Assessing the economic value of unlicensed use of the

# 6 GHz band in the Caribbean

May 2022

DSA
DYNAMIC • SPECTRUM • ALLIANCE

TELECOM ADVISORY SERVICES
New York - Buenos Aires - Madrid - Bogota

# Authors


- **Raúl Katz -** PhD Management Science and Political Science, and MS Communications Technology and Policy - Massachusetts Institute of Technology; Maîtrise and Licence - Communications Sciences, University of Paris; Maîtrise, Political Science - University of Paris-Sorbonne. Dr. Katz is currently Director of Business Strategy Research at the Columbia Institute for Tele-Information, Visiting Professor at the Universidad de San Andrés (Argentina) and President of Telecom Advisory Services, LLC (URL: www.teleadvs.com). Before founding Telecom Advisory Services, he worked for twenty years at Booz Allen Hamilton, where he was the Head of the Telecommunications Practice in North and Latin America and a member of the firm's Leadership Team.

- **Juan Jung –** PhD and MA Economics - University of Barcelona, and BA in Economics - *Universidad de la República* (Uruguay). Dr. Jung specializes in econometrics and statistical analysis of telecommunications. In addition to senior economist at Telecom Advisory Services LLC, he Assistant Professor at the Universidad Pontificia Comillas (Spain). Before joining the firm, Dr. Jung was Director of Public Policy in the Interamerican Association of Telecommunications and Director of the Center for Latin American Telecommunications Studies.


**Telecom Advisory Services LLC** (URL: www.teleadvs.com) is an international consulting firm registered in the state of New York (United States), with physical presence in New York, Madrid, Bogotá and Buenos Aires. Founded in 2006, the firm specializes in the development of business strategies and public policies for digital and telecommunications companies, governments, and international organizations. Its clients include leading companies in the digital and telecommunications sectors, as well as international organizations such as the International Telecommunication Union, the World Bank, the Inter-American Development Bank, the World Economic Forum, the UN Economic Commission for Latin America and the Caribbean, CAF Development Bank for Latin America, the GSMA Association, the CTIA, the NCTA, Giga Europe, the Wi-Fi Alliance, and the FTTH Council (Europe), as well as the governments of Argentina, Colombia, Ecuador, Costa Rica, Mexico, Saudi Arabia, and Peru.

*This study was commissioned by the Dynamic Spectrum Alliance, and was conducted in May of 2022; the authors are solely responsible for its contents.*

**CONTENTS**

## ACKNOWLEDGEMENTS

The authors would like to acknowledge the support from Jeffrey Yan, Principal Group Program Manager (Microsoft Corporation); Michael Daum, Director, Technology Policy (Microsoft Corporation); Chuck Lukaszewki, Vice-president – Wireless Strategy and Standards (HP Enterprise); Chris Szymanski, Director – Product Marketing and Government Affairs (Broadcom); Jane Coffin, Senior Vice President – Internet Growth (ISOC); Detlef Fuehrer, Senior Manager – Spectrum Management and Regulatory Affairs (HP Enterprise); Priscilla Argeris, Manager – Public Policy (Facebook); Mary Brown, Director – Government Affairs (Cisco); Burhan Masood (Broadcom); Megan Stull – Telecom Policy Counsel (Google); Michael Purdy – Senior Counsel – Commercial, Product and Policy (Google); Peter Ecclesine – Technology Analyst (Cisco)

We also thank ABI Research for permission to use their data in this report.

## EXECUTIVE SUMMARY

The objective of this study is to provide an assessment of the economic value to be derived by opening the 6 GHz spectrum band to unlicensed use in the Caribbean. The analysis estimates the impact on service quality, coverage, affordability, and focuses on specific applications and use cases likely to be introduced in the enterprise and consumer markets through devices[1] and favorable technical rules[2]. The methodology identifies the different sources of economic value, that can be aggregated within a single estimate (Table A).[3]

**Table A. Sources of Value of 6 GHz Band in the Caribbean countries**

| Source | GDP contribution | Producer surplus | Consumer surplus |
|---|---|---|---|
| Enhanced coverage and improved affordability | Improve affordability associated with broadband provision and increase access sharing in the Wireless ISP sector | | Faster speed of access for Wireless ISP subscribers |
| Increased broadband speed by reducing Wi-Fi congestion | Benefits of eliminating router bottleneck in high-speed connections by increasing speed of residential Wi-Fi | | Consumer surplus from increasing speed |
| Wide deployment of Internet of Things | Spillovers of IoT deployment on productivity of key sectors of the Caribbean economy (e.g., automotive, food processing, logistics, etc.) | Margins of ecosystem firms (Hardware, software, services) involved in IoT deployment in the Caribbean | |
| Reduction of enterprise wireless costs | | Cost reduction of enterprise use of wireless communications | |
| Deployment of AR/VR solutions | Spillovers of AR/VR deployment on the Caribbean economy | Margins of ecosystem firms involved in AR/VR deployment in the Caribbean | |
| Enhanced deployment of municipal Wi-Fi | Increase in GDP due to enhanced broadband adoption | | Consumer surplus from faster data download rate as enabled by faster broadband |
| Deployment of Free Wi-Fi Hot Spots | Increase in GDP due to enhanced broadband adoption | | Consumer surplus from faster data download rate as enabled by faster broadband |
| Aligning spectrum decision with that of other advanced economies | Potential opportunity of creating a Wi-Fi equipment manufacturing sector | Benefits of economies of scale of aligning the Caribbean countries with the regions of lower equipment prices | |
| Enhancing the capability for | | CAPEX reduction derived from offloading wideband | |

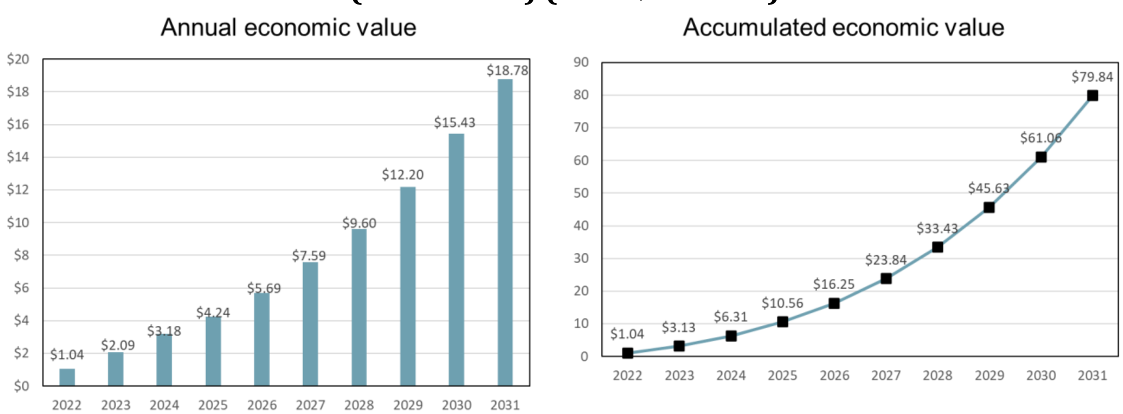
[1] The three classes of 6 GHz Restricted Radiation Radiocommunications Equipment are low power indoor devices, standard power devices, and very low power devices.
[2] Technical rules such as the amount of spectrum permitted for shared use, radiated power limit, radiated power spectral density limit, and the out-of-band-emissions limit for each class of devices will determine whether the 6 GHz band spectrum can be used to its fullest economic potential.
[3] All estimates in this report are provided in US dollars.

| Source | GDP contribution | Producer surplus | Consumer surplus |
|---|---|---|---|
| cellular off-loading | [redacted] | wireless traffic to carrier grade Wi-Fi hot spots | [redacted] |
| Increasing production of residential Wi-Fi devices and equipment | [redacted] | Margins of ecosystem firms involved in manufacturing Wi-Fi enabled equipment in the Caribbean | Consumer surplus from using Wi-Fi enabled residential devices and equipment |

*Source: Telecom Advisory Services analysis*

The countries analyzed include Barbados, Belize, Dominican Republic, Guyana, Jamaica, Trinidad & Tobago, and the nations that conform the Eastern Caribbean Telecommunications Authority (Dominica, Grenada, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines). The estimated economic value for the sum of those economies is expected to increase over time with significant acceleration towards the end of the period due to the value leverage capability of 6 GHz, yielding $18.8 billion by 2031 (Graphic A).

**Graphic A. Caribbean: Economic value of allocating 1200 MHz in the 6 GHz band (2022-2031) (in US$ billions)**




*Source: analysis Telecom Advisory Services*

The larger effects are expected to be generated in the Dominican Republic, with an economic value of $5.09 billion by 2031 (see table B).

**Table B. Economic value for the 6 GHz band in the Caribbean countries (2022-2031) (in US$ billions)**

| Country | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
|---|---|---|---|---|---|---|---|---|---|---|
| Barbados | $0.12 | $0.23 | $0.36 | $0.48 | $0.64 | $0.85 | $1.08 | $1.37 | $1.74 | $2.11 |
| Belize | $0.11 | $0.22 | $0.34 | $0.45 | $0.61 | $0.81 | $1.02 | $1.30 | $1.64 | $2.00 |
| Dominican Republic | $0.28 | $0.57 | $0.86 | $1.15 | $1.54 | $2.06 | $2.60 | $3.31 | $4.18 | $5.09 |
| Guyana | $0.12 | $0.24 | $0.36 | $0.49 | $0.65 | $0.87 | $1.10 | $1.40 | $1.77 | $2.15 |
| Jamaica | $0.14 | $0.28 | $0.42 | $0.56 | $0.75 | $1.01 | $1.27 | $1.62 | $2.04 | $2.49 |
| Trinidad and Tobago | $0.16 | $0.31 | $0.47 | $0.63 | $0.85 | $1.13 | $1.43 | $1.82 | $2.30 | $2.80 |
| ECTEL countries | $0.12 | $0.24 | $0.36 | $0.48 | $0.65 | $0.86 | $1.09 | $1.39 | $1.75 | $2.13 |

*Source: Telecom Advisory Services*

In conclusion, the allocation of the full 1200 MHz of the 6 GHz band in the Caribbean will result in total cumulative value of $ 79.84 billion, while addressing the region's digital divide.

