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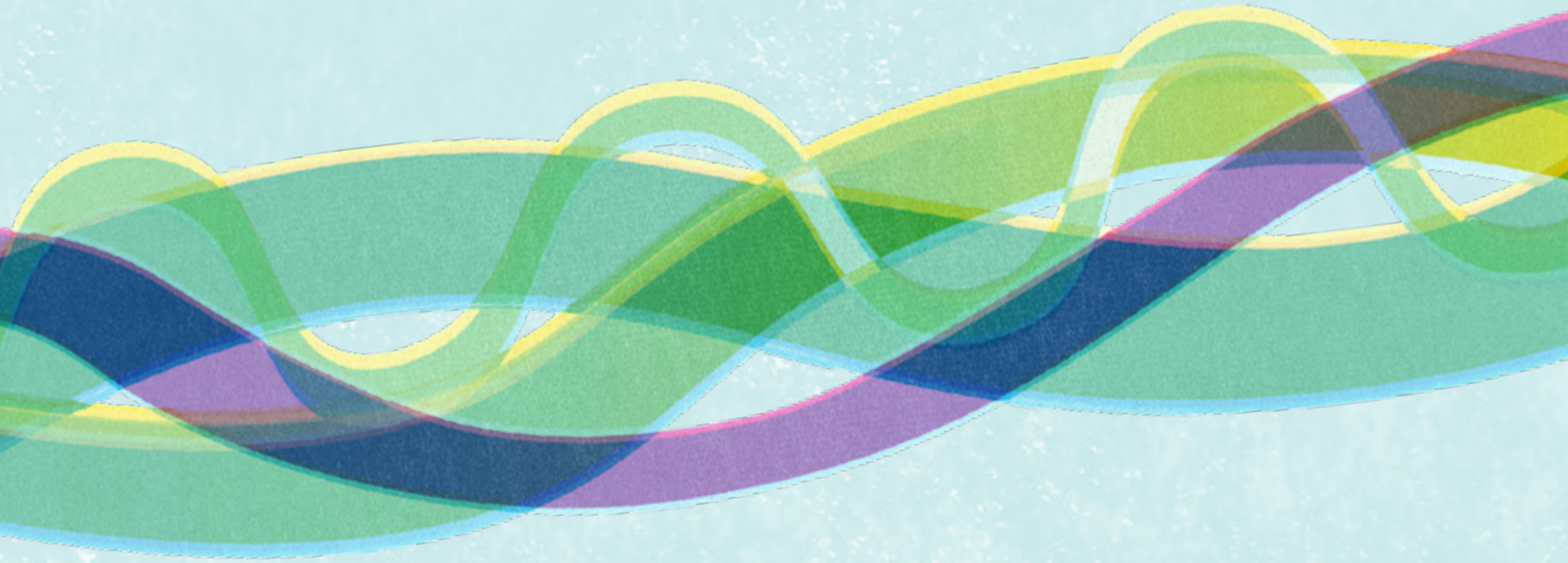
Successful Military Radar and 5G Coexistence in the Lower 3 GHz Band:

Evidence from Around the World



The lower 3 GHz band is used for 5G in nearly 50 countries, demonstrating real-world successful coexistence with U.S. military radars deployed abroad.

The global communications industry has aligned on the lower portion of the 3 GHz band—3300-3450 MHz—as a core 5G workhorse, providing the capacity needed to connect the industries of the future. Nearly 50 countries are already using full-power 5G networks in the lower 3 GHz band, with even more planning to do so soon.[1] Over 70 countries in total are planning for or using 5G in this band. More than 30 of those countries feature 5G deployments that are successfully coexisting with the same U.S. military radar systems that are used domestically, strongly suggesting that 150 megahertz of full power, licensed spectrum can be made available from 3.3-3.45 GHz in the U.S. without risking harmful interference to those military systems.[2]

New research from GSMA, CCS Insight, and DLA Piper detail these operations abroad, investigating 5G networks using lower 3 GHz spectrum near various radar operations. Together, these reports provide key insights on the widespread global use of 5G alongside U.S. military bases and radar systems deployed abroad. The global spectrum environment for lower 3 GHz spectrum is rapidly commercializing, a reality that the U.S. military must accommodate in its spectrum and international threat response planning.

