-Fi® is...

- The most commonly used wireless communications technology
- The primary medium for global internet traffic
- A driver of $3.3 trillion USD in global economic value
- Growing, with more than 4 billion devices shipping annually and 16 billion devices in use*

**IDC*

Source: Wi-Fi Alliance

As companies and organizations that are device manufacturers, chipset vendors and applications providers that rely on license-exempt, licensed, and shared spectrum, we are excited to be part of a wireless industry that has done so much to advance global quality of life and economic growth. A key part of our job is to continue to innovate on the massive success already enabled by Wi-Fi. To do that, license-exempt spectrum access to the entire 5925-7125 MHz band is critical. This paper explains the technological reasons for this, and why recently introduced competing proposals are poor alternatives in comparison to opening the full 6 GHz band to license-exempt technology.

This White Paper consists of several sections that explain the essential need for availability of the full 1200 MHz from 5925-7125 MHz to support Wi-Fi and 3GPP's New Radio-Unlicensed.

- Opening the full 6 GHz band to license-exempt Radio Local Area Network (RLAN) technologies is the best public policy choice for regulators globally. **The full 1200 MHz is needed to supply new technologies with the spectrum necessary to deliver on current and emerging innovative use cases, now and in the future. With just 500 MHz**, license-exempt technologies will be unable to support advanced use cases or support even routine consumer and enterprise networking needs in a few short years.

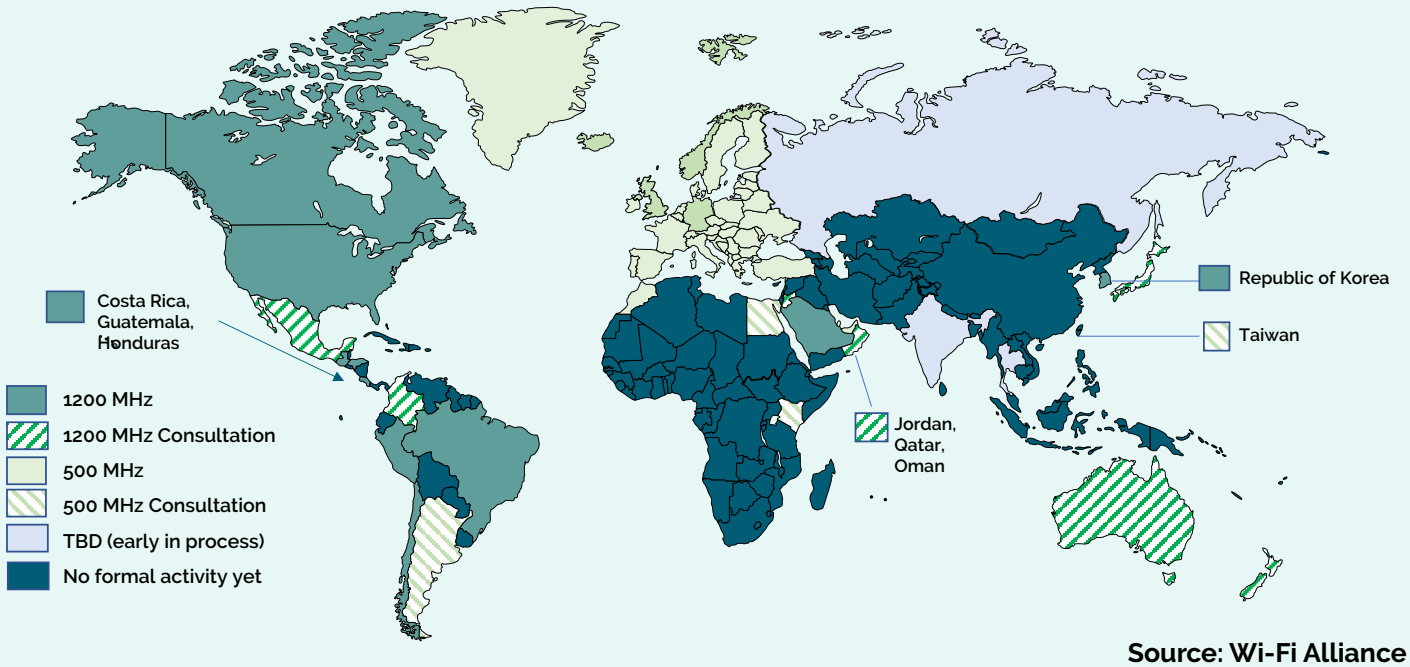
- The social and economic benefits of moving forward with allowing license-exempt usage throughout the full 6 GHz band are many. **Addressing the digital divide, improving rural connectivity, accelerating economic innovation, advancing energy efficiency through smart buildings and improving quality of service are just a few benefits** that regulators can look forward to when they open the full 6 GHz band to license-exempt use.

- **6 GHz Wi-Fi technology is ready now.** Standards are complete; interoperability certification is open, and equipment is moving into the market today. Benefits from spectrum use are available immediately.

- Failure to act brings with it large opportunity costs. **Any benefit of reserving a portion of the spectrum for a later decision on whether to allow IMT is entirely speculative and essentially nonexistent. No IMT specifications are in place nor is there any commercially available IMT equipment for this band.** Significant questions remain about technical feasibility of IMT use. One thing is certain if IMT to allowed in the upper portion of the 6 GHz band: Delay, which would result in immediate lost economic gains that would have accrued instead from opening the full 6 GHz band to license-exempt operations.

- License-exempt services in the 6 GHz band, operating **under appropriate regulatory conditions, enable incumbents to continue – and to grow – their operations in the band** while protecting them from harmful interference. Traditional wide-area IMT deployments in the band, however, would likely require that incumbents be cleared and/or relocated.

- The **best way to support 5G deployment in the 6 GHz band is to authorize license-exempt use throughout the entire 1200 MHz of the band, which supports mobile offload, 5G backhaul, and 5G NR-U operation.**



Source: Wi-Fi Alliance

This paper draws on the work of numerous regulatory agencies globally that have already designated the full 6 GHz band for use by license-exempt technologies. Since the United States Federal Communications Commission (FCC) released its decision in April 2020, and with the European examination of coexistence with incumbents drawing to a favorable close during the final months of 2020 and into early 2021, global momentum toward opening the 6 GHz band for license-exempt RLAN technology has been exploding. Importantly, in February, Brazil was one of the first Top 20 economies in Region 2 in 2021 to join the FCC in opening 5925-7125 MHz to license-exempt technologies, while Republic of Korea was the first in Region 3 in October 2020. Saudi Arabia boldly announced in March to its fellow Region 1 countries that it also would open the 5925-7125 MHz band to license-exempt use. Canada's Innovation, Science and Economic Development (ISED) soon followed in May, announcing that it is opening the full 5925-7125 MHz band to license-exempt use. Many countries have similarly been active in embracing license-exempt use of the full 6 GHz band. Peru, Costa Rica, Chile, Honduras, and Guatemala have all finalized changes to their Table of Allocations or to footnotes opening the full band as license exempt. Consultations or proceedings are now pending to open the full band in Japan, Mexico, Australia, Colombia, Qatar, Jordan, New Zealand, and Oman.

As of today, regulators globally have reached a remarkable and swift consensus with 6 GHz regulatory decisions **covering nearly 54%** of the global GDP, and nearly **42% of GDP having opened** or proposed opening the full 6 GHz band to license-exempt use.

Countries that have opened the lower 500 MHz for license-exempt use also have made important contributions. The European Commission in June 2021 published its decision to open the band to license-exempt equipment after exhaustive study of the impact to fixed satellite uplink and to fixed microwave services. In both cases, the European process found that license-exempt equipment could operate in the band without causing harmful interference to incumbent users, provided that mitigation rules, such as limiting power levels, were applied. However, regulators –

and particularly those in countries outside Region 1 – should not assume that a 500 MHz license-exempt designation is sufficient or that Europe will in the future conclude that it is adequate.

In a little more than a year, the world has transformed to welcome a new generation of Wi-Fi into the 6 GHz band. As of today, regulators globally have reached a remarkable and swift consensus with 6 GHz regulatory decisions covering nearly 54% of the global GDP, and nearly 42% of GDP having opened or proposed opening the full 6 GHz band to license-exempt use. This swift action is happening in part because governments around the world have recognized the key role that robust broadband connectivity plays in the lives of their citizens, its importance to their economies, and in supporting national 5G deployments. The Covid-19 pandemic has brought these realities into sharp focus. Recently, the Wireless Broadband Alliance commented that Wi-Fi usage grew by 80% during the pandemic.