# 1. INTRODUCTION

The purpose of this study is to provide an assessment of the economic value to be derived by opening the full 6 GHz band to so-called unlicensed use in the Caribbean countries by assessing the impact on service quality, coverage, and affordability, as well as focusing on specific applications and use cases likely to be introduced in the enterprise and consumer markets.

At the aggregate level, the methodology relied upon in this study is like the one used in our prior study for Ecuador, based on the estimates provided by extensive studies conducted for Argentina[4], Indonesia[5], Kenya[6], Nigeria[7], South Africa[8], Colombia[9], Mexico[10], and Peru[11], whereby the different sources of economic value were estimated independently and then aggregated within a single estimate (this allows combining GDP impact, with consumer and producer surplus).

The remaining of this study is structured as follows. Chapter 2 provides the background and theoretical framework to frame the analyses, while Chapter 3 presents the estimation methodology and results.

---

[4] See Katz, R. and Callorda, F. (2021). *Estimación del valor económico del uso no licenciado de la banda de 6 GHz en Argentina*. New York: Telecom Advisory Services (Diciembre).
[5] See Katz, R. and Jung, J. (2021). *Assessing the economic value of unlicensed use of the 6 GHz band in Indonesia.* New York: Telecom Advisory Services (October).
[6] See Katz, R. and Callorda, F. (2021). *Assessing the economic value of unlicensed use of the 6 GHz band in Kenya*. New York: Telecom Advisory Services (September).
[7] See Katz, R. and Callorda, F. (2021). *Assessing the economic value of unlicensed use of the 6 GHz band in Nigeria*. New York: Telecom Advisory Services (September).
[8] See Katz, R., Callorda, F. and Jung, J. (2021). *Assessing the economic value of unlicensed use of the 6 GHz band in South Africa*. New York: Telecom Advisory Services (December).
[9] See Katz, R. and Callorda, F. (2021). *Estimación del valor económico del uso no licenciado de la banda de 6 GHz en Colombia*. New York: Telecom Advisory Services (Enero).
[10] See Katz, R. and Callorda, F. (2021). *Estimación del valor económico del uso no licenciado de la banda de 6 GHz en México*. New York: Telecom Advisory Services (Enero).
[11] See Katz, R. and Jung, J. (2021). *Estimación del valor económico del uso no licenciado de la banda de 6 GHz en Perú*. New York: Telecom Advisory Services (Marzo).

## 2. THEORETICAL FRAMEWORK AND BACKGROUND

### 2.1. The intrinsic value of unlicensed spectrum

Unlicensed spectrum (that is to say, spectrum not owned by a license holder) existed since the 1930s. However, it was only in 1985 that the United States Federal Communications Commission (FCC), recognizing its importance, opened new spectrum for unlicensed use at the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands in 1985. This initiative led to the introduction of protocols such as Bluetooth and Wi-Fi. In 2003, recognizing the growing value of the technology, the International Telecommunications Union World Radio-communication Conference recommended to open more bands to Wi-Fi use around the world. Ever since then, Wi-Fi technology has taken a prominent position in the wireless ecosystem.[12]

The debate over the most effective way of allocating frequency spectrum has been carried on over the past fifty years, especially since the publication of Coase's seminal paper (1959) on spectrum management. A key issue of the policy debate relates to the management of unlicensed spectrum. Key policy questions range from whether granting exclusive licenses would deter innovation to if setting spectrum for unlicensed uses would be costly in terms of reduced government revenues to be derived from auctioning frequency rights. Along these lines, research to date has produced several very important theoretical and empirical studies in support of unlicensed use (Milgrom et al, 2011; Carter, 2003; Cooper, 2011; Marcus et al, 2013; Crawford, 2011; Benkler, 2012; Calabrese, 2013). That said, while the debate has highlighted the diverse beneficial effects of unlicensed spectrum - such as triggering technological innovation, complementing cellular networks, and the like - research has only recently focused on assessing unlicensed spectrum's economic value, particularly the producer and consumer surplus derived from keeping a portion of the spectrum unassigned as well as its GDP contribution[13]. Part of the difficulty in assessing the value of unlicensed spectrum resides on the fact that, unlike licensed spectrum that is used for a few, homogeneous services, unlicensed bands provide the environment for the provision of several heterogeneous services and devices. Furthermore, given the complementarity between applications relying on unlicensed and licensed spectrum, value estimation of the unlicensed portion is non-trivial. Nevertheless, an evidence-based policy debate requires the rigorous quantification of economic value of the unlicensed spectrum.

---

[12] The success of both standards led to the assignment in the United States of additional bands to unlicensed use. By the end of 2008, approximately 955 MHz were allocated to unlicensed use below 6 GHz (the most used bands included 900 MHz, 2.4 GHz, 5.2/5.3/5.8 GHz, and above 60 GHz). In 2014, the FCC assigned the 5.8 GHz band to unlicensed application and is presently considering supplementing this band by making the bottom 45 MHz of the 5.9 GHz band available to unlicensed use. Finally, in 2020, the FCC allocated 1,200 MHz in the 6 GHz band to unlicensed use.

[13] This is contrary to research on the valuation of consumer welfare derived from the use of licensed spectrum which has been a fairly standard research practice given the availability of auction data and consumption series (see Hazlett, 2005; Hausman, 1997).

In 2009, Richard Thanki produced the first study to determine the economic value of unlicensed spectrum. He estimated that three major applications (residential Wi-Fi, hospital Wi-Fi, and retail clothing RFID) in the United States generated value in the range of $16 billion to $36.8 billion. At the time, the author acknowledged that these estimates covered only a fraction of the economic value[14] and, consequently, were too conservative. Two years later, Milgrom et al. (2011) supported Thanki's estimates, but also provided additional quantification of value for other applications. For example, the authors estimated the economic value of Apple's iPad, a device intimately linked to the use of Wi-Fi, at $15 billion. Additionally, the authors quantified other benefits in the United States alone, such as Wi-Fi supported cellular off-loading ($25 billion) and the value of Wi-Fi faster data rates of mobile phones ($ 12 billion). Finally, they referenced other non-quantified benefits, such as the usage of Wi-Fi only devices and future applications such as Super Wi-Fi[15] and Advanced Meter Infrastructure. A year later, Thanki (2012) produced a new piece of research, refining his residential Wi-Fi estimate and quantifying other benefits of unlicensed spectrum. He estimated the annual consumer surplus of residential Wi-Fi to be between $118 and $225 per household (a total of $15.5 billion for the United States). Additionally, enlarging the original scope of benefits, he assessed the producer surplus derived from carrier savings resulting from Wi-Fi off-loading ($8.5 billion for the United States). Finally, he estimated the value generated by enhanced affordability (an assessment mainly focused on emerging markets) and mentioned potential innovation related benefits related to deployment by Wireless Internet Service Providers (WISPs). In the same year, Cooper (2012) calculated the economic value by estimating the number of cell sites that the wireless industry would avoid investing in as a result of traffic off-loading to Wi-Fi carrier grade hot spots (130,000), which would result in annual savings of $26 billion. In a similar vein, the author of this research has developed numerous studies assessing the economic value of unlicensed spectrum for different bands in the United States (Katz, 2014a, 2014b, 2018, 2020) and other advanced economies (Katz et al., 2018).

In all, the evidence is quite compelling about unlicensed spectrum capacity to enable numerous applications, services and devices (see Table 2-1):

**Table 2-1. Unlicensed Spectrum: Standards and enabled complementary technologies**

| Standards | Frequency bands | Geographic Range | Data rate | Devices and applications |
|---|---|---|---|---|
| Wi-Fi (802.11b, 802.11ax) | • 2.4 GHz<br>• 3.6 GHz<br>• 5 GHz<br>• 6 GHz | • indoor: 38 meters<br>• outdoor: 125 meters | • Up to 1200 Mbps | • Computers, Printers, scanners, tablets<br>• Mobile phones, scanners<br>• AR/VR devices |
| Bluetooth (802.15.1) | • 2.4 GHz | • Short range indoors | • 1-3 Mbps | • Phone headsets, PC networks<br>• Barcode scanners |

[14] Thanki estimated that the three applications represented 15% of the unlicensed wireless chipsets to be shipped in the US in 2014.
[15] Super Wi-Fi refers to IEEE 802.11g/n/ac/ax implementations over unlicensed 2.4 and 5 GHz Wi-Fi channels but with performance enhancements for antenna control, multiple path beam selection, advance control for best path, and applied intelligence for load balancing.

