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The Economic Impact of Each Additional 100 MHz of Mid-band Spectrum for Mobile

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Summary

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Executive Summary

The wireless industry is a cornerstone of the American economy, influencing daily life and business operations. As technology advances, the demand for wireless communication has surged, with Americans consuming 100 billion gigabytes of data last year. This reliance on wireless networks highlights their role as critical infrastructure for economic transactions, personal connections, and national security.

The industry's contributions to economic output and job creation emphasize its importance. Wireless drives economic activity through investments in communication infrastructure and by enabling new services that boost worker productivity. Over the past decade, it has contributed over $5 trillion to GDP and created 3 million jobs in the United States.

Approximately 1.1 GHz of licensed spectrum has supported this growth. However, the industry faces a spectrum deficit that threatens its continued expansion. Projections show that wireless operators will need at least 400 MHz of additional spectrum by 2027 to meet U.S. economic demands, a deficit that will continue to grow to over 1400 MHz by 2032. This spectrum is fundamental to providing:

- continued improvements to mobile service to millions of Americans
- improving fixed broadband coverage and penetration via fixed wireless access (FWA);
- supporting industries that rely on mobile connectivity, such as AI, video streaming, and cutting-edge VR and AR; and
- supporting industries that serve the wireless industry, such as construction and electronic maintenance.

All these activities will contribute to the American economy. We estimate that each additional 100 MHz of mid-band spectrum to mobile will generate $264 billion of GDP, about 1.5 million new jobs, and about $388 billion in consumer surplus.

Table 1: Economic impact of allocating each additional 100 MHz of mid-band spectrum to mobile[1]

GDP	Employment	Consumer Surplus
$264B	1.55 M	$388B

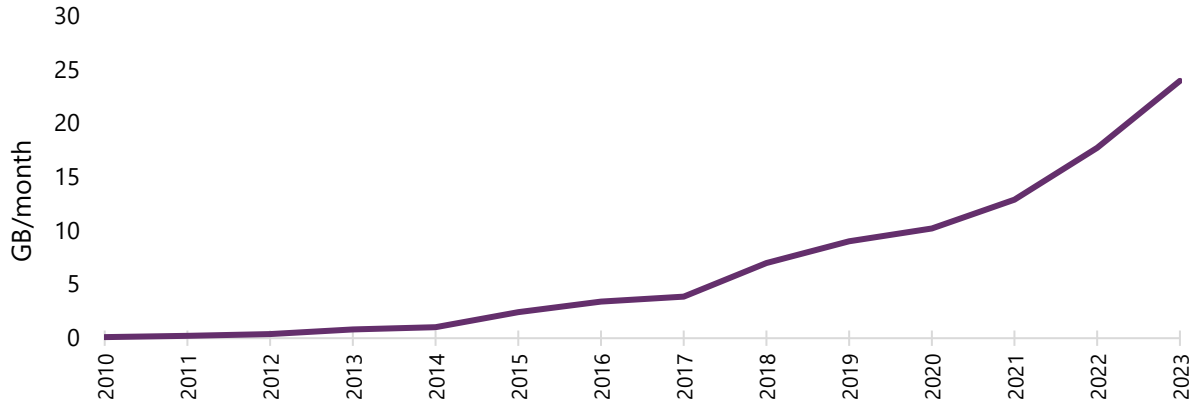
[1] We estimate the economic impact of an additional 400 MHz of mid-band spectrum. In the table, we report the average impact per 400 MHz.

1. Introduction

The core wireless industry, encompassing mobile and wholesale network operators, plays a vital role in the American economy. Since the first commercial cellular networks were launched, wireless providers have invested over $700 billion in U.S. communications infrastructure. In 2023 alone, they invested $30 billion, making this industry the second-largest source of direct investment in the country this decade. These investments have expanded network coverage, enhanced service quality, and introduced advanced technologies like 5G, resulting in a substantial economic impact. In 2020 alone, the wireless industry contributed $825 billion in GDP; including the effects of the core mobile industry and the broad mobile ecosystem.[2]

This growth has been supported by about 1.1 GHz of licensed spectrum currently allocated to mobile operators. However, data consumption continues to grow exponentially – increasing the need for additional spectrum. For example, Brattle estimates that the U.S. will need an additional 400 MHz of full-power spectrum by 2027 and 1.4 GHz by 2032.[3] Similarly, the GSMA estimates that densely populated American cities, such as New York, will require between 1 and 2 GHz of additional full-power mid-band spectrum by the end of the decade.[4]

Figure 1: Historical mobile data traffic per capita in the U.S.