While those who were connected placed unprecedented demands on Wi-Fi networking capabilities, too many children, families, and rural businesses remain unconnected or inadequately connected. As we have witnessed globally, cellular technologies alone have not solved the connectivity problem for those outside the reach of mobile networks or for those who cannot afford mobile subscriptions. The lack of IMT identified spectrum is not the reason so many communities lack adequate connectivity. As policymakers prepare to consider the opportunity presented by allowing license-exempt use in the full 6 GHz band, putting this spectrum to work now to help people and economies should be a top priority.

II. **OPENING THE FULL 6 GHZ BAND** FOR LICENSE-EXEMPT TECHNOLOGIES **IS IMPORTANT AND NECESSARY.**

A. The technology imperative for 1200 MHz – current and future use cases driving demand, density and high bandwidth

Delivery of broadband access is a continuously-evolving challenge. Since broadband access was introduced to consumers in the 1990s, the use of broadband networks, the applications that run on these networks, the throughput capability of devices, and the density of device deployments continues in an unrelenting upward trajectory. Most people's access to their fixed broadband network is through Radio Local Area Network (RLAN) devices such as Wi-Fi routers; thus, RLAN access and quality equals broadband access and quality. For companies that develop equipment and networks using license-exempt spectrum, we must look ahead to future use cases, applications, and demands that are not yet in the market, and do our best to help create today the regulatory and technology environment that will address the exponentially increasing consumer and business requirements of tomorrow. Consumers, businesses, and governmental agencies around the world will be able to take full advantage of

the technology evolution that industry has identified. Among other things, a wholly-new generation of RLAN technologies in the 6 GHz band will be enabled to address future networking needs for broadband access and beyond.

The last time a significant new designation of license-exempt spectrum for RLAN technology was made available was in the early 2000s, following the 2003 World Radio Conference. This activity opened new spectrum bands in the 5 GHz range, which were at that time optimal for earlier generations of RLAN technology, such as Wi-Fi 4, and later, Wi-Fi 5. In the almost two decades since that time, the equipment used for broadband networking, use cases, and applications, as well as engineering challenges to meet demand, have evolved considerably. In addition, the number of devices per user is proliferating. The capability of those devices – in processing power, screen resolution, streaming video support (now at 4k/8k HD), camera performance, and antenna

Device evolution requires improvements in network capability

iPhone 1 - 2,000-8,000 songs, up to 32 Gbps of memory, a 3.5 inch screen size with a resolution of 480 x 320.

iPhone 12 ProMax - 128,000 songs, up to 512 Gbps of memory, a 6.7 inch screen with a resolution of 2778 x 1284, and a more versatile camera capability, powered by a vastly more powerful processor.

functionality to name a few – has increased exponentially. Devices are deployed in increasingly dense residential or enterprise environments, and the broadband networks they connect to, whether wired or wireless, are also greatly improving in throughput and latency. But it is not simply the relentless improvements in devices that is increasing demand. New applications, such as consumer gaming or enterprise Advanced Manufacturing, demand low latency transmissions. An explosion in Augmented Reality/Virtual Reality/Mixed Reality (AR/VR/MR) technology is soon expected to impact

everything from how we learn to how we work and play. While that capability exists today, connectivity must expand and improve for these services to be placed into routine use by citizens and businesses. As that occurs, devices will be produced at scale and will be differentiated by use case.

Augmented Reality - digital information layered over the real world

"Many of our enterprise clients, especially in construction and medical sectors, are embracing AR headset devices to provide hands-free enhanced vision for planning, design and patient care and training," says Sam Watts, immersive partnerships director at immersive learning and development studio Make Real.

AR is also beneficial for any industry that relies on planning and visualisation, this includes almost any type of design and conceptualisation needs. "We have a number of onsite AR tools, using Microsoft HoloLens, to visualise construction when the real world is just a cleared, muddy plot," Watts tells us.

--AR smartglasses in 2021: the devices, apps and new tech coming, Wareable.com posted 14 June 2021

Rural Internet access networks that use Wi-Fi (e.g., as part of a 60 GHz mesh or TV White Spaces Network) and Wi-Fi at the edge of satellite links and new low earth orbit satellite constellations are also evolving use cases that will give regulators new tools to address unserved or underserved populations. According to a recent review of the new low earth orbit constellations by the Asia Development Bank:

> *At the current public beta pricing level, Starlink's $99 monthly plan is not affordable for many consumers in developing Asia. However, variable pricing by market (at different purchasing price levels) could result in a more affordable service offering. Similarly, community Wi-Fi models could be deployed, such as those being implemented by Hughes/ Express Wi-Fi in Indonesia and Latin America where an individual subscription supports time- or data-bound service to potentially hundreds of users consuming small data bundles (in the megabytes) through a publicly accessible Wi-Fi access point. Areas of limited subscriber base may be opportunities for direct or subsidized partnerships. -- ADB, Digital Connectivity and Low Earth Orbit Constellations, ADB Sustainable Development Working Paper Series, April 2021.*

For rural and unserved areas, it is clear that license-exempt technology is essential to enabling affordable services.

To further illustrate the dilemma faced as license-exempt technology producers look to the future, take an example where access points (APs) must be deployed in a dense configuration, such as a school, manufacturing plant, office, hospital, transportation hub, multi-tenant housing, or stadium. Each of these locations increasingly relies on license-exempt spectrum for broadband operations. As demand has increased, Wi-Fi APs have been deployed more densely, adding more capacity within the same overall network area. In general terms, the coverage area for an enterprise indoor AP has decreased from ~500-1000 meters2 in 2003, to ~250 meters2 by 2010, to as little as ~150 meters2 today. The practical limit of how densely APs can be deployed has been reached due to the resultant increase in radio frequency interference (both co-channel and adjacent channel interference). The only way to add capacity in these situations is through the use of multiple wider channels of

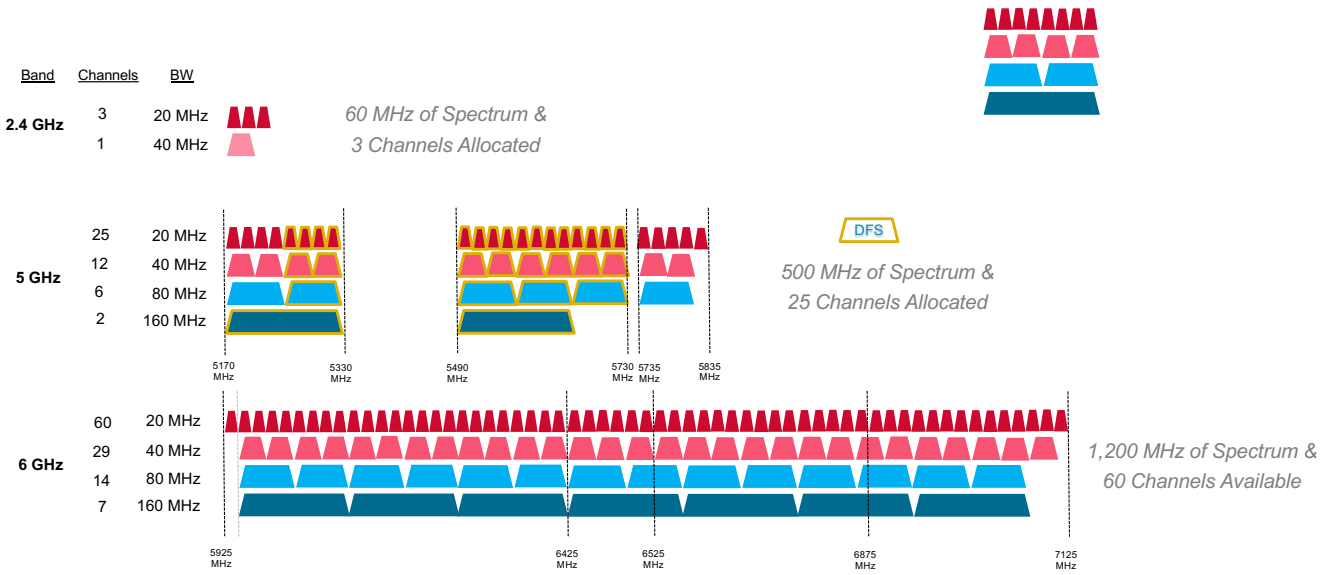
160 MHz and 320 MHz, which would be enabled by opening the full 1200 MHz of the 6 GHz band.