| | | | | |
|---|---|---|---|---|
| | | | | • Credit card payment machines |
| ZigBee (802.15.4) | • 915 MHz | • 75 meters | • 250 Kbps | • Wireless light switches<br>• Electrical meters with in-home-displays<br>• Traffic management systems |
| Wireless HART (802.15.4) | • 2.4 GHz | • indoor: 60 -100 meters<br>• outdoor: 250 meters | • 250 Kbps | • Equipment and process monitoring<br>• Environmental monitoring, energy management<br>• Asset management, predictive maintenance, advanced diagnostics |
| Wireless HD | • 60 GHz | • 30 feet | • 28 Gbps | • High Definition consumer electronic devices |
| WiGig (802.11ad) | • 60 GHz | • 5 -10 meters | • 6 Gbps | • Smartphones, Tablets, Docking stations<br>• PCs & Peripherals, TV & Peripherals<br>• Digital Cameras, Camcorders |
| RFID | • 50-500 KHz<br>• 13.56 MHz<br>• 0.9 to 2.5 GHz | • Up to 29 inches | • Read-only: 8.75 kbps<br>• Active Read - Write: 3 kbps | • Asset tracking<br>• Livestock tracking, credit card payments<br>• Highway toll payments<br>• Supply chain management |

*Source: compiled by Telecom Advisory Services*

The economic value generated by the use of unlicensed spectrum can be categorized across four dimensions:

- **Complementing wireline and cellular technologies:** A complementary technology is a resource that, due to its intrinsic strengths, compensates for the limitations of another. In the case of spectrum management, unlicensed frequency bands can enhance the effectiveness of devices that use licensed spectrum. For example, Wi-Fi base stations operating in unlicensed bands can enhance the value of cellular networks by allowing wireless devices to switch to Wi-Fi access points, thereby reducing the cost of wireless broadband access and increasing the access speed rate. Consumers accessing the Internet within the reach of a Wi-Fi site can reduce their costs of access by turning off their wideband service. They can also gain additional access speed because the transfer rate of Wi-Fi sites is generally faster than that offered by cellular technology (although 5G is narrowing down the difference).
Wireless operators can also reduce their capital spending by complementing their cellular networks with carrier-grade Wi-Fi access points, which are considerably less expensive than cellular network equipment with similar capacity. In addition to reducing spending, wireless carriers can offer fast access service without a base station congestion challenge. Finally, cellular carriers derive benefits from avoiding CAPEX because a portion of traffic is off-loaded to residential Wi-Fi or business networks.
- **Developing alternative technologies, thus expanding consumer choice**: In addition to complementing cellular networks, unlicensed spectrum can provide the environment needed for operating technologies that are substitutes to licensed uses, thereby providing consumers with a larger set of choices. By limiting power and relying on spectrum with low propagation, unlicensed bands avoid interference, rendering the need for property rights irrelevant. In fact, some of the most important

innovations in wireless communications are intimately linked to Wi-Fi for gaining access. This is particularly relevant in the 6 GHz band for the development of Very Low Power devices.

- **Supporting innovative business models:** By providing consumers with additional service choices, unlicensed spectrum also supports the development of innovative business models. The causality between unlicensed spectrum and innovation occurs at multiple levels. First, firms developing new applications in an unlicensed spectrum environment do not need approval from the operators of cellular networks. On the other hand, a firm that attempts to develop a product running on spectrum licensed to a set of exclusive holders faces a "coordination failure" barrier (Milgrom et al., 2011). Along those lines, if the product requires the acceptance and coordination of multiple license holders (say, multiple cellular network operators), the innovator must negotiate with every one of them (unless it is willing to face the problem of restricting its market reach).[16]
- **Expanding access to communications services**: In addition to the applications discussed above, technologies operating in unlicensed spectrum can bridge the broadband coverage digital divide. Further developments in the areas of spectrum sensing, dynamic spectrum access, and geolocation techniques (Stevenson et al., 2009) have improved the quality of wireless service based on unlicensed spectrum technologies, substantially extending the geographic range of conventional 802.11 standard, and providing cost-efficient access in rural settings.

## 2.2. Sources of economic value generated by the unlicensed use of the 6 GHz band

The objective of the study is to provide an assessment of the economic value to be derived by allowing unlicensed use in the 6 GHz band in the Caribbean countries. Our approach to measuring economic value of unlicensed spectrum focuses first on the new economic growth in Gross Domestic Product (GDP) enabled by the additional unlicensed spectrum channels in the 6 GHz band. By including the GDP contribution measurement, we follow Greenstein et al. (2010) and prior research literature measuring the economic gains of new goods. In measuring the GDP direct contribution, we strictly consider the revenues added "above and beyond" what would have occurred had the spectrum under consideration been licensed.

Beyond GDP contribution, we add to this analysis by measuring the economic surplus triggered by the adoption of the technologies operating in the unlicensed network band. The underlying assumption of this approach is that the unlicensed spectrum resource generates a shift both in the demand and supply curves resulting from changes in the production function of services as well as the corresponding willingness to pay. On the supply side, the approach measures changes in the value of inputs in the production of wireless communications. The most obvious example is whether Wi-Fi, enabled by unlicensed spectrum, represents a positive contribution to wireless carriers' CAPEX and OPEX insofar

[16] This is a very common phenomenon existing in the development of wireless devices, whereby manufacturers need to face not only type approval certification from regulatory agencies but also the need to sign distribution agreements with wireless operators.

as they can control their capital spending while meeting demand for increased wireless traffic. From an economic theory standpoint, the wireless industry can then increase its output, yielding a marginal benefit exceeding the marginal cost. This results in a shift in the supply curve by a modification in the production costs. To quantify incremental surplus derived from the adoption of technologies operating in the 6 GHz band, we itemize the number of technologies and applications intricately linked to this environment. We complement the concept of producer surplus with an assessment of the consumer surplus, a measure of user benefit.

At the aggregate level, the methodology relied upon in this study is like the one used in prior studies by the author[17], whereby the different sources of economic value were estimated independently and then aggregated within a single value (this allows cumulating GDP impact, with consumer and producer surplus[18]). Along those lines, we proceed to identify the sources of economic value, estimate their impact, and then combine them in the aggregate. The area of impact of each source of value varies (see Table 3-1).

**Table 2-2. Sources of Value of 6 GHz Band in the Caribbean countries**

| Source | GDP contribution | Producer surplus | Consumer surplus |
|---|---|---|---|
| Enhanced coverage and improved affordability | Improve affordability associated with broadband provision and increasing access sharing in the Wireless ISP sector | | Faster speed of access for Wireless ISP subscribers |
| Increased broadband speed by reducing Wi-Fi congestion | Benefits of eliminating router bottleneck in high-speed connections by increasing speed of in-door Wi-Fi | | Consumer surplus from increasing speed |
| Wide deployment of Internet of Things | Spillovers of IoT deployment on productivity on key sectors of the Caribbean economy (e.g., automotive, food processing, logistics, etc.) | Margins of ecosystem firms (Hardware, software, services) involved in IoT deployment in the Caribbean | |
| Reduction of enterprise wireless costs | | Cost reduction of enterprise use of wireless communications | |

[17] Katz, R. (2014a). *Assessment of the economic value of unlicensed spectrum in the United States*. New York: Telecom Advisory Services. Katz, R. (2014b). *Assessment of the future economic value of unlicensed spectrum in the United States*. New York: Telecom Advisory Services. Katz, R. (2018). *A 2017 assessment of the current and future economic value of unlicensed spectrum*. Washington, DC: Wi-Fi Forward. Katz, R. (2018). *The global economic value of Wi-Fi 2018-2023*. New York: Telecom Advisory Services. Katz, R. (2020). *Assessing the economic value of unlicensed use in the 5.9 GHz and 6 GHz bands*. Washington, DC: Wi-Fi Forward.

[18] We consider that cumulating GDP effect and producer surplus on equipment sales is reasonable given that the impact on GDP is fundamentally attributed in our models based on historical data to speed increase and not to producer surplus driven by equipment sales triggered by new unlicensed spectrum allocation. On the other hand, CAPEX savings incurred by wireless carriers offloading traffic to Wi-Fi has been occurring for a while and could then be included in the producer surplus model estimates.

| Source | GDP contribution | Producer surplus | Consumer surplus |
|---|---|---|---|
| Deployment of AR/VR solutions | Spillovers of AR/VR deployment on the Caribbean economy | Margins of ecosystem firms involved in AR/VR deployment in the Caribbean | |
| Enhanced deployment of municipal Wi-Fi | Increase in GDP due to enhanced broadband adoption | | Consumer surplus from faster data download rate as enabled by faster broadband |
| Deployment of Free Wi-Fi Hot Spots | Increase in GDP due to enhanced broadband adoption | | Consumer surplus from faster data download rate as enabled by faster broadband |
| Aligning spectrum decision with that of other advanced economies | Potential opportunity of creating a Wi-Fi equipment manufacturing sector | Benefits of economies of scale of aligning the Caribbean countries with countries producing equipment at lower prices | |
| Enhancing the capability for cellular off-loading | | CAPEX reduction derived from offloading wideband wireless traffic to carrier grade Wi-Fi hot spots | |
| Increasing production of residential Wi-Fi devices and equipment | | Margins of ecosystem firms involved in manufacturing Wi-Fi enabled equipment in the Caribbean | Consumer surplus from using Wi-Fi enabled residential devices and equipment |

*Source: Telecom Advisory Services analysis*

Next, we detail each of the identified value sources.

### 2.2.1 Enhanced broadband coverage and improved affordability

This analysis focuses on the economic impact generated by the 6 GHz decision on the wireless ISP (WISP) industry. Caribbean countries still have an important digital divide to close. Example of this are the penetration figures of some of the countries considered in terms of fixed broadband subscriptions per household: 31.6% in Dominican Republic, 46.8% in Trinidad and Tobago, or 29.6% Belize[19]. To close this connectivity gap, WISPs (Wireless Internet Service Providers) can play an important role. According to the International Telecommunications Union, the quantity of fixed-wireless broadband subscriptions amount to well above 90,000 in Dominican Republic in 2019, close to 55,000 in Trinidad and Tobago in the same year, and over 10,000 in Jamaica (2016). In other countries (as is the case of Guyana, or Sant Vincent and the Grenadines) the WISP presence is more limited, although an important number of households depend on this infrastructure for broadband connectivity.