This real-world evidence demonstrates how proven coordination methods are already facilitating simultaneous use of the band by 5G and military radars. Segmenting the band at 3.3 GHz with commercial wireless operating above and military radars tuning below can facilitate near-term coexistence. Coordination techniques—such as retuning, compression, and frequency coordination—provide assurance that 5G networks can be deployed in the U.S. at full power in lower 3 GHz spectrum while maintaining the ability to meet critical government missions that depend on radar systems.[3]

The clear trend of growing commercial use of the lower 3 GHz band internationally, as well as the actual use of 5G near military bases around the globe, should be fully reflected in the Administration and Congress's evaluation of future commercial access to the lower 3 GHz band. Segmenting the band with commercial wireless from 3.3-3.45 GHz and military radars below 3.3 GHz would offer the best protection for both the military and 5G commercial wireless. Evidence of ongoing coexistence abroad suggests that such frequency coordination can open this band for full-power commercial wireless use. Any computer simulations of future U.S. use should fully reflect—and be consistent with—the empirical data showing that the Department of Defense (DoD) is coexisting with the already extensive 5G operations around the world.

Innovation unlocked by high-capacity 5G is expected to generate economic growth of up to $1.5 trillion in GDP and 4.5 million additional jobs by 2030.[4] But the U.S. wireless industry will not be able to meet demand with today's spectrum inventory—the U.S. faces a looming spectrum deficit of 400 megahertz by 2027 and nearly 1500 megahertz needed by 2032, even after accounting for optimistic improvements in spectral efficiency and infrastructure deployment.[5]

The lower 3 GHz band is a critical component of the spectrum pipeline needed to fuel the growth of 5G, to the benefit of U.S. consumers, enterprises, and government agencies, including the DoD.

Background

The global community has aligned on the lower 3 GHz band as key mid-band spectrum for 5G services. This internationally harmonized spectrum has been standardized into equipment by 3GPP, such as the 3.3-4.2 GHz band (standardized as band n77), and 3.3-3.8 GHz (band n78), and enjoys world-wide economies of scale in base stations, chipsets, and other technology throughout the mobile ecosystem.[6] Global economies of scale are important in enabling lower cost network equipment, chipsets, and devices, ultimately unleashing innovation and growth for the U.S. and allied nations.

Fueling the spectrum pipeline in a way that allows participation in the same global market for chipsets and equipment is critical to enabling U.S. 5G leadership. Otherwise, the U.S. risks becoming a spectrum island, ceding leadership in 5G and the industries that depend on it to our rivals.

China, for example, is deploying 5G on a massive scale, having already allocated 1160 megahertz of mid-band spectrum (including the lower 3 GHz band), and planning to allocate up to a total of 1660 megahertz in 5 years.[7] They are also championing the lower 3 GHz band for global harmonization at the upcoming World Radio Conference, along with several others. Compared to the U.S., with only 450 megahertz of mid-band spectrum available for the foreseeable future, Chinese wireless operators are anticipated to have up to 3.7 times more mid-band spectrum.[8]

Static coordination methods such as geographic coordination, as was implemented with AWS-1, AWS-3, and AMBIT (3.45-3.55 GHz) spectrum, have worked well to facilitate coexistence in the past.[9] Partitioning the band at 3.3 GHz, with commercial wireless operating from 3.3-3.45 GHz and military radars tuned below, can rapidly enable coexistence, as demonstrated in over 30 countries around the world.

For the more challenging systems which cannot be retuned or have long timelines to relocate, a combination of geographic and time-based coordination can be achieved. Such