Forty (40) MHz channel sizes are increasingly insufficient to address the steep growth in the number of devices and higher bandwidth requirements per user. A typical two-stream client device can only achieve up to a 574 Mbps data rate when operating in a 40 MHz channel with Wi-Fi 6. When the channel width is increased to 80 MHz or 160 MHz, the data rate is increased to 1.2 Gbps and 2.4 Gbps respectively, fully enabling the "gigabit wireless" era. To retain the current quality of service for users in the future, 80 MHz-wide channels are required; to increase the quality of service, 160 MHz-wide (and larger) channels are required. With those wide channels, the radios can get on and off the air more quickly, delivering the high-bandwidth content users demand while maintaining the ability to share spectrum with other license-exempt transmitters. Lack of wider channels would create a detrimental impact on real-time video services, and high-bandwidth immersive services such as AR/VR/MR will be starved of sufficient capacity. There is no realistic possibility of delivering multiple 160 MHz wide channels on existing 2.4 GHz and 5 GHz spectrum allocations, which are too fragmented and which were allocated in an era of now-outmoded generations of RLAN technology.

To add to the engineering challenge, radios in the 2.4 GHz and 5 GHz bands today consist of multiple generations of equipment with a variety of less spectrally-efficient capabilities. This is a design necessity because networks must be able to communicate with older generations of radios. Therefore, technologies like Wi-Fi are always backward compatible with previous generations of Wi-Fi operating in the same frequencies. The additional requirement of interoperability between Wi-Fi generations and the burden of backward compatibility results in further reductions in efficiency and determinism that in turn further negatively impacts voice and video quality. Wi-Fi 6 in the 6 GHz band (known as Wi-Fi 6E) is not required to interoperate with any previous generation of 6 GHz Wi-Fi technology because no Wi-Fi has yet existed in the 6 GHz band. The 6 GHz band would, for the first time, eliminate outdated and less efficient radio access technology, permitting the far more spectrally-efficient Wi-Fi 6E (and above) to operate without the burden of legacy radio interoperability. This will dramatically improve the user experience and spectral efficiency, which will promote the adoption of advanced Wi-Fi technologies.

Considering all of these challenges, the license-exempt technology industry concluded that Wi-Fi 5 and earlier technology would soon be insufficient to deliver the required level of broadband and related capabilities in the near future. Industry's response was twofold – 1) to develop new, advanced technologies and 2) to find mid-band spectrum that could support the channel widths required for these new technologies.

First, we redesigned technology to enable a new approach to address dense networking, low latency, and higher-bandwidth needs. For example, deployment of OFDMA as part of Wi-Fi 6 fundamentally improves spectral efficiency, enabling an AP to communicate individual packet streams to multiple clients at the same time. In addition to adopting OFDMA, some of the most important innovations in the Wi-Fi 6 generation of technology are: (1) multi-user MIMO that allows more downlink data to be transferred at one time, enabling APs to concurrently handle more devices and support uplink as well; (2) 160 MHz channel utilization capability increases bandwidth to deliver greater performance with low latency; (3) Target Wake Time (TWT) significantly improves network efficiency and device battery life, in-



BROADCOM

cluding for IoT devices; (4) 1024 QAM modulation increases throughput for emerging, bandwidth-intensive uses by encoding more data in the same amount of spectrum; (5) transmit beamforming enables higher data rates at a given range to increase network capacity; (6) addresses excessive management overhead relative to prior generations; (7) supports "Out of Band" discovery of networks, further reducing management overhead; and (8) strict scanning rules prevent unnecessary use of spectrum (e.g., only scans on a subset of the 6 GHz band channels). These innovations are a generational improvement in Wi-Fi technology, designed to take on the demands that future devices, applications, and use cases will present.

Second, to provide the spectrum needed to make these technologies practical, industry identified a large and contiguous allocation of spectrum, specifically 5925-7125 MHz, to support the wireless industry's need to migrate to multiple wide channels. Just as the cellular industry is migrating to 80 MHz and 100 MHz channels of mid-band spectrum per operator to support 5G services, the next generations of license-exempt technologies (e.g., Wi-Fi 7, and 5G NR-U) also utilize wider channel bandwidths. The additional 1.2 GHz of spectrum on which Wi-Fi 6E will run provides a roughly equivalent number of 80 MHz channels in 6 GHz band spectrum as there are 40 MHz channels in the 5 GHz band. For the first time, 80 MHz channel plans would be possible from a "best practices" perspective in dense deployments. Contiguous spectrum would also support seven 160 MHz wide channels and multiple 320 MHz wide channels, which are expected with the next generation of Wi-Fi now going through the IEEE standardization process (i.e., IEEE 802.11be). The Wi-Fi Alliance has named Wi-Fi 6 devices enabled for the 6 GHz band as "Wi-Fi 6E" devices. This is important not only because Wi-Fi is always backward compatible to earlier generations, but because Wi-Fi 6E devices are designed so that tri-band radios will be the norm, enabling legacy support in the 2.4 GHz and 5 GHz bands

as well. With the full 6 GHz band, the RLAN industry can continue to play its important role in delivering broadband access, facilitating the IoT, and enriching experiences at work, home, and play.

In fact, Wi-Fi 7, which is currently being standardized in IEEE as 802.11be, relies on access to the greenfield spectrum of the 6 GHz band to deliver its greatest innovations, which could include numerous improvements to make Wi-Fi even more useful to users and applications that are currently in draft form or under discussion. While the need for 320 MHz-wide channels has been widely discussed, other innovations are also important. This new generation of technology will operate at 4096 QAM and permit "multi-link operation" that can use the 2.4 GHz, 5 GHz, and 6 GHz spectrum bands simultaneously. Once standards are complete, these improvements will enable lower latency, higher throughput, and more deterministic networking capability (e.g., higher reliability or QoS) relative to Wi-Fi 6E. These features provide a step function increase in terms of enabling Wi-Fi to address immersive services with demanding QoS requirements for a larger number and diversity of applications, devices, and use cases, in particular those of industrial IoT. In addition, these improvements scale throughput capability to future upgrades in access network capacity (e.g., 10G Fiber, DOCSIS 4.0, Fixed Wireless) allowing the RLAN wireless network to evolve with the broadband access connections. However, if there is insufficient spectrum available to make Wi-Fi 7 capabilities compelling to someone purchasing a new AP, Wi-Fi 7 may not see widespread use.

B. An allocation of 500 MHz in lieu of the full 5925-7125 MHz is not sufficient

If only 500 MHz of 6 GHz spectrum were made available, networks would effectively need to operate in a manner similar to the scenario playing out in the 5 GHz band today. Opening only 500 MHz of the 6 GHz band would require channel plans in dense deployments to continue relying on 20 MHz or 40 MHz bandwidths. In countries allowing access to just 500 MHz, users would not be able to take full advantage of the benefits of Wi-Fi 6 (and eventually Wi-Fi 7) in the 6 GHz band, lower service quality will be the norm, and congestion will fall on users of Wi-Fi in enterprises, schools, transportation hubs, and other public venues.

For consumers, congestion issues arise as the number of high-demand Wi-Fi enabled devices in a home continues to multiply. Countries such as Japan, Korea, and the United States are already at 12-14 devices per capita, and the continued integration of license-exempt technology into consumer durable goods promises that the number of devices in a home will continue to grow. Indeed, no analyst projects that the curve will flatten for the foreseeable future. That is because the advantages of connectivity continue to multiply: smart televisions that allow user choice in video streaming, connected security devices from video camera doorbells to whole home systems, and smart appliances that allow manufacturers to download new generations of software are examples of the types of new capabilities that were not in existence before the mid-2000s.

Nor are the coming challenges limited to consumers. Hospitals increasingly rely on video and robotics. Schools at all levels require connectivity to each student's laptop or tablet, and they are seeing increased demands on their wireless networks from security systems to remote learning. Whole industries are transforming how they operate by deeply integrating wireless technologies into their business operations. Cisco has projected that globally, machine-to-machine modules will account for 50% (14.7 billion) of all networked devices by

2023, compared to 33% (6.1 billion) in 2018.

With only a 500 MHz allocation of 6 GHz band spectrum, spectrum constraints will not, over time, support a good user experience particularly as applications evolve toward new immersive services. More devices would contend for airtime in the same frequencies as IoT and cloud-based analytics proliferate. Users would have a very mixed experience where applications might work in some locations, such as within certain portions of their home, and might not work well in other portions or in their businesses, public areas, and venues. Inconsistent bandwidth delivery has consequences well beyond consumer unhappiness – it inhibits innovation generally and may even stop developers from successfully creating and delivering new applications.