Source: TeleGeography. Note: Includes FWA.

Mid-band spectrum, which comprises frequencies between 3.0 and 8.5 GHz, is well-suited to cover the spectrum deficit owing to its unique balance between high capacity and good propagation.

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2 Compass Lexecon, 2022, The Importance of Licensed Spectrum and Wireless Telecommunications to the American Economy, available at: https://api.ctia.org/wp-content/uploads/2022/12/Compass-Lexecon-Licensed-Spectrum-Report.pdf

3 Brattle 2023, How much licensed spectrum is needed to meet future demand for network capacity?

4 Coleago, 2021, Estimating the mid-band spectrum needs in the 2025-2030 time frame, available at: https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2021/07/Estimating-Mid-Band-Spectrum-Needs.pdf

2. The economic impact of allocating mid-band spectrum to mobile

Allocating additional mid-band spectrum to mobile – in the form of full-power flexible-use licenses – will create economic value throughout the economy. In particular, we focus on the impact on mobile consumers, FWA consumers, industries that rely on mobile connectivity, and industries that support the wireless industry. In addition, there may be additional benefits not captured in this paper owing to the ever-changing technological landscape of the mobile industry.

- Mobile consumers will benefit from faster and more robust services at no additional cost.
- FWA consumers will benefit from additional coverage, increased penetration, higher speeds, higher additional data consumption, and lower prices.
- Industries that rely on mobile connectivity, such as video streaming, mobile games, and cutting-edge virtual reality, will enjoy a more robust platform to deliver their services.
- Industries that support the wireless industry will benefit from the additional capital expenditure (capex) required to deploy the spectrum and the additional operational expense (opex) required to maintain the network.

Table 2 shows the metrics estimated for each channel affected by the spectrum allocation and deployment.

Table 2: Summary of the economic impact of allocating 100 MHz of mid-band spectrum to mobile

	GDP ($B)	Employment (M)	Consumer Surplus ($B)
Continued improvements to mobile service to millions of Americans			385
Improving broadband with FWA	40	0.30	3
Supporting industries that rely on mobile connectivity	188	0.93	
Supporting industries that serve the wireless industry	36	0.32	
Total	**264**	**1.55**	**388**

Note: Effect of each 100 MHz up to 400 MHz

2.1. Continued improvements to mobile service to millions of Americans

Mobile consumers will be the prime beneficiaries of the additional spectrum. The spectrum will enable faster and more reliable mobile connectivity, which will enable better and more valuable services. For

example, 15 years ago, data-intensive applications such as video streaming and video calls on mobile were not commonplace, whereas nowadays, they represent a typical consumer experience. Furthermore, these improved services have not historically been matched by equivalent price increases because additional spectrum has come online to meet capacity needs. If anything, spectrum has enabled the data-centric era dominated by unlimited plans.

However, without additional spectrum, networks will become congested. Plans tiered by consumption would likely come back, and those wishing to add additional data would likely pay more. This difference, what consumers would be willing to pay without additional spectrum and what they pay with spectrum, is the consumer surplus produced by the spectrum.

Based on research by Hazlet & Munoz (2004, 2009) and Rosston (2003), we estimate that each additional 100 MHz of spectrum would produce an incremental consumer surplus for mobile consumers of between $320 and $480 billion.

Table 3: Consumer surplus associated with a better mobile service at no additional cost

	100 MHz
Concept	**Consumer Surplus ($B)**
Hazlet & Munoz 2004[a]	320
Hazlet & Munoz 2009[b]	356
Rosston 2003[c]	480
Average	**385**

Note: Effect of each 100 MHz up to 400 MHz
Source: (a) Hazlett and Munoz, 2004, A Welfare Analysis of Spectrum Allocation Policies," Joint Center: AEI-Brookings Joint Center for Regulatory Studies.
(b) Hazlett and Munoz, 2009, A welfare analysis of spectrum allocation policies. RAND Journal of Economics Vol. 40 No. 3: 424-454.
(c) Rosston, 2003, The long and winding road: the FCC paves the path with good intentions. Telecommunications Policy 27: 501-515. These papers show that the annual consumer surplus produced by the spectrum is linked to its competitive price. We use C-band and 3.45 GHz auction prices.