Another relevant issue to consider in tackling the digital divide is limited affordability. Several countries in the region exhibit a high affordability barrier that prevents their citizens from subscribing to a broadband connection (see Table 2-3). The countries with higher affordability barriers are Belize, Saint Vincent and the Grenadines, and Jamaica. Through the

[19] Source: International Telecommunications Union. Data for Dominican Republic and Trinidad and Tobago is from 2020, while data from Belize is 2019.

development of WISPs, connectivity costs can be reduced and thus, more families can become connected.

**Table 2-3. Fixed-broadband Internet 5GB (as a % of GNI pc)**

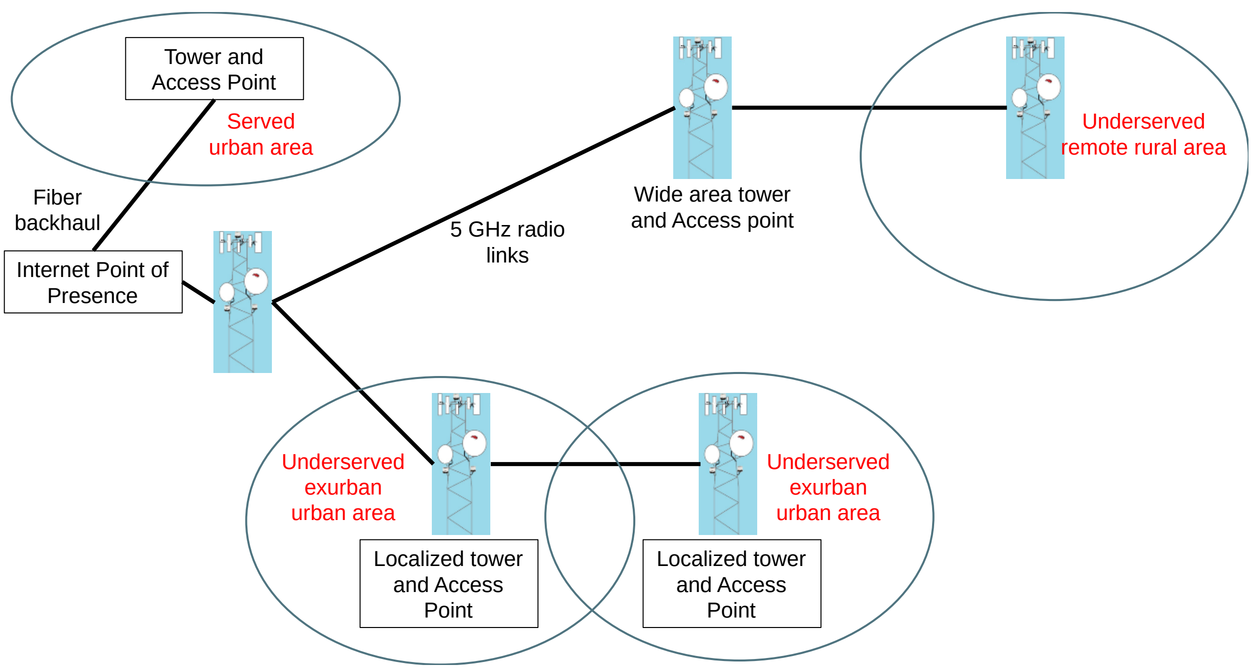
| Countries | | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| Barbados | | 3.4% | 3.4% | 3.1% | 4.1% |
| Belize | | 8.8% | 8.8% | 9.5% | 10.3% |
| Dominican Republic | | 3.2% | 3.2% | 2.9% | 3.2% |
| Guyana | | 7.6% | 8.0% | 7.1% | 6.1% |
| Jamaica | | 6.0% | 6.4% | 5.7% | 7.9% |
| Trinidad and Tobago | | 1.6% | 1.6% | 1.5% | 3.2% |
| ECTEL countries | Dominica | 5.9% | 5.9% | 5.2% | 6.3% |
| | Grenada | 4.5% | 5.5% | 5.4% | 6.1% |
| | Saint Kitts and Nevis | 2.3% | 2.8% | 2.7% | 3.3% |
| | Saint Lucia | 4.2% | 4.4% | 4.1% | 5.1% |
| | Saint Vincent and the Grenadines | 6.1% | 6.7% | 7.2% | 7.3% |

*Source: ITU*

Broadband non-adopters are, as expected, concentrated on the lower income population in urban areas and rural geographies. WISPs tend to have a primary focus on the vulnerable population and part of their deployment is in rural municipalities. In that sense, it is critical to understand how these players could benefit from the 6 GHz allocation.

For reference, the network architecture of a WISP is composed of backhaul to link the internet point of presence to local access points. In turn, each access point relies on Wi-Fi technology operating in the 2.4 GHz spectrum, to provide broadband service to consumers (see Figure 2-1).

**Figure 2-1. Caribbean: WISP Network Architecture**



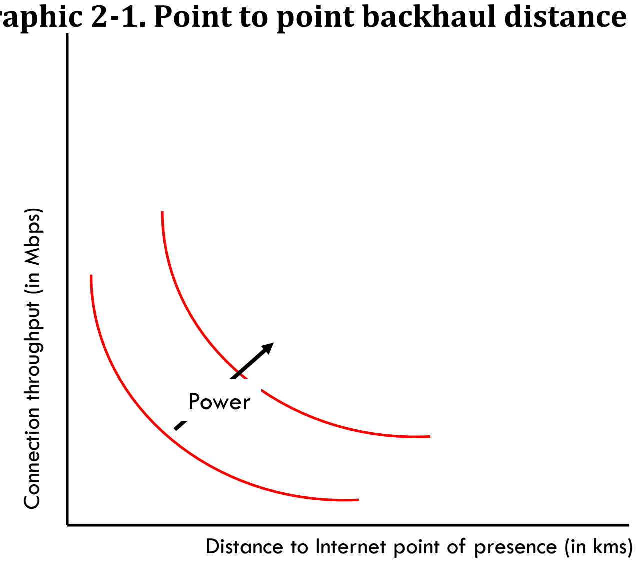
*Source: Telecom Advisory Services*

Access to the 6 GHz spectrum band could have an impact on the WISP business at four levels:

- **Enhanced point to point back-haul capacity which allows WISPs to increase coverage**: as mentioned above, the link between access points is generally handled by 5 GHz radios. Under current spectrum use, the 5 GHz band is very crowded, depicting high interference. Under current spectrum designation, scaling of coverage is fulfilled by deploying additional access points which operate in the 2.4 GHz band. An access point relying on a single backhaul link provides access in the 10-20 Mbps bandwidth and serves 30-40 subscribers. However, growth of subscribers is limited by the capacity of the backhaul. While there is no limit in increasing the number of access points to serve additional users, when this occurs, service quality diminishes, and interference becomes very high because the backhaul becomes the primary bottleneck.[20]

  Access to the 6 GHz unlicensed spectrum band would allow the WISP to increase the number of access points with no backhaul constraint, since at this point the bandwidth available increases to 100 Mbps. A critical benefit of this move will be that WISPs could further penetrate rural areas, thereby addressing part of the digital divide. As expected, the distance that WISPs could enhance their backhaul coverage is a function of path loss and has an impact on available speed to be delivered to the consumer. Along those lines, the higher the power to be available, the lower the path loss (see conceptual Graphic 2-1).

**Graphic 2-1. Point to point backhaul distance**




Note: This relationship assumes free space path loss with no obstructions.
*Source: Telecom Advisory Services*

[20] This effect is commonly experienced by WISPs operating in urban areas, but less so by providers serving rural areas.

Beyond extending their point to point backhaul links, by having the large spectrum in 6 GHz available, different WISPs could operate in similar areas with little risk of interference or serve specific communities.

- **Increase in speed to existing subscribers**: The consumer welfare of WISP customers is expected to benefit from the 6 GHz allocation and the consequent increase in access point performance, which will yield faster broadband service. Beyond the benefit of the speed increase to the existing subscriber base, the growth in throughput provides a more efficient use of infrastructure for sharing lines across users.

- **Increase coverage per access point:** under use of the 2.4 GHz spectrum, WISP served areas range between 3.5 kms in urban settings to 12 kms in rural areas. Coverage is a function of spectrum frequency and power (the higher the frequency the higher the path loss, which is compensated by an increase in power). Under standard power allowance, increased coverage could be gained by bonding channels (a technology not yet frequently used as of yet by WISPs), available by the 6 GHz allocation. A caveat should be raised in this point: given the type of vulnerable population served by WISPs, their ability to gain access to high end devices powered with 6 GHz chips would be limited in the very near future.

- **Higher capacity per access point**: The use of 6 GHz channels would allow the WISPs to increase the number of subscribers to be handled by access point, particularly in the closer areas. OFCOM estimates that the cumulation of 2.4 GHz, 5.8 GHz and 6 GHz could increase the number of subscribers per access point to at least 200. This positive effect might be limited by the caveat raised above regarding the availability of devices powered by 6 GHz chips.

### 2.2.2 Increased broadband speed by reducing Wi-Fi congestion

The economic value of allocating the 6 GHz band to unlicensed use reduces router congestion, increases Wi-Fi throughput, and has a net effect of accelerating broadband speed. This result does not affect all fixed broadband connections, although its impact among high-speed broadband users has a net effect increasing average broadband speed at the customer premise and device level. The increase in average speed yields two types of economic contribution: a growth in GDP (also called the "return to speed"), and an increase in consumer surplus. This transitive causal chain can be disaggregated into three effects:

- A removal of Wi-Fi congestion has an impact on broadband speed at the device level in the customer premise.
- An increase in broadband speed for high-speed users in turn drives a contribution to the Caribbean GDP.