A "wait and see" approach, where 500 MHz is allocated now and the balance of the band is allocated sometime in the future, is a poor option. As discussed further below, there is an opportunity cost for countries that decide on a staggered approach to spectrum allocation compared to nations that decide to designate 1200 MHz from the outset. One main drawback is the opportunity cost of impaired use cases and inability to fully meet broadband needs, especially in dense enterprise and urban environments where more than three wideband channels (of 160 MHz and greater) are required. Countries that only designate 500 MHz of 6 GHz band spectrum will be unable to reliably support high-throughput and low-latency applications in all environments where those applications need to perform. When Wi-Fi 7 standards are completed in about three years, industry will implement channels up to 320 MHz wide. Countries that only designate 500 MHz of 6 GHz band spectrum for license-exempt use will not be able to fully experience the benefits of applications built to take advantage of that channel size. Opening all 1200 MHz of the 6 GHz band now enables countries to realize a stronger and more diverse license-exempt ecosystem, which will benefit the entire nation when 6 GHz applications and services are rapidly deployed.

Many types of equipment are expected to support the entire 1200 MHz of the 6 GHz band, as the United States, Brazil, Canada, Saudi Arabia, and the Republic of Korea are enabling the band for such operations, with many other countries expected to do so in 2021.

Many types of equipment are expected to support the entire 1200 MHz of the 6 GHz band, as the United States, Brazil, Canada, Saudi Arabia, and the Republic of Korea are enabling the band for such operations, with many other countries expected to do so in 2021. Due to the need to limit manufacturing and logistical complexity, most 6 GHz equipment will be designed to support the full 1200 MHz, with firmware settings used as necessary to limit operation to the lower 500 MHz. Without the full 1200 MHz available, consumers of 6 GHz equipment would not benefit from the higher throughput and lower latency, but would nevertheless pay for the more complete technology that they are unable to use.

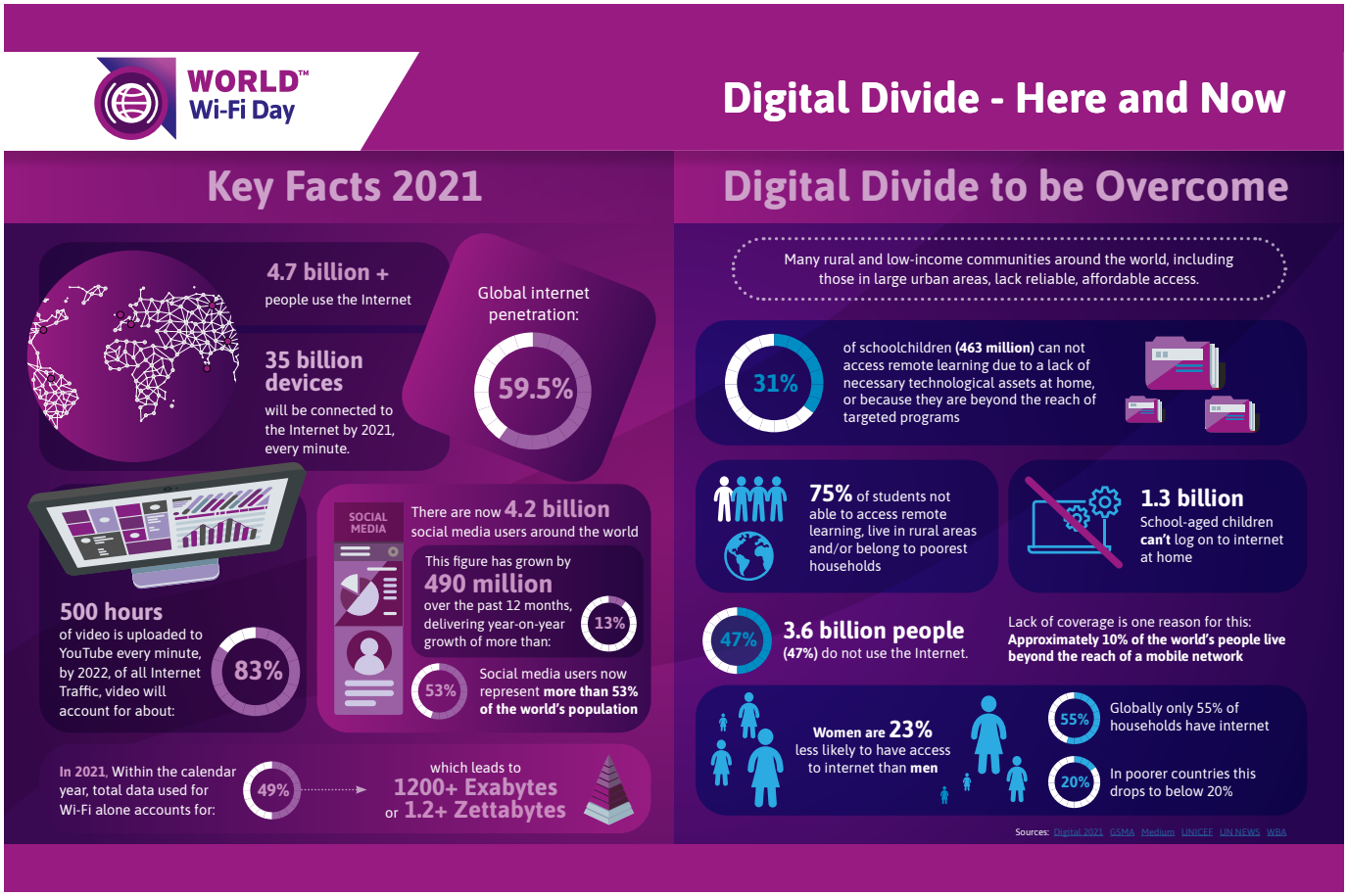
Nor is there another spectrum band available that compares to the 6 GHz band and can deliver the same

benefits. Most importantly, the 6 GHz band is adjacent to the 5 GHz band, enabling easier deployment of tri-band radios using 2.4 GHz, 5 GHz, and 6 GHz band frequencies. From a consumer perspective, 6 GHz band frequencies will deliver a consistent experience similar to that of the 5 GHz band assuming that reasonable power levels are adopted. From a regulatory perspective, license-exempt radio systems are highly complementary to incumbent systems and can coexist given the appropriate regulatory rules – and the incumbent systems are similar around the globe, which facilitates reasonably uniform sharing obligations on license-exempt devices as more countries open the 6 GHz band.

Another important consideration for countries initially authorizing only Low Power Indoor (LPI) and/or Very Low Power (VLP) operations in the 6 GHz band is preserving the opportunity for Standard Power (higher power indoor and outdoor) license-exempt operations. To date, regulators in the US and Canada have concluded that authorizing Standard Power devices can be done in a manner consistent with protecting incumbent fixed satellite services as well as fixed microwave through the combined efforts of power levels, projected number of outdoor devices, and geolocation database controls on the RLAN networks. Standard Power use cases are particularly important to a number of deployment types and settings, including manufacturing, logistics, agriculture, rural broadband, higher education, hospitality, healthcare, and municipal. Standard Power would operate in conjunction with an Automated Frequency Coordination (AFC) geolocation database capability, which is aware of incumbent user operations and can safely authorize Standard Power license-exempt use at a particular location while protecting the incumbents from harmful interference. Because of this requirement to avoid and protect incumbent services, the frequency ranges or channels that will be available at any particular location will often be only a subset of the overall spectrum that has been allocated for potential Standard Power use by the regulator. Importantly, the countries that have either already supported Standard Power or are actively studying it, including the United States, Canada, South Korea, and Saudi Arabia, have all moved to open the entirety of 5925-7125 MHz for license-exempt use in the Low Power and/or Very Low Power modes of operation. This allows for blocking or protecting certain frequencies or channels at particular locations, while still yielding a sufficient number of wide-bandwidth channels to support next-generation RLAN services. Opening the full 1200 MHz of the 6 GHz band to license-exempt use will provide the overall spectrum needed to support Standard Power under AFC control, whereas 500 MHz would be insufficient for Standard Power in the age of 80, 160, and 320 MHz channels.