2.2. Improving broadband with FWA

5G Fixed Wireless Access (FWA) is the fastest-growing terrestrial broadband technology. In 2024, FWA accounted for nearly all of the net broadband additions and one of the largest terrestrial footprints.[5] This expansion has already benefited consumers through lower prices.[6]

In particular, Singer and Urschel estimate that the consumer benefits associated with more choice and price competition in the fixed market owing to the availability of mobile FWA are around $6 billion

[5] Opensignal, 5G Fixed Wireless Access (FWA) Success in the US: A Roadmap for Broadband Success Elsewhere?, Available at: 5G Fixed Wireless Access (FWA) Success in the US: A Roadmap for Broadband Success Elsewhere? | Opensignal

[6] https://www.ctia.org/news/fcc-shows-how-wireless-is-delivering-much-needed-home-broadband-competition-closing-the-digital-divide

annually.[7] Based on FWA's long-term spectrum needs, we attribute 5% of this benefit to each 100 MHz of spectrum.

Table 4: Present value of the consumer benefits associated with 100 MHz of additional mid-band spectrum

Market type	Annual benefit of FWA ($M)	Annual benefit of 100 MHz ($M)	Present Value of benefit @ 10% ($M)
Cable	6,104	305	3,052
Cable/Fiber	246	12	123
Total	6,350	317	3,175

Note: Effect of each 100 MHz up to 2 GHz
Source: NERA Economic Consulting

Additional spectrum will also contribute to closing the digital divide. Previous research by the GSMA has found that the number of units that can be served from a single base station is proportional to the spectrum holding.[8] [9] Additional spectrum will make it economical to increase coverage marginally.[10]

According to the latest national broadband map released by the FCC, 96.2% of the country's residential and business locations are covered by terrestrial technologies.[11] Based on this data, we estimate that an additional 100 MHz of mid-band spectrum will increase coverage by around 0.17%, or around 275k residential and business units. The additional penetration will be followed by an increased broadband penetration.[12] Figure 2 shows the increased broadband penetration caused by the additional spectrum. We assume the additional penetration will peak around 0.44% and then reduce to 0% – that is, we assume that other competing technologies will eventually cover the same locations.

7 Singer and Urschel, 2023, Competitive Effects of Fixed Wireless Access on Wireline Broadband Technologies. Available at: CTIA - Competitive Effects of Fixed Wireless Access on Wireline Broadband Technologies

8 In particular, a base station can support 90 users with a bandwidth of 400 MHz, 315 with 1.4 GHz, and 540 with 2.4 GHz.

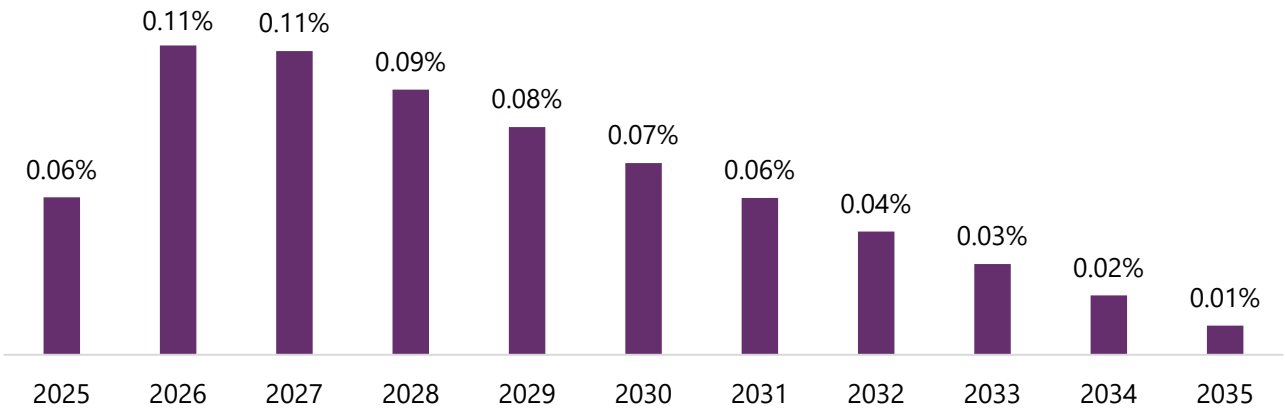
9 GSMA and Coleago Consulting, 2021. Estimating the mid-band spectrum needs in the 2025-2030 time frame (Global Outlook), available at: Estimating-Mid-Band-Spectrum-Needs.pdf.