- An increase in broadband speed increases the willingness to pay of users of high-speed broadband access because they can gain access to a larger number of applications.

Empirical literature has supported the economic impact generated by higher broadband speeds (Carew et al, 2018; Kongaut and Bohlin, 2014; Rohman and Bohlin, 2013; Briglauer and Gugler, 2018).

### 2.2.3 Wide deployment of Internet of Things

The development of Internet of Things (IoT) in the Caribbean countries has been limited so far, with Trinidad & Tobago exhibiting more advance than its neighbors in this area (Table 2-4).

**Table 2-4. Cellular M2M connections (% population)**

| Country | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|
| Barbados | 2.9% | 3.4% | 3.7% | 4.1% |
| Belize | 3.6% | 4.1% | 4.5% | 4.8% |
| Dominican Republic | 3.1% | 3.5% | 3.8% | 4.2% |
| Jamaica | 5.9% | 6.5% | 6.5% | 7.0% |
| Trinidad and Tobago | 8.3% | 9.7% | 10.1% | 11.0% |

*Source: GSMA Intelligence*

Industry participants have been clear in stipulating that future development of IoT can only be fulfilled if several barriers ranging from business process redesign to technology standards are addressed[21]. Spectrum availability is one of the barriers to IoT development. The assignment of the 6 GHz band for unlicensed use will result in a broader scale IoT deployment.

The economic value linked to a wider deployment of IoT is based on two sources: (i) the development of firms within the IoT ecosystem, which generate a producer surplus (i.e., margin) by selling their output in the Caribbean countries, and (ii) the spillover of IoT on the economy, which is focused on those sectors that are IoT intensive (e.g., logistics, Health Care, Natural Resources).

### 2.2.4 Reduction of enterprise wireless costs

The increase in unlicensed channel capacity enables more extensive delivery of ubiquitous, high throughput wireless connectivity across multiple access points in business facilities, such as industrial plants, enterprise campus, and the like. This will allow firms to leverage Wi-Fi infrastructure and generate further savings in the use of wideband wireless communications.

[21] CompTIA (2016). *Sizing up the Internet of Things*.

When the 6 GHz band is opened and added to the existing unlicensed bands in 2.4 GHz and 5 GHz, the combined spectrum will be able to support eight 160 MHz channels or three 320 MHz channels (under the allocation of the full 1200 MHz), which will be a source of economic value for production units. The first effect will result in the enabling of faster in-door broadband speeds. Moreover, the addition of channels in 6 GHz will enable providers to deliver fast next-generation speeds to businesses, industrial facilities, hospitals, ports, railyards, and airports across the country. The estimation of economic value in this domain will focus on the new applications and use cases. In addition, the additional spectrum will allow the support of a high number of devices on a single access point. Some Wi-Fi 6 solutions can handle up to 1,500 devices, which makes them ideal for enterprise applications.

### 2.2.5 Deployment of AR/VR solutions

Virtual Reality (VR) is already being used within a wide array of areas, ranging from the gaming industry and entertainment, to training and simulation, in the medical field. Other areas of application include education and culture, sports, live broadcasting, real estate, advertising, architecture, and the arts. On the other hand, Augmented Reality (AR) has an almost limitless range of uses in a wide variety of areas, be it commerce, technical applications, work processes or education. VR and AR serve both consumers and professional users who can be private and public. The AR/VR solutions market is developing at a fast pace driven by a broad range of applications. This development yields two effects similar to the one reviewed in the IoT case.

The development and diffusion of AR/VR applications in the production side of the economy is being driven by an ecosystem comprised of local firms ranging from software development to hardware production and applications development. The margins of firms involved in this endeavor represent producer surplus.

On the other hand, the adoption of AR/VR among Caribbean enterprises will in turn have spillover effects on productivity, thereby contributing to the growth of GDP. The spillover effects range from improved training to the acceleration of product design and delivery. For example, manufacturing companies are already incorporating VR in their product development processes to reduce the time incurred between initial design and physical modelling. AR glasses also help warehouse workers provide parts information for engineers and technicians in the field. Finally, AR/VR solutions can be used to sell and showcase products in retailing.

### 2.2.6 Enhanced deployment of municipal Wi-Fi and free Wi-Fi Hot Spots

Municipal Wi-Fi and free Wi-Fi Hot-Spots are a relevant source of connectivity in many countries exhibiting a large digital divide and affordability barriers. As for free Wi-Fi Hot-Spots, there are approximately 230,000 in the Caribbean countries under analysis (Table 2-5).

**Table 2-5. Free Wi-Fi Hot-Spots (2022)**

| Countries | | City | Free Hotspots |
|---|---|---|---|
| Barbados | | Bridgetown | 5,000 |
| Belize | | Belize City | 1,000 |
| Dominican Rep. | | Santo Domingo | 51,000 |
| | | Santo Domingo Oeste | 41,000 |
| | | Santo Domingo Este | 43,000 |
| | | Santiago de los Caballeros | 13,000 |
| | | San Pedro de Macorís | 2,000 |
| | | La Romana | 2,000 |
| Guyana | | Georgetown | 2,000 |
| Jamaica | | Kingston | 17,000 |
| | | Spanish Town | 1,000 |
| | | Portmore | 1,000 |
| | | Montego Bay | 3,000 |
| | | Mandeville | 1,000 |
| Trinidad & Tobago | | Port of Spain | 10,000 |
| | | Chaguanas | 3,000 |
| | | Mon Repos | 7,000 |
| | | San Fernando | 6,000 |
| | | Laventille | 13,000 |
| ECTEL countries | Dominica | Roseau | 1,000 |
| | Grenada | St. George’s | 1,000 |
| | Saint Kitts and Nevis | Basseterre | 1,000 |
| | Saint Lucia | Castries | 1,000 |
| | Saint Vincent and the Grenadines | Kingston | 1,000 |
| | | Kingston Park | 1,000 |

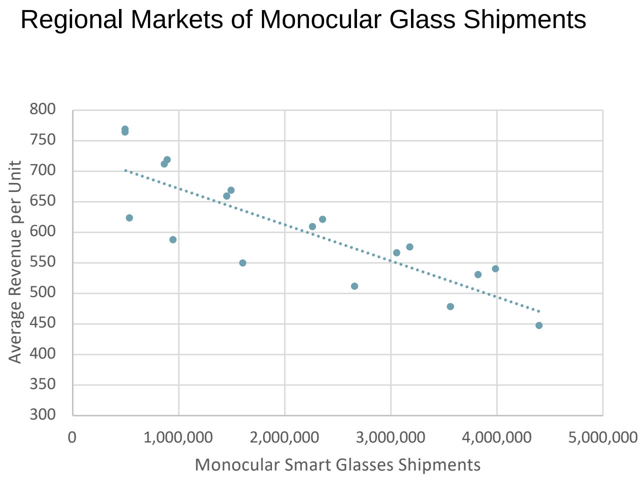
*Source: Wiman.me*

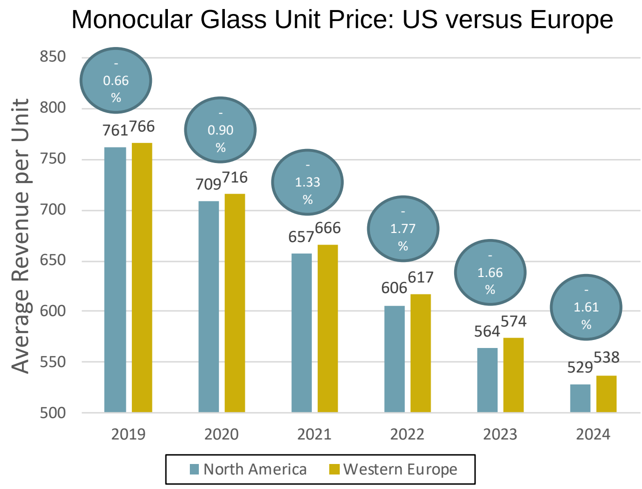
Wi-Fi infrastructure relying only on 2.4 GHz and 5.8 GHz bands is exposed to service degradation as well as inability to support a large user base. Municipal and free Wi-Fi Hot Spots are applications with a critical need of additional spectrum to satisfy the growth in the number of clients but also to deal with interference from other devices operating in competing frequencies. As an example, the 2.4 GHz band currently handles may appliances and devices on wireless standards such as Bluetooth and Zigbee, creating significant interference for Wi-Fi. We will assess the economic benefit of the 6 GHz allocation focusing on its capacity to increase speed of access with the consequent generation of consumer surplus while at the same time providing the economically disadvantaged population with access to the Internet.

### 2.2.7 Aligning spectrum decision with that of other advanced economies

By allocating the full 6 GHz band, the Caribbean countries will not only alleviate the pressure on unlicensed spectrum resulting from explosive Wi-Fi usage but will also make a decision with implications for cost of inputs for local firms and for the region’s industrial policy. A comparative assessment of unit average selling price of AR/VR equipment indicates that the United States has an economic advantage (lower cost) over Europe, resulting from economies of scale (see Graphic 2-2).

**Graphic 2-2. AR/VR Equipment: Economics of production**




Note: Chart on left comprises Data for North America; Western Europe and Asia-Pacific
*Sources: ABI Research; Telecom Advisory Services analysis*

As indicated in the left-hand chart, the production of AR/VR equipment is, as expected, driven by economies of scale. As a result, the chart of the right indicates a price advantage residing within North America. Consequently, it might be advantageous to align the Caribbean's 6 GHz spectrum allocations issue with the full 6 GHz allocation model that has been adopted by Wi-Fi equipment leaders, such as the United States and South Korea, to allow local firms to benefit from lower input prices.