C. Social and economic benefits flow from designating the full 6 GHz band to license-exempt use

Expanding spectrum availability for license-exempt technologies will help governments everywhere address improvements in broadband access for their populations and help close the digital divide. RLAN technologies such as Wi-Fi have an important role to play, particularly in offering low-cost mechanisms for multiple users in a household to connect to the Internet. License-exempt technologies are embedded in a wide array of client devices, from laptops to tablets and smartphones, that are part of a

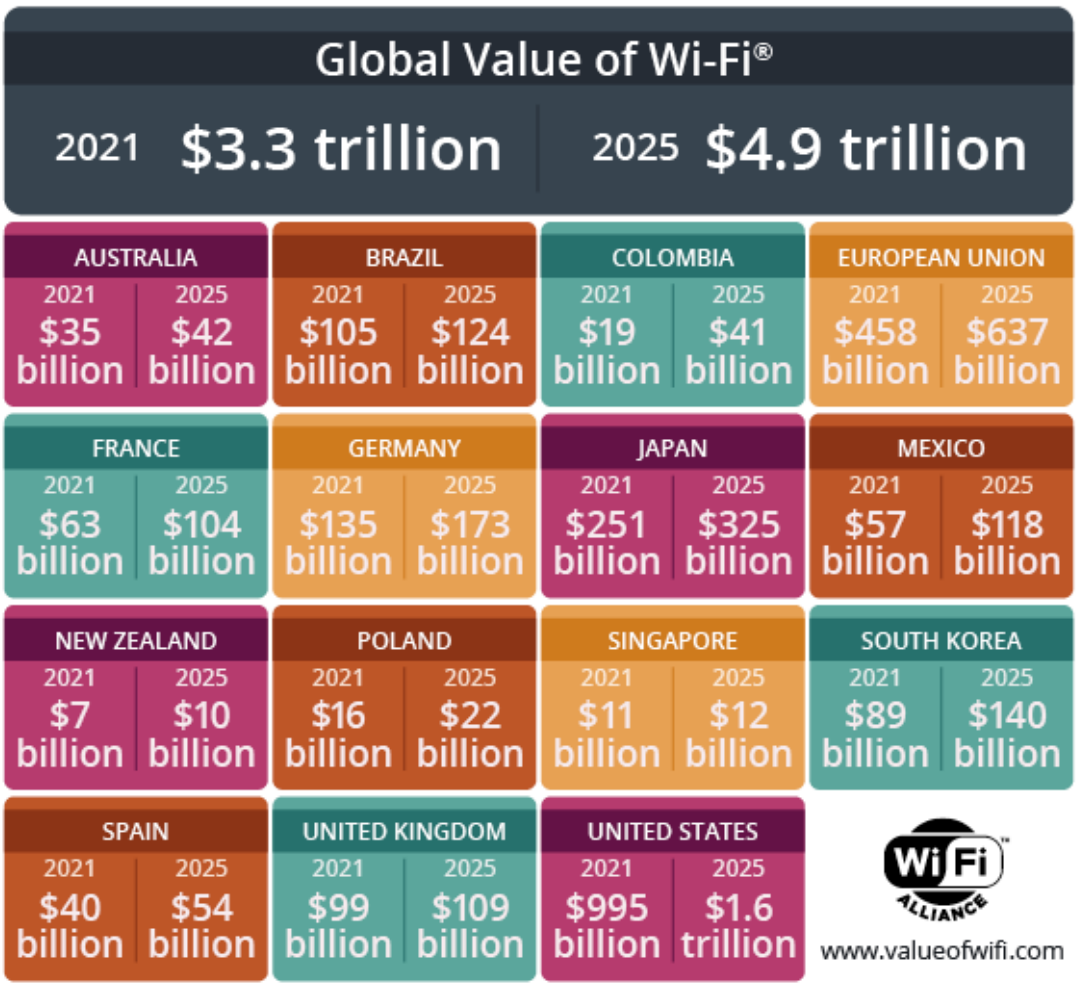


Source: Wireless Broadband Alliance

highly-competitive market that offers consumers a range of choices in device capability and price. Wi-Fi is also used to deliver rural broadband in areas where commercial wireline or wireless services have not been deployed. With backhaul spectrum capability similar to that in the 5 GHz band, TV White Spaces, or 60 GHz mesh, Internet service operators can offer broadband connectivity to households served by a Wi-Fi AP within the home. Similarly, satellite broadband connectivity also enables Internet access to a consumer inside the home, by using a Wi-Fi AP to reach the end device.

Ample spectrum for license-exempt use also gives market participants and governments new tools to reach unserved or underserved populations and can help provide low-cost broadband arrangements. The Digital Divide issue is so large and diverse that it is unlikely to be solved by any one technology. Regulators should advance all technologies that may be capable of addressing the Digital Divide, including low-cost options enabled by license-exempt spectrum technologies.

Allocating the entire 6 GHz band to license-exempt use provides important economic benefits. The Wi-Fi Alliance has conducted exhaustive studies with Telecom Advisory Services of the impact of Wi-Fi on global and national economies, concluding that globally, assuming regulators open the full 6 GHz band to Wi-Fi, the $3.3 trillion in Wi-Fi value to the world's economy in 2021 will rise to $4.9 trillion in 2025. The study examined ten sources of economic



Source: Wi-Fi Alliance

value, including: increased broadband coverage and broadband speeds; reduction of costs by telecommunications providers; deployment of IoT, AR/VR, municipal Wi-Fi, and free Wi-Fi hotspots; benefits of aligning with other major economies; increased capacity for cellular offload; and access to Wi-Fi equipment.

These projections reflect both global conditions now and in the coming years. In this regard, this economic forecast is similar to a technological forecast, but it differs in one important regard – it depends upon regulators to open the 6 GHz band to obtain the benefits that flow from robust license-exempt technologies. It also requires policymakers to think about the broadband future that is possible. This supports a larger point - the economic value of Wi-Fi will continue to rise as all forms of broadband connectivity continue to proliferate and increase in speed – whether fixed broadband as seen in the above chart or satellites such as the new low earth orbit satellite constellations or 4G/5G terrestrial mobile.

A growing group of leading regulators that have similarly concluded that the benefits of license-exempt technologies are important to their national interests. Among the key benefits cited are -

CITC 	"Importance of WLAN use in the Kingdom and **substantial amount of Wi-Fi traffic**, which was **exemplified during the COVID-19 lock-downs**, and the **emergence of a promising device ecosystem that can be taken advantage of starting from 2021**.
FCC 	"Most importantly, as explained in the Notice and in this Order, we believe that providing new opportunities for unlicensed operations across **the entire 6 GHz band can help address the critical need for providing additional spectrum resources for unlicensed operations**. Making the entire band available for these unlicensed operations enables use of wide swaths of spectrum, **including several 160-megahertz channels as well as 320-megahertz channels, which promotes more efficient and productive use of the spectrum**, and would also help create a larger ecosystem in the 5 GHz and 6 GHz bands for U-NII devices."
ISED 	"ISED continues to be of the view that releasing **the entire 1200 MHz of spectrum will immediately unleash the full potential of the 6 GHz RLAN technology**. Moreover, making the full 6 GHz band available for licence-exempt use as soon as possible **will maximize the social and economic benefits** that Canadians will derive from this spectrum. The increased demand for broadband Internet and, consequently, the spectrum required to support Wi-Fi enabled devices and applications for remote working and virtual learning, has been demonstrated over the past year with the COVID-19 pandemic. **Notably, current Wi-Fi capacity and speeds are the main constraint, even in homes with high-speed wireline connections, when a family unit is utilizing numerous Wi-Fi enabled devices. This discrepancy will only become more amplified as available wireline speeds increase**. The additional licence-exempt spectrum will provide the improvements needed in Wi-Fi throughput for homes and businesses and reduce congestion between neighbours living in close proximity. The additional spectrum will also support the ability for small wireless Internet service providers to provide **cost-effective enhanced broadband connectivity in rural and remote areas."**

Regulators in many economies have agreed with these views, with South Korea, Brazil, Chile, Costa Rica, Honduras, Guatemala, and Peru already acting to open the full band to license-exempt technologies. Regulators should put their countries on the same path to align with the growing consensus that the full 6 GHz band should be available for license-exempt use.

D. Wi-Fi technology, standards, and interoperability are all in place today, ready for regulatory action

Equipment is available to consumers and businesses as soon as license-exempt use is permitted in the 6 GHz band. RLAN operations can be introduced with mitigations to ensure that existing users are not adversely impacted, enabling countries to maximize benefits from the band without enduring the hardships of relocating incumbents. Enterprise, industrial, and governmental needs today and in the future also can be more easily met with the new generation of technologies designed to operate throughout the entire 6 GHz band.

Standards are ready

The IEEE has extended the latest Wi-Fi standard, 802.11ax (also known as "Wi-Fi 6") to include the 6 GHz band. The standard is complete and has been published. In addition to the IEEE standard, Europe's ETSI BRAN EN 303 687 has reached a "stable draft", providing further support for standards-based deployments. 3GPP-based licensed-exempt technologies are also in standards development, with New Radio-Unlicensed included in Release 16 covering the full 6 GHz band.