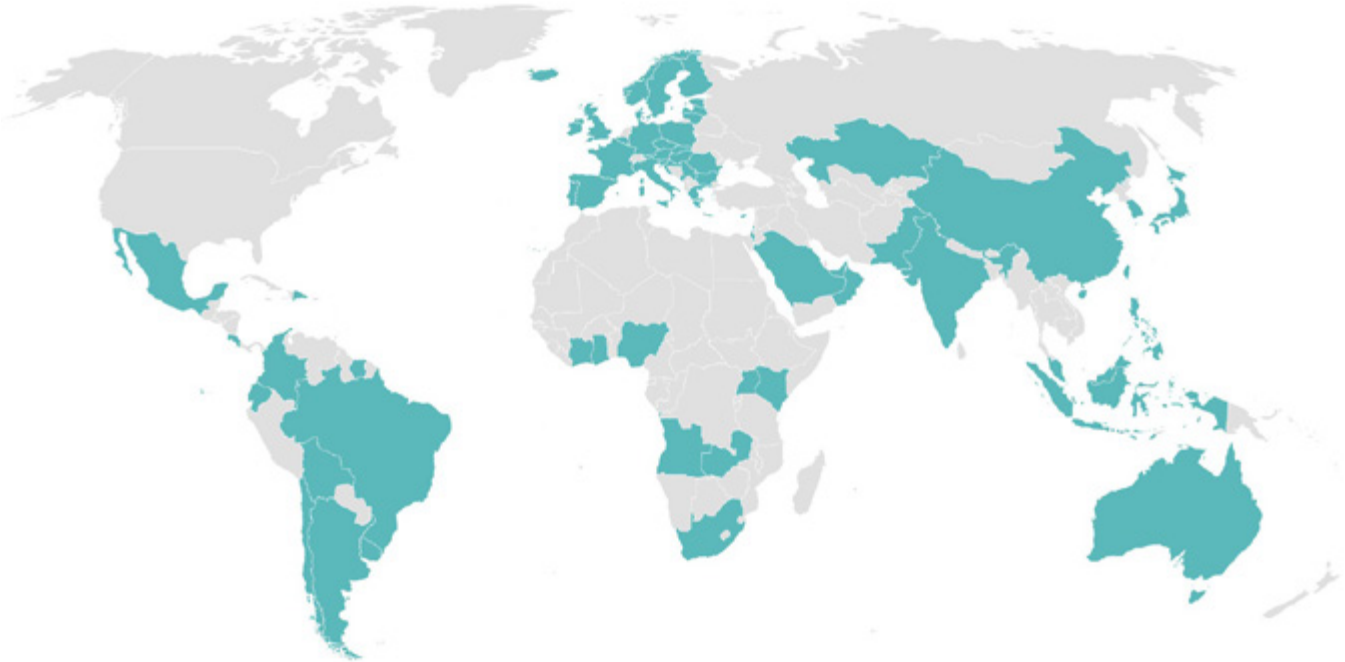


Figure 1. Lower 3 GHz 5G allocations around the world.

coordination can enable full-power 5G operations without the need for a new complex spectrum sharing framework.

Coexistence in lower 3 GHz spectrum between 5G and U.S. military radars

Many countries have demonstrated coexistence between 5G in this spectrum band with radar systems used by the U.S. military and its allies.[10] Key U.S. military systems in the lower 3 GHz band include Station-Keeping Equipment (SKE), airborne radar such as the Airborne Warning and Control System (AWACS), shipborne systems such as the AN/SPY-1/6, as well as ground-based radars like the AN/TPQ-53. These systems are used by both the U.S. and its allies, domestically and overseas.

In the Americas region, Mexico provides a prime example of 5G coexistence with lower 3 GHz radar systems. The Mexican regulator, IFT, authorized mobile 5G operations in the 3.35-3.45 GHz band without restriction.[11] These 5G deployments successfully coexist with ground-based radar systems just across the border at Fort Bliss near El Paso, Texas. The country has a long-standing relationship of cooperation with the U.S., including cross-border spectrum coordination when necessary.

Recent field testing commissioned by CTIA in El Paso, Texas verified that lower 3 GHz signals from the Mexican operator Telcel are present across the border surrounding Fort Bliss. These operations are coexisting today with ground-based radars at the Doña Ana Range Complex, 40-45 kilometers from the border.[12] The Mexican operator is using full-power 5G this close to the radar systems at the testing range, and potentially could use it even closer without harmful interference.

Since the U.S. government has not established a coordination agreement across the border in the 3.3-3.45 GHz band, and there have been no reported cases of harmful interference, one must conclude that the radar is able to coexist with actual co-channel 5G signals.[13] If coordination is needed the AN/TPQ-53 radar can be tuned to the lower end of the band to avoid interference.[14] This establishes that with only modest geographic separation, full-power 5G signals can coexist with military radars in the lower 3 GHz band.