10 For example, suppose a based station can support X households with existing holdings and X + D with additional spectrum. The additional spectrum will enable additional coverage in places where the NPV of serving X < C < NPV of serving X+D

11 https://broadbandmap.fcc.gov/data-download. November 13 2024.

12 Our methodology relies on estimating the impact of 400 MHz, and then attributing the results proportionally to each block of 100 MHz.

Figure 2: Increase in penetration associated with an additional 100 MHz of mid-band spectrum



Note: Effect of each 100 MHz up to 400 GHz. We estimate the impact of 400 MHz and report the average per 100 MHz in this chart.
Source: NERA analysis of FCC data

We use the Bureau of Labor Statistics' employment forecasts and the Bureau of Economic Analysis's GDP forecasts to estimate the impact of increased penetration on GDP and employment. We multiply these forecasts by their penetration elasticities, 0.1856% for GDP and 0.25% for employment.[13] [14] Based on these forecasts and elasticities, our estimated economic impact is shown in Table 5.

Table 5: Economic impact of increased FWA penetration associated with 100 MHz

	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
GDP ($ B)	3.0	6.1	6.1	5.4	4.7	4.1	3.4	2.7	2.0	1.4	0.7
Employment ('000)	24.1	47.5	46.8	41.0	35.4	29.9	24.6	19.4	14.3	9.4	4.6

Source: NERA Economic Consulting

2.3. Supporting industries that rely on mobile connectivity

The wireless industry provides essential services that support a wide range of other industries and economic activity. Originally, the wireless industry supported basic communications via text messaging and voice calls. Today, it enables much richer forms of interaction, allowing people to share not only messages and voice calls, but also photos, videos, and other forms of content through social media platforms. This has given rise to industries that rely on mobile connectivity to deliver their products

[13] Source: ITU, 2021, The economic impact of broadband and digitalization through the COVID-19 pandemic, available at: https://www.itu.int/dms_pub/itu-d/opb/pref/D-PREF-EF.COV_ECO_IMPACT_B-2021-PDF-E.pdf

[14] Crandall et al., 2007, The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data, Issues in Economic Policy, The Brookings Institution.

and services to customers. Table 6 shows that approximately 86% of mobile traffic supports around $58 billion of annual revenues for industries that rely on mobile connectivity.

Table 6: Output and network traffic generated by selected use cases for wireless connectivity

	Social media	Video and audio streaming	Device and cloud gaming	General web apps	File sharing
Share of total mobile network traffic	35%	32%	7%	5%	7%
Output generated in 2024	$139.0	$73.0	$55.4	$287.5	$7.3
Share of traffic taking place on mobile	18%	8%	10%	7%	8%
Industry output attributable to mobile	$24.6	$5.9	$5.4	$21.5	$0.6
Output CAGR	16.7%	6.1%	3.4%	10.4%	0.4%

Source: Network usage data from Sandvine Global Internet Phenomena Report 2024[15]; industry output data from IbisWorld Market Research Reports[16]. Output attributable to mobile is equal to the produce of industry output share of traffic taking place on mobile networks. The output for general web apps is assumed to be from search only.