In addition, both the Wi-Fi Alliance (for IEEE 802.11) and WInnForum (for 5G NR-U) are engaged in projects to standardize the interfaces between Standard Power APs and AFCs. Standardization of the interface helps simplify AFC implementation because the two interfaces will be known and documented, creating built-in incentive for AFCs to utilize the standards. Standard Power APs can be manufactured and used with the confidence that the equipment will interface with any standards-compliant AFC.

Interoperability testing is ready

The Wi-Fi Alliance has named Wi-Fi 6 products capable of operating in the 6 GHz band as "Wi-Fi 6E" devices and released a certification plan for global interoperability as of January 2021. Interoperability testing has become the hallmark of technologies that use license-exempt spectrum, because it ensures that consumers can purchase devices with the confidence that the device will work with their router and with other devices. Multiple product vendors are already announcing Wi-Fi 6E devices that use super-wide 160 MHz channels and uncongested bandwidth in 6 GHz to deliver multigigabit, low latency Wi-Fi. Per the Wi-Fi Alliance, "Wi-Fi CERTIFIED™ provides a standards-based approach for product vendors to introduce secure and interoperable Wi-Fi 6E products throughout the world, helping to create a diverse device ecosystem." The first set of products already have been certified for interoperability.

6 GHz license-exempt equipment is entering the market

The United States FCC published its test requirements for the 6 GHz band, and the first devices have completed test review and approval. Then, FCC Chairman Ajit Pai marked the certification of the first device in December 2020 with the following statement:

> *We expect Wi-Fi 6E to be over two-and-a-half times faster than the current standard. This will offer better performance for American consumers at a time when homes and businesses are increasingly reliant on Wi-Fi. During the COVID-19 pandemic, we've all seen how Wi-Fi has enabled everything from work-at-home to telehealth to remote learning to streaming and gaming. Wi-Fi 6E will turbocharge each of these and more, and will also complement commercial 5G networks. Bottom line: The American consumer's wireless experience is about to be transformed for the better.*

With 6 GHz equipment testing rules now available, manufacturers can proceed to test equipment, and Telecommunications Certifications Bodies that receive the test reports prior to the certification application proceeding to the FCC laboratory can begin their review of manufacturer testing and begin inde-

pendent testing. Dozens of successful 6 GHz equipment certifications have been completed, with significantly more expected this year.

Similarly, in Europe, with the ETSI standard reaching the stable stage, and with the first stage of the European process reaching completion, equipment is entering the European market as individual countries complete steps to adopt the European findings into national rules. And, the Republic of Korea's National Radio Research Institute has announced its revision of the test method for conformity assessment of radio equipment for the 6 GHz band. The Wi-Fi Alliance now projects that 340 million Wi-Fi 6 (802.11ax) devices will be sold in 2021 globally, with about 20% of them (or 68 million devices) 6 GHz-ready. Shipments of 6 GHz-capable Wi-Fi 6 devices are expected to ramp up very quickly in 2022 and beyond.

E. The opportunity cost of opening less than the full band to license-exempt use RLAN is great, with very limited near-term benefits attributable to an IMT designation

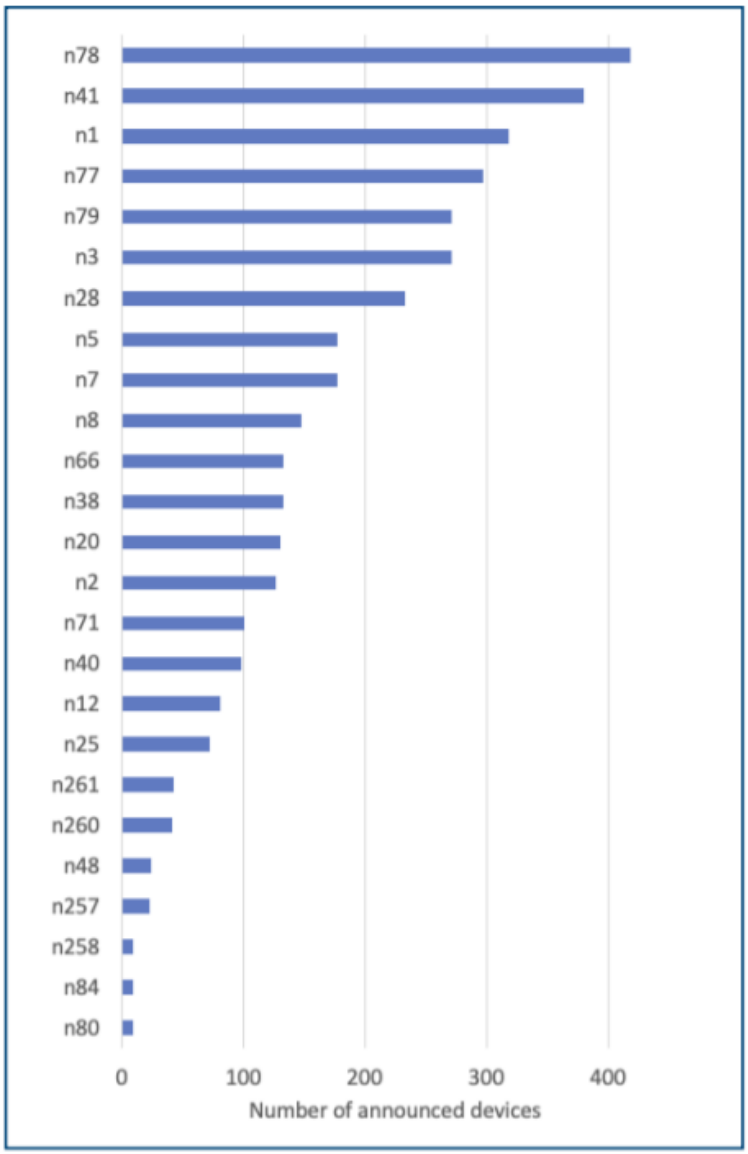
There is a real and significant opportunity cost to countries from not opening the full 6 GHz band for license-exempt use. As described in previous sections, the footprint of geographies that have already opened the full 6 GHz band ensure that there will be a global market for license-exempt equipment that uses the full 1200 MHz, and a continued drive toward global harmonization. The technology case for opening the 6 GHz band to license-exempt use is compelling; doing so generates important social and economic benefits. Countries that fail to act or delay action will fall increasingly behind in realizing the social and economic benefits of license-exempt use. Equipment is ready for the market, with standards and interoperability testing in place. Consumer, enterprise, industrial, and governmental needs today and in the future can be more easily met with the new generation of license-exempt technology designed to operate throughout the 6 GHz band.

Some parties may argue that the portion of the band above 6425 MHz should be reserved for possible IMT use, or that IMT technologies "require" 6 GHz band spectrum, but the arguments do not stand up to scrutiny. The IMT community's mid-band spectrum advocacy for many years has focused on spectrum in the 3 GHz range. For much of the last decade, the IMT community has advised governments globally that it is essential to make available 100 MHz per operator in this 3GHz range to support 5G needs, administrations did not identify 6 GHz as a pioneer band for 5G, and the IMT community did not even mention the 6 GHz band for their 5G needs. Most importantly from a cost-benefit analysis perspective, the IMT community did not advance the use of 6 GHz frequencies beyond ensuring that 5G New Radio – Unlicensed (i.e. 5G NR-U) be specified in its Release 16 for 5925-7125 MHz as Band n96. In 2019, GSMA, in a publication directed to operators about why they should care about 5G, said this:

> *"5G networks require access to spectrum in low, medium and high radio frequencies and in larger contiguous blocks than previous mobile generations require. Regulators that get as close as possible to assigning 100MHz per operator in 5G mid-bands (e.g. 3.5GHz) and 1GHz per operator in millimetre wave bands (e.g., 26GHz and 28GHz) will best support robust 5G services." GSMA, The 5G Guide: A Reference for Operators, April 2019.*

Notably, GSMA did not raise the 6 GHz band frequencies, and failed to list the 6 GHz band in its exhaustive appendix of "5G New Radio Spectrum Bands." The IMT community's actions over the last decade on the 6 GHz band, or rather its inaction, speak far louder than GSMA's recent hyperbolic press release describing the allocation of 6 GHz for license-exempt use a "clear threat to 5G". Regulators and policymakers globally have gone to great lengths to provide the 3 GHz mid-band spectrum that

Figure 5: Announced devices with known spectrum support, by broad category (data not available for all devices)



Source: GSA April 2021

In addition to making available further parts of the 3.3-4.2 GHz band range for licensed 5G, countries are also considering parts of the 4.4-5.0 GHz band range to provide even further mid-band IMT spectrum based on the existing 3GPP band n79 ecosystem.

the cellular industry has long said was the critical enabler for 5G. The IMT industry should act to meet its promises for 5G with the spectrum that has been made available, not to claim that 6 GHz licensed spectrum is suddenly critical to enable 5G operations.