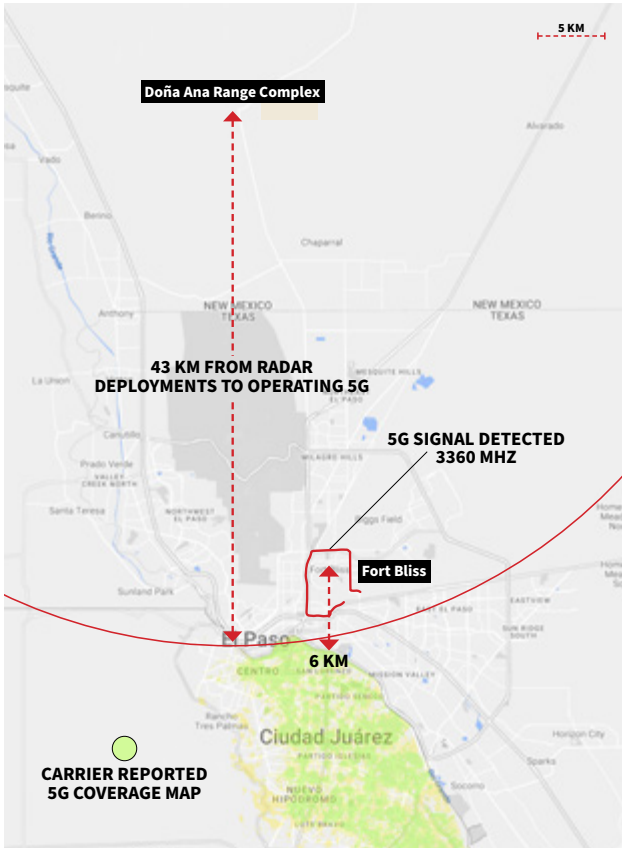


Figure 2. 5G full power signals from Mexico are operating within 40-45 km of AN/TPQ-53 radars at Fort Bliss, TX

Figure 3. The AN/TPQ-53 ground-based radar is used in the US and abroad in Asia and Europe.

Figure 4. AN/SPY-1/6 naval radar system operating out of Japan and near South Korea, Taiwan, and the Philippines

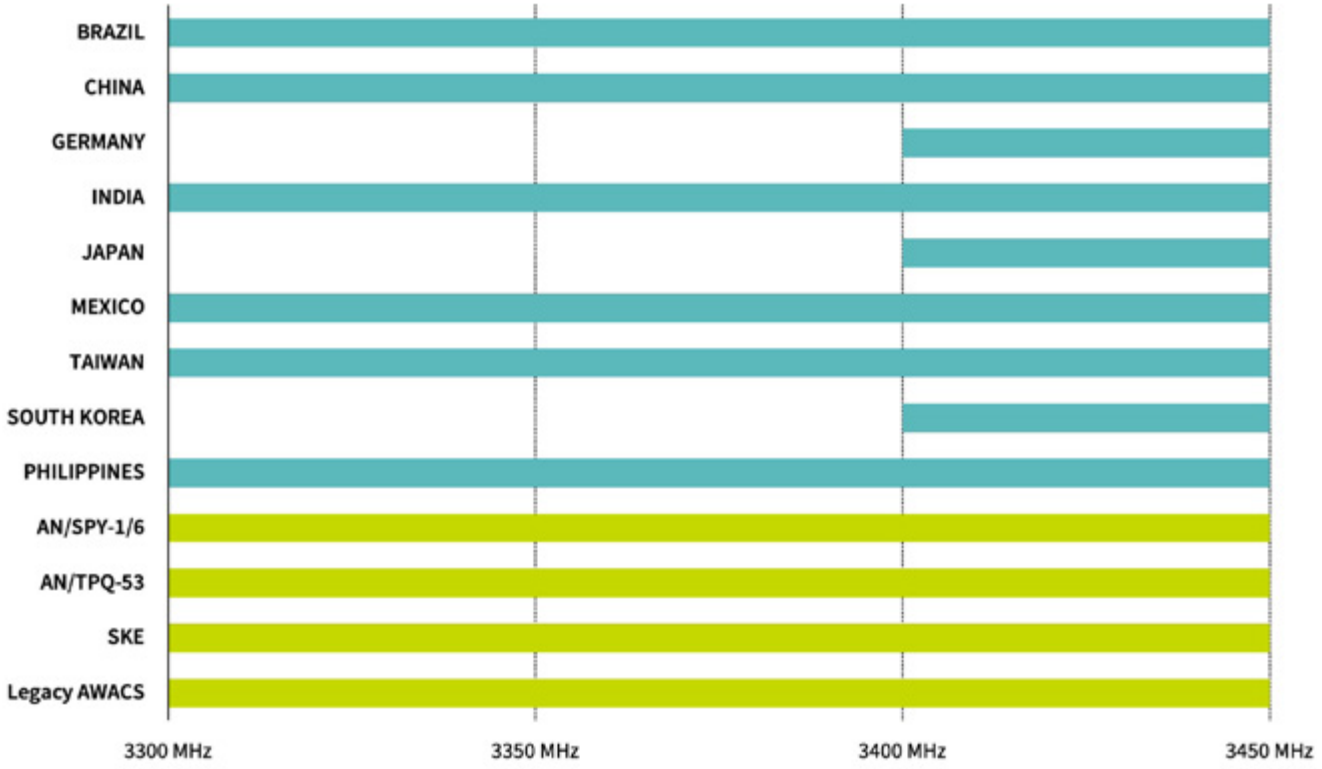


Figure 5. Select lower 3 GHz 5G allocations around the world and Defense Department radar operations[15]

Several additional examples throughout Asia and Europe further demonstrate coexistence of full-power 5G networks operating while the U.S. military and its allies use the same radar systems that are used domestically.