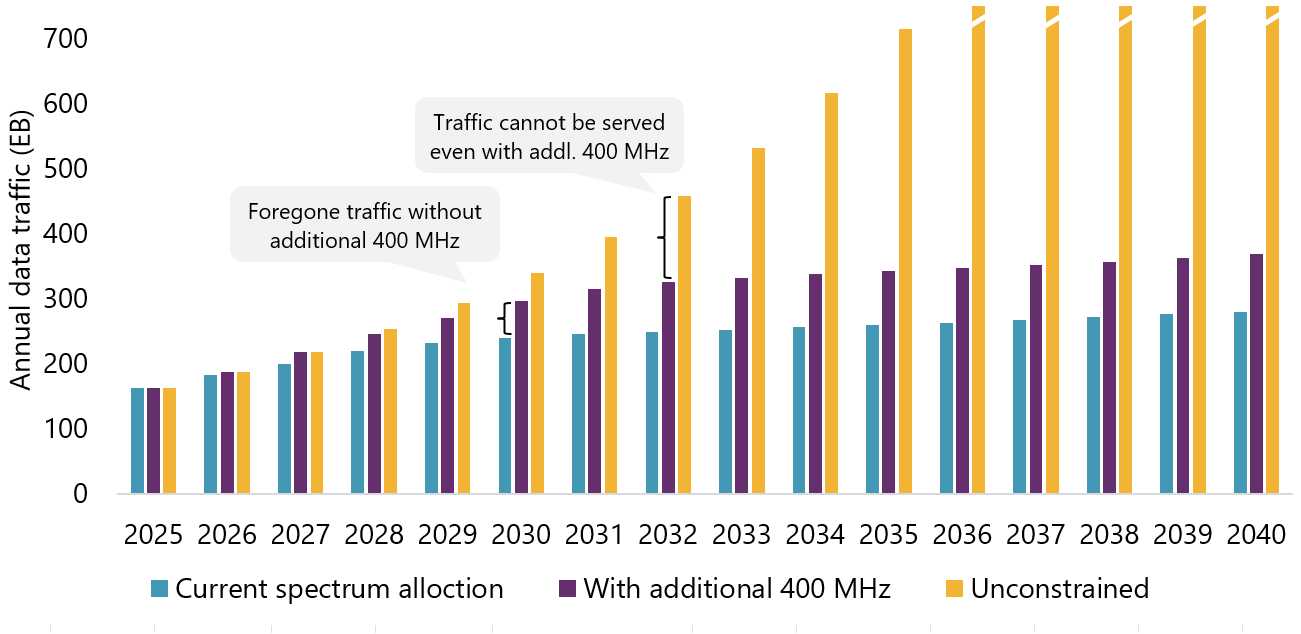
Without additional spectrum, mobile networks will become congested, and the revenues of industries that rely on mobile connectivity would decline. For example, if a consumer is unable to watch a streaming video owing to buffering as a result of network strain, they will inevitably churn away from the streaming platform to do something else. Consequently, the streaming platform loses out on ad revenue that it would have otherwise obtained had the network-enabled the user to stream content smoothly.

We measure the impact of network constraints on the revenues of the industries that rely on mobile connectivity by projecting traffic hourly and estimating the forgone traffic and revenues at different times of the day. Figure 3 shows our traffic projection with and without an additional 400 MHz of spectrum. The difference in traffic between these two scenarios allows us to identify the volume of traffic that would be foregone if no additional spectrum were allocated to mobile.

15 Sandvine, 2024, The Global Internet Phenomena Report, available at: https://www.sandvine.com/phenomena

16 IbisWorld, 2024, Market Research Reports, available at: https://www.ibisworld.com/

Figure 3: Mobile data traffic with and without an additional 400 MHz of spectrum



Source: NERA analysis based on Ericsson Mobility Visualizer traffic data for North America

We convert our estimated forgone traffic to revenues by estimating the marginal revenue per unit of mobile data, and revenues to GDP and employment using input-output multipliers. Table 7 shows the total impact on U.S. GDP and employment of an additional 100 MHz by selected applications between 2025 and 2040. Over this period, we estimate that the social media, video and audio streaming, mobile gaming, general web apps and file sharing industries will generate around 180 billion dollars in GDP and close to 1 million jobs.

Table 7: Total economic impact generated by an additional 100 MHz for selected applications, 2025-2040

Application	GDP ($B)	Employment (K)
Social media	85	436
Video and audio streaming	19	95
Device and cloud gaming	5	77
General web apps*	78	317
File sharing	2	8
Total	**188**	**932**

Note: Effect of each 100 MHz up to 400 GHz. We estimate the impact of 400 MHz and report the average per 100 MHz.
**General web apps includes 5% traffic share plus residual traffic share of 14%*
Source: NERA Economic Consulting

In addition to the impact estimated in this paper, the allocation of additional mid-band spectrum for mobile may give rise to new applications and business models that are not feasible today owing to network constraints. With more bandwidth and faster speeds, new applications like VR gaming or improved telehealth services may emerge, driving the creation of further output, GDP, and jobs. In particular, AI is expected to greatly accelerate data growth. AI mobile data is expected to grow at a 55% CAGR between 2023 and 2033, increasing the need and value of the spectrum. AI traffic is expected to be bursty and unpredictable, require low latency, and increase the demand for the uplink (for applications using cloud computing).