Today, the established path to mid-band licensed 5G is through the 3 GHz band (roughly 3300-4200 MHz globally). Most mid-band NR devices have been announced for the 3 GHz range (n77, n78) along with devices for the 2500 MHz band (n41) and 2100 MHz (n1). At 6 GHz, there is no New Radio specification for standard FDD or TDD 3GPP technology, although 5G NR-U has been specified for license-exempt use in the 6 GHz band. Because of this, there is neither infrastructure nor client device equipment that can support licensed New Radio in the 6 GHz band. In contrast, there are mature specifications for both LTE and 5G NR for the 3 GHz range, and infrastructure and client device manufacturers have implemented support in a wide variety of equipment already available in the market. Radios supporting 5G NR bands n77 and n78 in the 3 GHz range are the path to instant mid-band 5G as soon as 3 GHz band spectrum becomes available, just as there is a large and growing ecosystem of equipment that can instantly leverage designation of the full 6 GHz band for license-exempt use.

GSMA correctly recommends that policymakers and regulators "support harmonised mid-band 5G spectrum". With major markets, such as the U.S., Canada, South Korea, and Brazil, having allocated 5925-7125 MHz for license-exempt use, these frequencies will not be harmonized for licensed 5G. Instead regulators are making decisions to allocate the 6 GHz band in a way targeted toward easing the mid-band deficit of license-exempt spectrum around the world, keeping in mind that 5G NR-U can also use these frequencies.

Regulators around the globe agree that withholding the upper 700 MHz of the 6 GHz band for future consideration for IMT is inadvisable.

- In Canada, "ISED is of the view that delaying the release of the spectrum would not meet the policy objectives outlined in section 2, as it would hinder access to affordable broadband services for Canadians in rural and urban areas and would negatively impact the opportunities for innovation."

- In Saudi Arabia, the CITC noted that it favored 3 GHz band spectrum, not the 6 GHz band, for 5G mid-band needs, stating that its focus was on making 3 GHz band spectrum available for 5G. CITC noted "the substantial amount of licensed TDD mid band spectrum already being made available for IMT and 5G.... CITC believes that this bandwidth will be sufficient to cover the mid-band spectrum needs of IMT for the foreseeable future....The existing mid-bands for exclusive IMT use have robust ecosystems already as well as superior propagation characteristics. If mobile operators want to access the 6 GHz band, they can do so on a license-exempt basis using NR-U (which 3GPP has defined as band n96)."

- In Brazil, one commissioner explained that "IMT operators wanted us to give a part of this spectrum for licensed use, arguing that it was important for 5G. If we wanted to do that, we would have to wait until 2024 to start the discussion about that and maybe in 2027 we would have the deployment. Considering the moment that we are in right now, considering the pandemic, considering the need for connectivity for everyone for the recovery of the economy, considering all of that, we understood that we could not wait until 2024 or 2027 to start using this frequency band. That's so important. We decided to start using it right now, because right now we have the equipment, we have a Wi-Fi 6E ecosystem. If we waited more than six years to take this decision, these are six years that we lose all the innovation, all the revenues, all the development this frequency band may bring to our economies."

- In the United States, the FCC declined the "requests that we repurpose substantial portions of the 6 GHz band for new licensed services in place of new unlicensed operations and existing incumbents. Most importantly, as explained in the Notice and in this Order, we believe that providing new opportunities for unlicensed operations across the entire 6 GHz band can help address the critical need for providing additional spectrum resources for unlicensed operations.... Repurposing large portions of the 6 GHz band for new licensed services would diminish the benefits of such use to the American public."

Consistent with these observations, many jurisdictions have opened the full 6 GHz band to license-exempt use. It also is important to understand the status of and reasoning behind European action on the 6 GHz band. Europe's 2017 decision to evaluate the lower 500 MHz of spectrum was based on genuine but parochial concerns by a few countries, mostly those that were in the process of migrating narrowband fixed links from other bands into the upper portion of the 6 GHz band. To conserve regulatory administrative resources and to ensure that these narrowband fixed link transitions were completed properly, which then would allow for coexistence to be studied, these countries requested that the initial license-exempt study be restricted to 5925-6425 MHz. Other countries, however, proposed opening the full 6 GHz band to license-exempt use or suggested 5925-6725 MHz for the scope of the coexistence study. European regulators opted for a "lowest common denominator" approach, resulting in the initial study of 5925-6425 MHz. When the European Commission issued a final revision

to the study mandate to reflect the compromise, it said:

> *Based on the results of the compatibility and coexistence studies covering the 5925-6425 MHz band to be carried out under this Mandate, the relevant harmonised technical conditions should enable the coexistence with other systems in this and adjacent frequency bands.*

Thus, once coexistence rules were established for the lower portion of the band, regulators have completed a relevant portion of the work that would be needed for a study of the upper portion of the band. Fully understanding the Mandate's meaning requires an understanding of the debate and ultimate resolution over the size of the band to be studied that preceded it – namely, an expectation that the upper portion of the band could be studied for license-exempt use in due course. In concluding its study of the lower 6 GHz band and approving LPI and VLP portable devices, the European Commission – and the European regulators that participated – did not decide that the upper portion should be used for IMT. Their mandate on that matter is silent.

In any event, the approach that European regulators used to define the boundaries of their study in 2017 has no bearing on the rest of the world. The rationale was internal-to-CEPT decision-making and should not serve as a limiting factor on how any other country studies the 6 GHz band. Nor should it cause other countries to fall short of adopting the best public policy outcomes possible.

> *In fact, no country has designated the 6425-7125 MHz spectrum for IMT. Therefore, there is an absence of consensus among the world's regulators – in contrast to the many countries embracing license-exempt use of the full 6 GHz band -- that any part of the 6 GHz band is necessary for 5G licensed mid-band spectrum. In light of this and the inactivity on the 6 GHz band among the IMT community discussed above, the benefits associated with reserving the upper 700 MHz of the 6 GHz band for possible future IMT use remain speculative.*

There is currently an ITU-R study question on coexistence between IMT and incumbent FS and FSS networks at 6425-7025 MHz (Region 1), as well as another on 7025-7125 MHz (globally). The study question is probably most noteworthy as another marker of the regulatory direction of the band, because Regions 2 and 3 specifically explicitly declined to join in on the Region 1 coexistence study at the WRC-19. Region 1 will be evaluating whether IMT could coexist with fixed satellite uplink, fixed microwave, and other services such as a mobile satellite downlink located in the 6425-7125 MHz band. In the 2017-2021 European examination of license-exempt coexistence, the European process concluded that LPI and VLP license-exempt devices could coexist with

Many types of equipment are expected to support the entire 1200 MHz of the 6 GHz band, as the United States, Brazil, Canada, Saudi Arabia, and the Republic of Korea are enabling the band for such operations, with many other countries expected to do so in 2021.

these same types of services at 5925-6425 MHz. While license-exempt devices can coexist with 6 GHz incumbent services previously studied, and therefore can likely coexist with many of the same services in the upper portion of the 6 GHz band, it is unlikely that IMT could coexist with these same services without significant modifications. The power levels and other mitigations included in the examination of the lower band coexistence between license-exempt and incumbent services are a strong indication of the kinds of limitations the IMT community would need to accept in the upper part of the band in order to coexist with incumbents.

> *The satellite community in Europe has recently and publicly articulated its view that "IMT use of the band 6425-7125 MHz would not be compatible with current & future satellite use of the band", although with certain conditions Wi-Fi (i.e., license exempt) use could be compatible – referencing the coexistence work done in the lower portion of the band. Regulators also have noted the serious and uncertain issues with respect to satellite uplink coexistence if IMT use is considered, with the FCC stating that such a plan presented "no certain or clear path" toward achieving IMT use. Similarly, the FCC said that microwave incumbents had concerns about the "reasonableness and practicality of relocation" if IMT was considered, as they did not see an opportunity for IMT and FS to coexist. Moreover, no regulatory proceeding on designating the 6 GHz band of which we are aware has included a clear expression of how IMT would propose to use the band and at what power levels, although additional detail may be forthcoming as part of the ITU-R study item. IMT networks are typically located outdoors to provide outdoor coverage. In the 6 GHz range it is expected that IMT networks would need additional EIRP to overcome the steeper building entry losses that occur with higher frequency ranges. This supports regulators' concerns about IMT's ability to coexist with incumbent services. Philip Marnick, Group Director of Spectrum for Ofcom UK, presenting at the Dynamic Spectrum Alliance Global Summit on 9 June 2021, shared a slide stating "IMT identification is being considered for region 1 at WRC-23. But coexistence between existing users and high power outdoor mobile is not possible – would require clearing incumbents".*

The GSMA's new-found fervor for licensing 6 GHz and their calls for policymakers and regulators to "safeguard" the 6 GHz band for 5G in advance of WRC-23 do not address, or even acknowledge, the issue of what to do about the incumbent services present in the band. In sharp contrast, the license-exempt technology industry has been on the record since 2016 with the principle that their uses of 5925-7125 MHz would not only protect existing incumbent operations, but also provide for their continued growth.