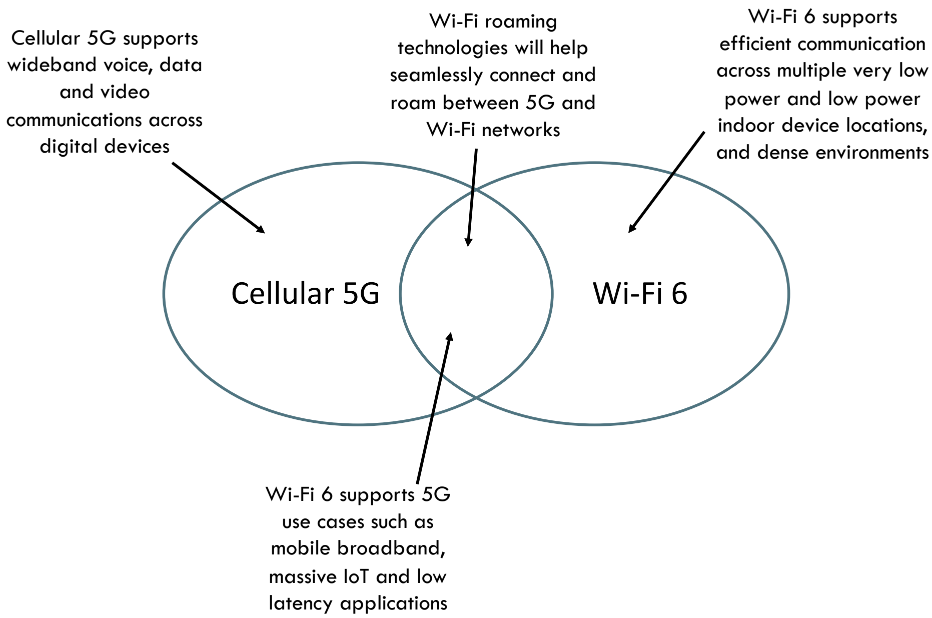
### 2.2.8 Enhancing the capability for cellular off-loading

Wi-Fi acts as a complementary technology, compensating for the economic limitations of cellular. In the case of spectrum management, unlicensed frequency bands can enhance the effectiveness of devices that use licensed spectrum. For example, Wi-Fi base stations operating in unlicensed bands can enhance the value of cellular networks by allowing wireless devices to switch to hot spots, thereby reducing the cost of broadband access and increasing the access speed rate. Consumers accessing the Internet within the reach of a Wi-Fi site can reduce their costs of access by turning off their wideband service. They can also gain additional access speed because the transfer rate of Wi-Fi sites is generally faster than that offered by cellular technology.

Wi-Fi allows cellular service providers to decrease the capital and operating expenses required to accommodate exploding data traffic. The estimation of savings is predicated on the assumption that, in the absence of additional unlicensed spectrum bands, service providers would have to deploy expensive infrastructure to accommodate the growth in traffic. Thus, the calculation of economic value is based on the portion of capital investments (and potential incremental network operations and maintenance operating expenses) that service providers can avoid when they and consumers shift traffic from cellular networks to Wi-Fi.

While complementarity has been hailed for prior cellular and Wi-Fi technology generations, this feature remains for Wi-Fi 6 and 5G. To begin with, access devices like smartphones and sensors will tend to be equipped with both generations for users and service providers to optimize infrastructure use. This will be critical not only for traffic handling in densely packed environments such as apartment complexes and hospitals, but also to support surveillance cameras, point of sale terminals, environmental sensors and other IoT devices. Complementarity will also manifest itself at homes and enterprises, although this benefit has already been accounted for in the sections above (see Figure 2-2).

**Figure 2-2. Complementarity of Wi-Fi6 and 5G NR-U**




*Source: Adapted from Suarez, M. (2020). Unlicensed spectrum access in the 6 GHz band. Presentation to ANATEL*

As an example, the vast majority of data consumed on smartphones and other mobile devices flows over Wi-Fi networks, never touching mobile carrier spectrum or infrastructure. In fact, the share of data traffic offloaded via Wi-Fi is expected to increase sharply as mobile technology upgrades from 4G to 5G, since high- bandwidth applications are typically used at home, work, and other indoor locations. Cisco projects that 76% of all data traffic on smartphone and other mobile devices will be offloaded onto Wi-Fi in North America by 2022[22]. Even cellular providers acknowledge Wi-Fi's central role. For example, Verizon's Executive VP and Consumer Group CEO told an investor conference in January 2020 that between 70% and 75% of mobile device data traffic in the United States is offloaded onto Wi-Fi[23].

Consequently, the economic value of spectrum allocation in the 6 GHz band not only manifests itself in the ability of cellular carriers to reduce capital in 5G deployment by off-

---

[22] C*isco 2019 VNI Report* at 104.
[23] Verizon, Citi 2020 Global TMT West Conference, Webcast (Jan. 7, 2020). Available: https://www.verizon.com/about/investors/citi- 2020-global-tmt-west-conference.

loading traffic but, most importantly, to indirectly account for Wi-Fi use in calculating their investment.

### 2.2.9 Production and adoption of Wi-Fi Equipment

This source of value is initially based on consumers receiving an economic surplus by purchasing Wi-Fi devices at a price lower than their willingness to pay for them. The value is calculated based on the devices operating in the 6 GHz band. Products in this ecosystem include a full range of consumer electronics.

In addition to the consumer surplus generated by the consumption of Wi-Fi equipment, we will also estimate the producer surplus resulting from their manufacturing. The methodology in both cases is the same. However, when estimating consumer surplus, imported and domestically produced goods that are consumed locally are considered, while when measuring producer surplus, only goods manufactured in the Caribbean are measured, regardless of the country in which they are consumed.

## 2.3 International models for 6 GHz allocation

Ever since October 2018, when the Federal Communications Commission in the United States presented a Notice of Proposed Rulemaking (NPRM) that recommended opening the 6 GHz band to unlicensed operations, countries around the world have either launched public consultations or made allocation decisions. At the highest level, countries have been following two approaches – allocating the entire band or just its lower portion – although differences exist in terms of the authorization to use the band for specific devices. For example, the United States regulator permitted standard power and low power indoor devices to operate in the 6 GHz band but proposed a third category of 6 GHz RRRC Equipment -- Very Low Power devices (VLP), that should be permitted to be used indoors or outdoors in certain sub-bands.[24] In a more radical move, Canada became the world's first country to allow all three (LPI, VLP, and standard power) device classes to operate in 6 GHz.[25]

Some countries have followed or are considering an approach to allocate only the lower band – 5925-6425 MHz – which is adjacent to the currently used 5 GHz band, has similar mid-range propagation characteristics, and offers, wide, non-overlapping channels. The underlying rationale for considering only the 5,925-6,425 MHz band is that some countries (especially in Europe) have critical services in the upper part of the 6 GHz band (e.g., large amounts of point-to-point fixed services, earth to space communications, road intelligent traffic systems and communication-based train control, and some radio astronomy sites).

---

[24] Very Low Power devices (VLP), authorized to power levels 160 times lower than standard-power Wi-Fi, and permitted to be used indoors or outdoors in certain sub-bands, and not requiring frequency coordination because they would operate with 60 times less power than standard-power Wi-Fi. These VLP devices would be capable of operating using multiple extremely wide channels (160 MHz) with sub-millisecond latency performance. The category includes AR/VR headsets, Ultra High-Definition Video Streaming, high-speed[24] tethering (watches, ear pods) or entertainment devices in the automobile.

[25] Government of Canada (2021). *Government of Canada to make more spectrum available to support high-quality wireless service,* Ottawa, May 21.

That said, those countries that have adopted the allocation of only the lower portion of the 6 GHz band, recognize that this can change in the future. For example, OFCOM in the United Kingdom made its final decision to allocate 500 MHz for unlicensed use low power indoor and very low power outdoor use as an initial matter[26]. The purpose in limiting the allocation to 500 MHz is to initially show Wi-Fi can benefit from the lower part of the band and investigate the upper part in the future[27]. In the words of OFCOM, "we will continue to review use of the upper 6 GHz band to determine what the optimal use may be".[28]

The current state of the process in the allocation of the 6 GHz around the world can be summarized at the closing of this study as follows (see Table 2-6).

**Table 2-6. Countries that have either approved or are considering allocating the 6 GHz band for unlicensed use**

| Continent | Lower part (5925-6425 MHz) | | Full band (5925-7125 MHz) | |
|---|---|---|---|---|
| | Adopted | Under consideration | Adopted | Under consideration |
| Americas | | Argentina | Brazil, Canada, Chile, Costa Rica, Guatemala, Honduras, Peru, United States | Colombia, Mexico |
| Europe | European Union, Norway, United Kingdom | Switzerland, Turkey | | |
| Arab States | United Arab Emirates | Oman | Saudi Arabia | Jordan, Qatar |
| Asia Pacific | | New Zealand | South Korea | Australia, Japan, Malaysia |
| Africa | Morocco | Egypt, Tunisia | | Kenya |

*Source: Compiled by Telecom Advisory Services from regulatory agency websites.*

[26] OFCOM (2020). *Statement: improving spectrum access for wi-fi – spectrum use in the 5 and 6 GHz bands* (July 24).
[27] Ebbecke, Ph. (2019). *Road to 6 GHz in Europe*. Presentation to WLPC Prague 2019
[28] OFCOM (2020). *Improving spectrum access for Wi-Fi*. London, p.21.