2.4. Supporting industries that serve the wireless industry

The wireless industry will spend billions of dollars deploying and operating additional mid-band spectrum – increasing the demand for equipment, construction, power, and other industries that serve the wireless industry. These investments will be roughly proportional to the number of 100 MHz blocks deployed and operated in the short and mid-terms because the maximum 5G carrier in mid-bands is 100 MHz.

To estimate the economic impact of the additional capex and opex associated with the deployment and operation of the spectrum, we follow two steps:

1. We estimate the additional capex and opex required to deploy and operate 100 MHz of mid-band spectrum nationwide.
2. We use an input-output model and data from the Bureau of Economic Analysis to estimate the economic impact of the marginal capex and opex on GDP and employment.

We estimate the opex and capex requirements using company filings about the C-band. AT&T has reported spending $7 billion in deploying C-band, and Verizon has reported $10 billion.[17] [18] Based on these filings, we estimate that deploying 100 MHz of mid-band spectrum requires about $8.57 billion. In addition, these capex investments will trigger additional opex expenditures. Based on previous studies, we assume that mobile operators will spend about 25% of the capex in annual opex for 10 years.[19] Based on these estimations of capex and opex, we estimate the incremental GDP and employment using input-output multipliers. Table 8 shows that each additional 100 MHz will generate around $36 billion of GDP and 300 thousand new jobs.

[17] Telecoms.com, 2021, AT&T to spend less than Verizon on C-band 5G rollout, available at: https://www.telecoms.com/5g-6g/at-t-to-spend-less-than-verizon-on-c-band-5g-rollout

[18] Telecoms.com, 2023. Verizon confirms climb-down from C-band capex peak, available at: Verizon confirms climb-down from C-band capex peak

[19] GSMA and Coleago Consulting, 2021. Estimating the mid-band spectrum needs in the 2025-2030 time frame (Global Outlook), available at: Estimating-Mid-Band-Spectrum-Needs.pdf

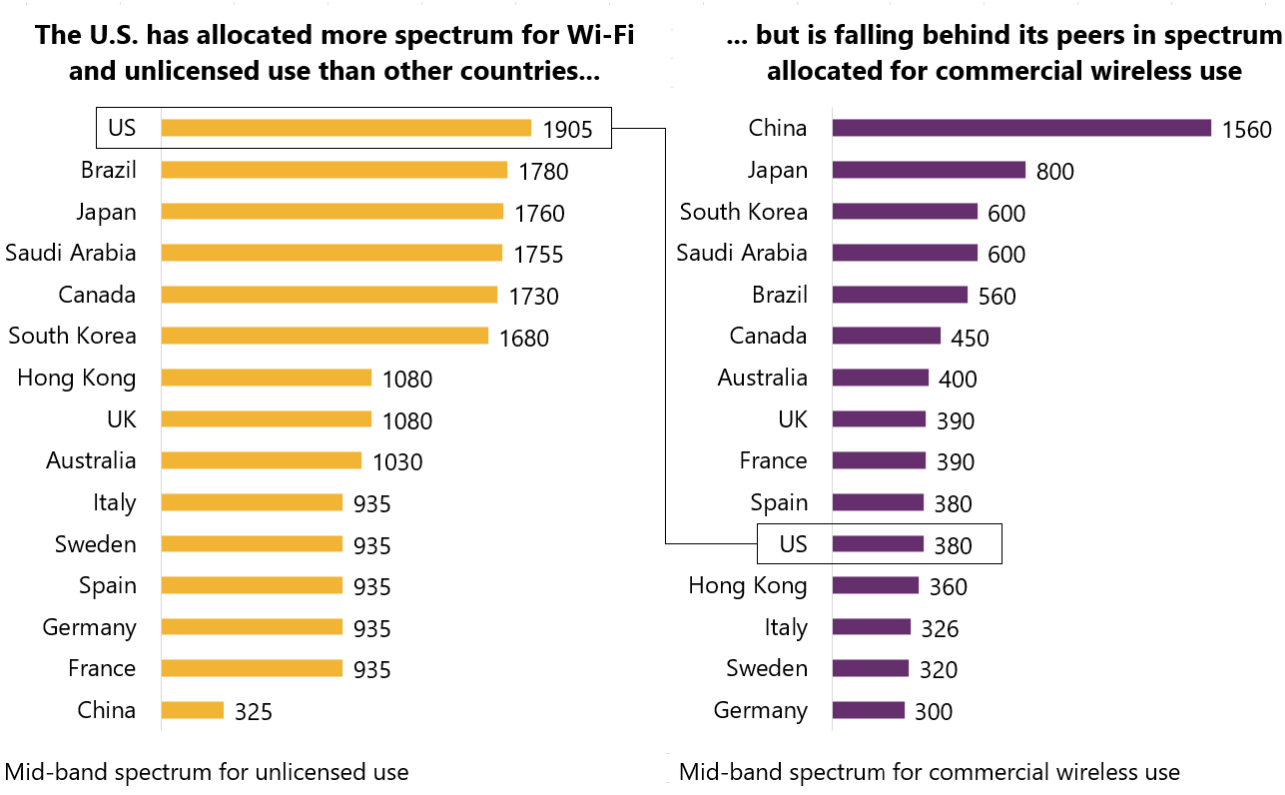
Table 8: Economic impact of deploying and maintaining 100 MHz of mid-band spectrum