Waiting for the outcome of WRC-23 is unnecessary – especially in ITU Regions 2 and 3 where 6425-7025 MHz is not even being considered, and only the top 100 MHz is to be studied for a With a high opportunity cost for failing to open the band to market-ready, license-exempt RLAN technologies, no obvious corresponding

benefit to the public for reserving part of the band for yet-to-be-defined future IMT use, and serious and unresolved questions about the ability for IMT to coexist with 6 GHz incumbents (or, alternatively forcing the band to be cleared of incumbents) - opening the full 6 GHz band to license-exempt technologies immediately is the right policy decision.

F. With the right regulatory framework, FS and FSS incumbents can continue and grow their primary licensed uses

One important benefit of opening the full 6 GHz band to license-exempt technologies is that incumbent users are not required to be relocated, and in fact, can grow their network operations over time. Mitigations, such as lower power levels, indoor-only requirements, very low power levels for portable devices, and Automated Frequency Coordination (AFC) will ensure that licensed incumbent operations can continue. Moreover, as the FCC and ISED concluded, opening the band to license-exempt technologies will help drive development of new technologies that support shared use. According to Canada's ISED:

> *"ISED has performed detailed technical analysis on the coexistence of RLANs with existing users. Furthermore, ISED has reviewed and analyzed various technical studies submitted in other jurisdictions with similar incumbent users. ISED is of the view that, under the proposed licence-exempt approach, existing licensed users such as public safety agencies, major telecom operators for backhaul connectivity, satellite service providers and broadcasters will be able to continue to operate and grow in this band."*

Coexistence is essential as it avoids service disruptions and the regulatory uncertainty and delay associated with migrating users to new spectrum. Regulators should recognize license-exempt coexistence with incumbent operations as a significant benefit of opening the full 6 GHz band to license-exempt use.

G. Permitting license-exempt technologies throughout the full 6 GHz band is the best way to support both future growth and innovation in 5G through 5G offloading, backhaul, and NR-U

Regulators globally have also recognized the important and critical role that license-exempt technologies like Wi-Fi play in furthering the 5G market and cite this as a reason to allocate the entire 6 GHz band to license-exempt use. Many of our companies have interests in both licensed and license-exempt 5G technologies, and view both as necessary to deliver on future wireless demands. Spectrum allocations should be sufficient to support both. The two technologies interact in important ways. Designating

the full 6 GHz band for license-exempt technologies will play an important role in ensuring a strong 5G future for all.

First, license-exempt technologies support a substantial amount of mobile traffic offloads for indoor environments, saving operator capital expenses and conserving licensed mobile spectrum. Offloading mobile traffic to Wi-Fi networks generates enormous economic benefits that have been estimated in the tens of billions of dollars for operators' capital and operating expenses globally. When Canada opened the full 6 GHz band for license-exempt technologies, it stated that it expects offloading of mobile traffic to increase over time, which is consistent with more data being consumed inside homes or indoor business locations.

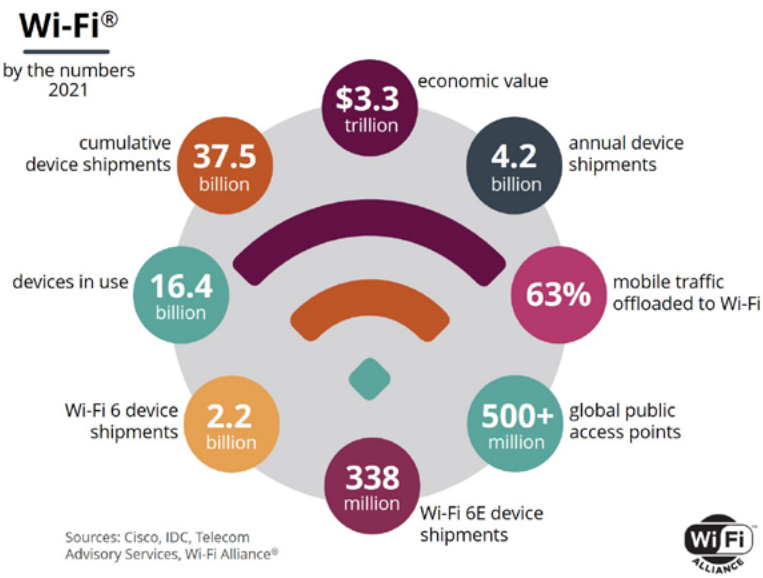
Second, incumbent microwave uses can remain in the 6 GHz band even after permitting license-exempt use, allowing for microwave links to remain available to support 5G networks. IMT interests have cited the 6 GHz band as potentially useful for backhaul, and operators today use the band to support backhaul for mobile operations. However, backhaul uses are licensed on a link basis and do not require large geographic footprints like IMT macrocells do. While fiber optic technology would be the expected backhaul technology of choice for 5G, depending on traffic volume, modern microwave links can be deployed as part of a 5G backhaul network. As 5G backhaul needs grow, more microwave links can be added to the band in support of operator networks; license-exempt technologies will not cause harmful interference to them. Third, 3GPP free use technology – 5G New Radio-Unlicensed – can be deployed by operators to extend their networks into license-exempt spectrum. Operators can use a 3GPP platform to take advantage of "free" spectrum while delivering 5G services to their subscribers. NR-U was standardized in 3GPP Release 16 for 5925-7125 MHz and is available today. Importantly, the NR-U and Wi-Fi industry have already been working on coexistence. Industry supports technology-neutral rules that would allow both technologies to operate in the 6 GHz band.

Via growth in offloading, backhaul, and NR-U, opening the 6 GHz band for license-exempt use provides strong support for the licensed 5G networks of tomorrow, while benefiting users of license-exempt technologies now and in the future. Maximization of the fulfilment of the broad and affordable mobile 5G vision requires Wi-Fi 6E as a component.

III. COUNTRIES SHOULD PROMPTLY ADOPT A LICENSE-EXEMPT MODEL FOR THE FULL 6 GHZ BAND

Opening the full 6 GHz band to license-exempt technologies is a critical step to foster innovation. Expeditious action by regulators will make spectrum available for new applications and services via successful and proven spectrum sharing techniques and facilitate increased availability of low-cost broadband access. With new 6 GHz products already entering the market, finalized rules will help to ensure that citizens and businesses can take full advantage of the latest, most advanced license-exempt technology available while keeping their countries positioned on the leading edge of innovation.

In the chart below, the Wi-Fi Alliance has summarized at-a-glance what the license-exempt industry delivers today, and industry is convinced more can be done. We have developed the technology. What is needed is access to the full 6 GHz band.



Source: Wi-Fi Alliance

Fixed and mobile broadband networks continue to get faster from the evolution in fiber and coaxial cable technologies, as well as from the transition from 4G to 5G (with 6G already on the horizon in standards bodies). At the same time, applications continue to become more bandwidth intensive as connected devices with increasing data demands continue to proliferate. The sustainability of this ecosystem is reliant on license-exempt technologies like Wi-Fi, which serve as significant delivery mechanisms for carrying massive amounts of data traffic for consumer and enterprise network customers. As broadband delivery networks, applications, and devices quickly gravitate toward increasing multi-gigabit connectivity, license-exempt technology must continue to be positioned to perform its essential functions.

Expeditious action by regulators will enable essential access to multiple wide 160 MHz and 320 MHz channels underlying the Wi-Fi 6 and Wi-Fi 7 standards and the vision of a more connected future. As countries take action, they will position themselves among the world's leading regulators that have opened the full 6 GHz band to license-exempt technologies. Regulators should promptly adopt rules opening the full 5925-7125 MHz band for license-exempt technologies, applications, and services.

Apple Inc.

Broadcom Inc.

Cisco Systems Inc.

Dynamic Spectrum Alliance

Facebook Inc.

Google LLC

Hewlett-Packard Enterprise

Intel Corporation

Microsoft Corporation

Qualcomm Incorporated