## 3. ESTIMATION OF THE ECONOMIC VALUE OF UNLICENSED USE OF THE 6 GHZ BAND IN THE CARIBBEAN

The sample of analysis for this study is comprised by Barbados, Belize, Dominican Republic, Guyana, Jamaica, Trinidad & Tobago, and the block of countries that conform the Eastern Caribbean Telecommunications Authority (Dominica, Grenada, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines). Previous studies conducted for Argentina, Colombia, Indonesia, Kenya, Mexico, Nigeria, Peru, and South Africa allowed us to estimate the economic value to be generated by the allocation of 1200 MHz of the 6 GHz band for unlicensed use in those countries. The sum of economic value for all those countries for the period 2021-2030 equals $ 555.35 billion, as represented in Table 3-1.

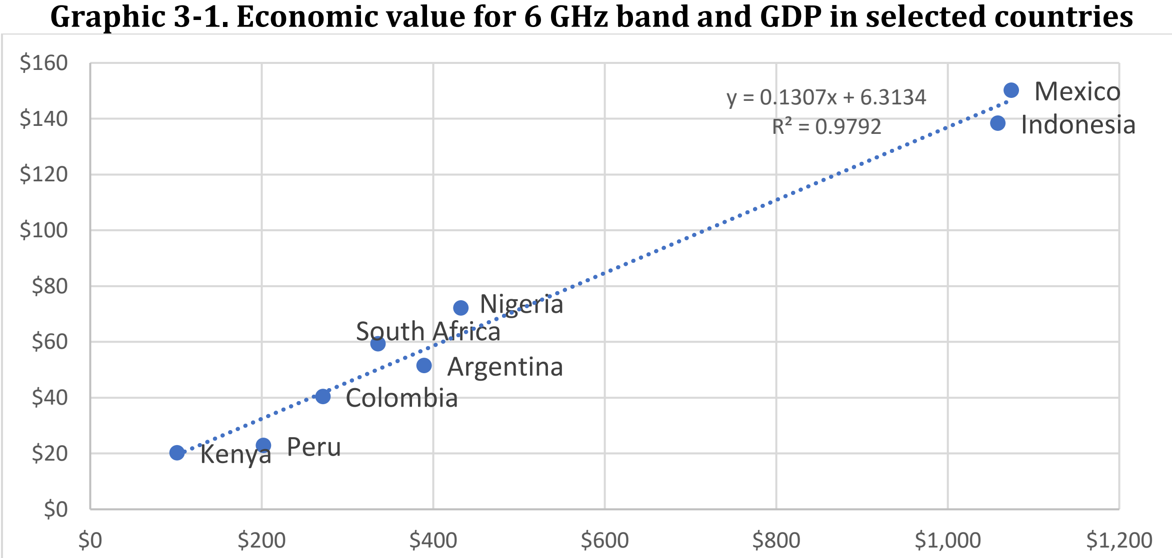
**Table 3-1. Economic value from 6 GHz band in selected countries (in US$ billions) (2021-2030)**

| Country | Accumulated economic value |
|---|---|
| Argentina | $51.59 |
| Colombia | $40.42 |
| Indonesia | $138.37 |
| Kenya | $20.29 |
| Mexico | $150.27 |
| Nigeria | $72.14 |
| Peru | $22.87 |
| South Africa | $59.40 |
| TOTAL | $555.35 |

*Source: Telecom Advisory Services*

Since the economic value generated by the 6 GHz band is proportional to each country GDP, as depicted in Graphic 3-1, is it possible to interpolate the economic value generated by the allocation of the 6 GHz band for unlicensed use in the Caribbean countries.

**Graphic 3-1. Economic value for 6 GHz band and GDP in selected countries**




*Source: Telecom Advisory Services*

Based on the relationship between GDP and 6 GHz economic value estimated for the detailed studies, the economic value accumulated for period 2031-2030 for each Caribbean country "x" can be approximated through the following calculation:

$$Economic\ value_{21-30}^{x} = 0.1307 * (GDP_{2020}^{x}) + 6.3134$$

However, that economic value does not cover the required period under analysis (2022-2031). Therefore, the calculated economic value will be used as an input to estimate the first value for the first year of the required series, 2022. Once the 2022 economic value for each country considered in the sample is estimated, we will extrapolate its evolution up to 2031 applying the weighted average growth rates for the countries presented in Table 3-1 for the corresponding years.

To estimate the 2022 economic value in the Caribbean economies, first we proceeded to calculate the share of total value that 2022 represents in the already estimated countries: this percentage varies from 1% (Nigeria) to 2.4% (Colombia), being 1.7% the weighted average (Table 3-2).

**Table 3-2. Economic value from 6 GHz band in selected countries (in US$ billions) – Ratio 2022 / total**

| Country | Cumulative economic value 2021-2030 | Economic value 2022 | Ratio 2022 / Total |
|---|---|---|---|
| Argentina | $51.59 | $0.78 | 1.5% |
| Colombia | $40.42 | $0.97 | 2.4% |
| Indonesia | $138.37 | $2.10 | 1.5% |
| Kenya | $20.29 | $0.28 | 1.4% |
| Mexico | $150.27 | $3.28 | 2.2% |
| Nigeria | $72.14 | $0.70 | 1.0% |
| Peru | $22.87 | $0.45 | 2.0% |
| South Africa | $59.40 | $0.90 | 1.5% |
| TOTAL | $555.35 | $9.45 | 1.7% |

*Source: Telecom Advisory Services*

By applying the 1.7% to the economic value calculated for each Caribbean economy, it is possible to approximate the 2022 economic value in each case, ranging from $0.11 billion (Belize) to $0.28 billion (Dominican Republic). Having estimated the starting point, we extrapolate the evolution of economic values through the years by applying the weighted average growth rates for the already estimated countries from Table 3-1. For the growth between 2030 and 2031, we only apply the rates from Argentina, Indonesia, and South Africa, as these were the only countries in which the analysis covered year 2031. The bigger effects are expected to be registered in the Dominican Republic, with the economic value yielding $5.09 billion by 2031 (Table 3-3).

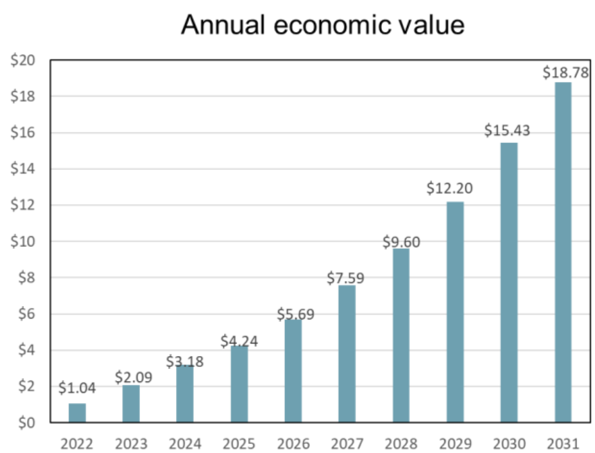
**Table 3-3. Economic value from 6 GHz band in Caribbean countries (in US$ billion) (2022-2031)**

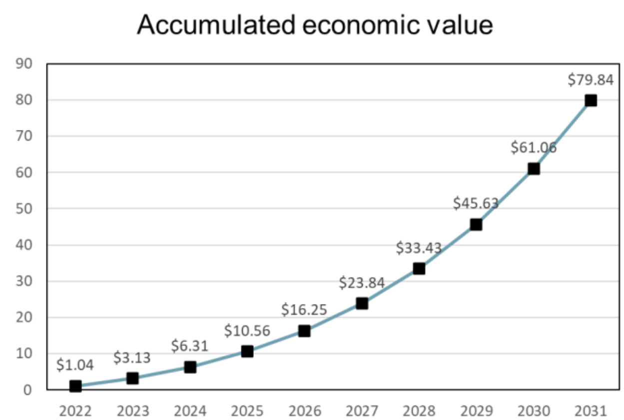
| Indicador | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 |
|---|---|---|---|---|---|---|---|---|---|---|
| Weighted average growth rate (Argentina, Colombia, Indonesia, Kenya, Mexico, Nigeria, Peru, South Africa) | | 100.2% | 52.5% | 33.3% | 34.2% | 33.3% | 26.5% | 27.1% | 26.5% | 21.7% (*) |
| Economic value estimated applying growth rate of analyzed countries | | | | | | | | | | |
| Barbados | $0.12 | $0.23 | $0.36 | $0.48 | $0.64 | $0.85 | $1.08 | $1.37 | $1.74 | $2.11 |
| Belize | $0.11 | $0.22 | $0.34 | $0.45 | $0.61 | $0.81 | $1.02 | $1.30 | $1.64 | $2.00 |
| Dominican Republic | $0.28 | $0.57 | $0.86 | $1.15 | $1.54 | $2.06 | $2.60 | $3.31 | $4.18 | $5.09 |
| Guyana | $0.12 | $0.24 | $0.36 | $0.49 | $0.65 | $0.87 | $1.10 | $1.40 | $1.77 | $2.15 |
| Jamaica | $0.14 | $0.28 | $0.42 | $0.56 | $0.75 | $1.01 | $1.27 | $1.62 | $2.04 | $2.49 |
| Trinidad and Tobago | $0.16 | $0.31 | $0.47 | $0.63 | $0.85 | $1.13 | $1.43 | $1.82 | $2.30 | $2.80 |
| ECTEL countries | $0.12 | $0.24 | $0.36 | $0.48 | $0.65 | $0.86 | $1.09 | $1.39 | $1.75 | $2.13 |

*Note: (*) growth rate considering only Argentina, Indonesia, and South Africa as these were the only countries in which the analysis covered year 2031.*
*Source: Telecom Advisory Services*

Considering the sum of all economies represented in Table 3-3, The total economic value will increase over time with significant acceleration towards the end of the period due to the value leverage capability of 6 GHz, yielding $18.8 billion by 2031 (see Graphic 3-2).