	GDP ($B)	Employment (K)
Capex	9.7	71
Opex	26.6	245
Total	**36.3**	**316**

3. Allocating additional spectrum to Mobile vs Wi-Fi

Spectrum is a scarce natural resource with many competing uses. Two key conflicting uses for spectrum are mobile telecommunications, which benefits most from high-power dedicated licenses, and unlicensed use, which includes Wi-Fi, where users share low-power spectrum. To ensure the U.S. remains a leader in wireless telecommunications, and for spectrum to deliver maximum economic value, both use cases require access to sufficient spectrum bandwidths. Figure 4 shows that while the U.S. already has ensured Wi-Fi's spectrum needs are met by allocating more mid-band frequencies to unlicensed use than any other country, its spectrum policy has not delivered the mid-band spectrum mobile operators need. As a result, the U.S. has fallen behind the likes of China, Japan, and the UK, all of which have allocated more mid-band spectrum to commercial wireless use than the U.S.

Figure 4 Mid-band spectrum allocations for unlicensed use and commercial wireless use in selected countries by 2027



Source: Adapted from Analysys Mason, 2022, Comparison of total mobile spectrum in different markets.
Notes: We have removed any spectrum that is not available on an exclusive use, full-power basis.

The discrepancy in mid-band spectrum allocations to unlicensed use and commercial wireless use does not align with how these technologies use the spectrum. Wi-Fi and other unlicensed users operate at low power in localized environments, like homes and offices, where spectrum is readily available for re-use, even in close proximity. With Wi-Fi, a relatively small amount of bandwidth is capable of serving high volumes of traffic in a given geographic area. In contrast, mobile networks serve users spread across wide geographic areas, travelling at differing speeds, and often outdoors. The wide coverage areas that need to be served mean that wireless operators need access to full power, exclusive spectrum licenses to avoid interference and maintain network quality. Therefore, the scope for frequency re-use is relatively limited, leading to wireless operators needing much more spectrum per GB of traffic served than unlicensed users.

4. Conclusion

The wireless industry is a vital pillar of the American economy, driving significant growth and innovation across various sectors. With the staggering consumption of data and the increasing reliance on wireless communication, the industry is a critical infrastructure that supports economic transactions, personal connections, and national security.

The allocation of additional full-power mid-band spectrum is essential for enhancing mobile services, improving broadband access, supporting industries that rely on mobile connectivity, and supporting industries that serve the wireless industry. The economic impact of providing each additional 100 MHz of mid-band spectrum is projected to be profound, generating over $260 billion in GDP, 1.5 million jobs, and nearly $390 billion in consumer surplus, and provide new terrestrial broadband coverage for 275k households.

As the U.S. faces increasing competition from other nations in the investment of spectrum they are willing to make in their domestic wireless networks, it is imperative for US policymakers to prioritize the identification and release of additional mid-band spectrum for commercial wireless use. The current spectrum deficit poses a significant risk to the continued growth and innovation of the wireless industry, which is crucial for maintaining the nation's leadership in global connectivity.

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