**Graphic 3-2. Caribbean: Economic value of allocating 1200 MHz in the 6 GHz band (2022-2031) (in US$ billions)**




*Source: analysis Telecom Advisory Services*

In conclusion, the allocation of the full 1200 MHz of the 6 GHz band in the Caribbean will result in total cumulative value of $ 79.84 billion, while addressing the region's digital divide.

## BIBLIOGRAPHY


ABI Research. *Augmented and Mixed Reality Market Data: devices, use cases, verticals and value chain*. MD-ARMR-103, QTR 4 2019

ABI Research, *Virtual Reality Market Data: devices, verticals, and value chain*. MD-VR-108, QTR 1 2020

ABRINT (2018). *Plano de modernização e expansão de acessos com implantação de redes FTTH*

ANATEL (2020). *Analise No 29/2020/CB.* Processo no 53500.012176/2019-58.

Benkler, Y. (2012). "Open wireless vs. licensed spectrum: evidence from market adoption". *Harvard Journal of Law & Technology*. Volume 26, Number 1 fall 2012

Blackman, J. (2020). "UK to release 6 GHz and 100 GHz spectrum for Wi-Fi in smart homes, offices, factories". *Enterprise IoT insights* (January, 27).

Bohlin, E. and Rohman, I. (2012). *Does Broadband Speed Really Matter for Driving Economic Growth? Investigating OECD Countries?* Available at SSRN: http://ssrn.com/abstract=2034284 or http://dx.doi.org/10.2139/ssrn.2034284. , 2013

Briglauer, W. and Gugler, K. (2018). *Go for Gigabit? First evidence on economic benefits of (Ultra-) Fast broadband technologies in Europe*. Centre for European Economic Research Discussion Paper No. 18-020.

Calabrese, M. (2013). *Solving the "Spectrum Crunch": Unlicensed Spectrum on a High-Fiber Diet*. Washington, DC: Time Warner Cable Research program on Digital Communications.

Carew, D., Martin, N., Blumenthal, M., Armour, P., and Lastunen, J. (2018). The potential economic value of unlicensed spectrum in the 5.9 GHz Frequency band: insights for allocation policy. RAND Corporation (Rand study).

Carter, K. (2006) "Policy Lessons From Personal Communications Services: Licensed Vs. Unlicensed Spectrum Access," *CommLaw Conspectus* 93

Cho Mu-Hyun (2020). "South Korea makes 6 GHz band available for Wi-Fi", *ZDNet* (October 16).

Cooper, M. (2011). *The consumer benefits of expanding shared used of unlicensed radio spectrum: Liberating Long-Term Spectrum Policy from Short-Term Thinking*. Washington DC: Consumer Federation of America.

Crawford, S. (2011). *The FFC's job and unlicensed spectrum – Waldman report*. Statement to the FCC.

Ebbecke, Ph. (2019). *Road to 6 GHz in Europe*. Presentation to WLPC Prague 2019

FCC ex parte notification from Apple Inc., Broadcom Inc., Facebook Inc., Google LLC, Hewlett Packard Enterprise, Intel Corp., Marvell Semiconductor Inc., Microsoft Corporation, Qualcomm Incorporated (July 2, 2019).

Gobierno de Chile. Ministerio de Transportes y Telecomunicaciones; Subsecretaría de telecomunicaciones. *Modificación a la Resolución del 6 de Octubre de 2017*. Octubre 22, 2020.

Hausman, J. (1997). *Valuing the Effect of Regulation on New Services in Telecommunications*. Brookings Papers on Economic Activity, Economic Studies Program, 28(1997-1), pp. 1- 54.

Hetting, C. (2019). "Europe's process to release 6 GHz spectrum to Wi-Fi on track, expert says", *Wi-Fi Now* (June, 2).

Hetting, C. (2020). "EU and CEPT countries 'highly likely' to release 6 GHz to Wi-Fi in early 2021, expert says". *Wi-Fi Now* (October 21).

Hetting, C. (2020). "South Korea could become Asia's first 6 GHz nation". *Wi-Fi News* (June, 27).

Katz, R. (2014a). *Assessment of the economic value of unlicensed spectrum in the United States*. New York: Telecom Advisory Services. Retrieved from: wififorward.org/resources

Katz, R. (2014b). *Assessment of the future economic value of unlicensed spectrum in the United States*. New York: Telecom Advisory Services. Retrieved from: wififorward.org/resources

Katz, R. (2018). *A 2017 assessment of the current and future economic value of unlicensed spectrum* . Washington, DC: Wi-Fi Forward. Retrieved from: wififorward.org/resources

Katz, R. and Callorda, F. (2018). *The economic contribution of broadband, digitization and ICT regulation: Econometric modelling for the Americas*. Geneva: International Telecommunication Union. Retrieved from: http://handle.itu.int/11.1002/pub/81377c7f-en

Katz, R. (2018). *The global economic value of Wi-Fi 2018-2023*. New York: Telecom Advisory Services. Retrieved from: *wi.fi.org*

Katz, R. (2020). *Assessing the economic value of unlicensed use in the 5.9 GHz and 6 GHz bands*. Washington, DC: Wi-Fi Forward. Retrieved in: http://wififorward.org/wp-content/uploads/2020/04/5.9-6.0-FINAL-for-distribution.pdf.

Katz, R.; Jung, J. and Callorda, F. (2020a). "Can digitization mitigate the economic damage of a pandemic? Evidence from SARS". *Telecommunications Policy* 44, 102044.

Katz, R.; Jung, J. and Callorda, F. (2020b). *COVID-19 and the economic value of Wi-Fi*. New York: Telecom Advisory Services. Retrieved at: https://www.wi-fi.org/download.php?file=/sites/default/files/private/COVID-19_Economic_Value_Wi-Fi_202012.pdf

Katz, R. and Callorda, F. (2021). *Estimación del valor económico del uso no licenciado de la banda de 6 GHz en Argentina*. New York: Telecom Advisory Services (Diciembre).

Katz, R. and Jung, J. (2021). *Assessing the economic value of unlicensed use of the 6 GHz band in Indonesia.* New York: Telecom Advisory Services (Octubre).

Katz, R. and Callorda, F. (2021). *Assessing the economic value of unlicensed use of the 6 GHz band in Kenya*. New York: Telecom Advisory Services (Septiembre).

Katz, R. and Callorda, F. (2021). *Assessing the economic value of unlicensed use of the 6 GHz band in Nigeria*. New York: Telecom Advisory Services (Septiembre).

Katz, R., Callorda, F. and Jung, J. (2021). *Assessing the economic value of unlicensed use of the 6 GHz band in South Africa*. New York: Telecom Advisory Services (Diciembre).

Katz, R. and Callorda, F. (2021). *Estimación del valor económico del uso no licenciado de la banda de 6 GHz en Colombia*. New York: Telecom Advisory Services (Enero).

Katz, R. and Callorda, F. (2021). *Estimación del valor económico del uso no licenciado de la banda de 6 GHz en México*. New York: Telecom Advisory Services (Enero).

Katz, R. and Jung, J. (2021). *Estimación del valor económico del uso no licenciado de la banda de 6 GHz en Perú*. New York: Telecom Advisory Services (Marzo).

Kongaut, Chatchai; Bohlin, Erik (2014). *Impact of broadband speed on economic outputs: An empirical study of OECD countries* , 25th European Regional Conference of the International Telecommunications Society (ITS), Brussels, Belgium, 22-25 June 2014,

Law 360 (2020). *DC Circuit won't block new FCC rules on 6 GHz for now* (October 1)

Liu, Y-H; Prince, J., and Wallsten, J. (2018). *Distinguishing bandwidth and latency in households' willingness-to-pay for broadband internet speed*.

Marcus, S. and Burns, J. (2013). *Study on Impact of Traffic off-loading and related technological trends on the demand for wireless broadband spectrum: a study prepared for the European Commission DG Communications Networks, Content & Technology.* Brussels: European Union

Milgrom, P., Levin, J., & Eilat, A. (2011). *The case for unlicensed spectrum*. Stanford Institute for Economic Policy Research Discussion paper No. 10-036, p. 2. Retrieved from https://web.stanford.edu/~jdlevin/Papers/UnlicensedSpectrum.pdf.

Nevo, A., Turner, J., and Williams, J. (Mar. 2016). "Usage-based pricing and demand for residential broadband", *Econometrica*, vol. 84, No.2, p. 441-443.

Ofcom (2020). *Statement: improving spectrum access for wi-fi – spectrum use in the 5 and 6 GHz bands* (July 24).

Ofcom (2020). *Improving spectrum access for Wi-Fi*. London, p.21.

Rohman, Bohlin, E. (2013). *Socio-economic effects of broadband speed*. Ericsson 3/221 01-FGB 101 00003.

Stevenson, C. et al. (2009). "IEEE 802.22: The first cognitive radio wireless regional area network standard," *Communications Magazine IEEE* 47 (1): 131.

Suarez, M. (2020). *Unlicensed spectrum access in the 6 GHz band. Presentation to ANATEL*

Thanki, R. (2009). *The economic value generated by current and future allocations of unlicensed spectrum*. United Kingdom: Perspective Associates

Thanki, R. (2012). *The Economic Significance of License- Exempt Spectrum to the Future of the Internet.* London

Yonhap (2020). "Unlicensed frequency band to boost Wi-Fi speed, smart factory penetration: ministry", *The Korea Herald*, (June, 27).