Throughout Asia, nearly 20 countries have deployed in the lower 3 GHz band, with several demonstrating successful coexistence between 5G and U.S. military radar systems. Key examples of 5G operating alongside U.S. military radars include Japan, South Korea, Taiwan, and the Philippines.

- Japan features several U.S. radar systems amid extensive 5G deployments. The U.S. has deployed naval and ground-based systems in Japan, along with AWACS.[16] Three Japanese wireless operators, NTT DOCOMO, KDDI, and Softbank, have broadly deployed 5G from 3.4-3.6 GHz. The U.S. military has major bases in Yokosuka, Sasebo, Kadena, and Hamamatsu. Japan has a well-established host nation agreement and coordinates with the U.S. military to ensure systems do not interfere.[17]

- South Korean operators have also deployed 5G in the lower 3 GHz band. In this case, LGU+, SK Telecom, and KT operate in the 3.4-3.7 GHz band at full power with extensive coverage near U.S. military bases. In South Korea, the U.S. Army has several camps located near Seoul as well as Kunsan Air Base to the west and Busan Naval Base to the south. Like Japan, the U.S. military is forward deployed alongside local forces in Korea, and they routinely conduct joint military exercises among lower 3 GHz 5G networks.

- Taiwan, uniquely situated across the Taiwan Straits from mainland China, has extensive full power 5G networks using 3.3 GHz spectrum.[18] While there is no formal host nation agreement with Taiwan, U.S. Navy warships routinely transit the Straits of Taiwan, demonstrating coexistence with nearby full power 5G networks deployed across the island.[19]

- The Philippines has allocated 3.3 GHz spectrum to three operators, DITO, Globe, and Smart.[20] Given increased geopolitical tensions in the region, the U.S. military is expanding the number of bases in the Indo-Pacific region.[21] In addition to the existing four air bases and one army base in the region, the U.S. is establishing four additional bases. The U.S. military will operate in and around existing 5G networks which have been deployed across the Philippines, requiring coexistence with radars such as the AN/SPY-1/6.[22]

- India has also allocated 3.3 GHz spectrum for 5G use and has found ways to ensure cooperation between wireless operators and the government agencies to make spectrum available for 5G alongside military radars.[23]

Throughout Europe, nearly 30 countries either have already deployed 5G in lower 3 GHz spectrum or are in the process of doing so, including several NATO countries. NATO relies on the same AWACS radars as those used by the U.S. military, and routinely operate them in areas with lower 3 GHz 5G deployments. Europe has coordinated spectrum for terrestrial wireless in the 3.4 GHz range, using a small guard band for frequency separation while radar systems operate below that portion of the band.[24]

Germany is another prime example of successful coexistence. Here again, Germany has extensive 5G deployments alongside several U.S. military bases. These bases are home to AWACS and other U.S. military airborne systems such as Station Keeping Equipment (SKE).[25] Furthermore, the same ground-based radars used by the U.S. military are used in Germany as well. Research suggests that frequency and geographic coordination are likely occurring to ensure that both 5G networks and military radars can coexist without interference.[26] This form of coexistence exists in several other countries in Europe including many NATO countries.

The aging U.S. AWACS fleet (with an average age of over 44 years of service) is slated for replacement starting in 2027.[27] The AWACS successor—the new Wedgetail aircraft—is currently being equipped with the Multi-Role Electronically Scanned Array (MESA) surveillance radar. Other countries already using this system, such as Australia, South Korea, Turkey, and the United Kingdom, are operating below the 3 GHz band.[28]

The AWACS successor should be designed to coexist with the plethora of deployed 5G networks in 3.3-4.2 GHz in the U.S. and abroad, which is achievable by using the established MESA system that relies on L-Band spectrum below 3 GHz. This lower frequency spectrum offers radar systems longer range with better penetration of clouds and rain than spectrum used by the legacy AWACS fleet.[29]

Similarly, the C-130 SKE systems are likely due for an upgrade, and options exist that would be more resilient to 5G signals.[30] These technology upgrades to older platforms are consistent with modernizing communications and radar systems to be higher performing and more robust. Freeing up spectrum for commercial use can provide the impetus and capital (through auction revenues) to upgrade government systems to better achieve their missions.

Figure 6. Airborne Warning and Control System (AWACS) operate in USA, Europe, Japan, South Korea, NATO Countries, Chile, for example.

Figure 7. C-130 planes with SKE operate in the US, Germany, Japan, and elsewhere in Asia, for example.

Conclusion

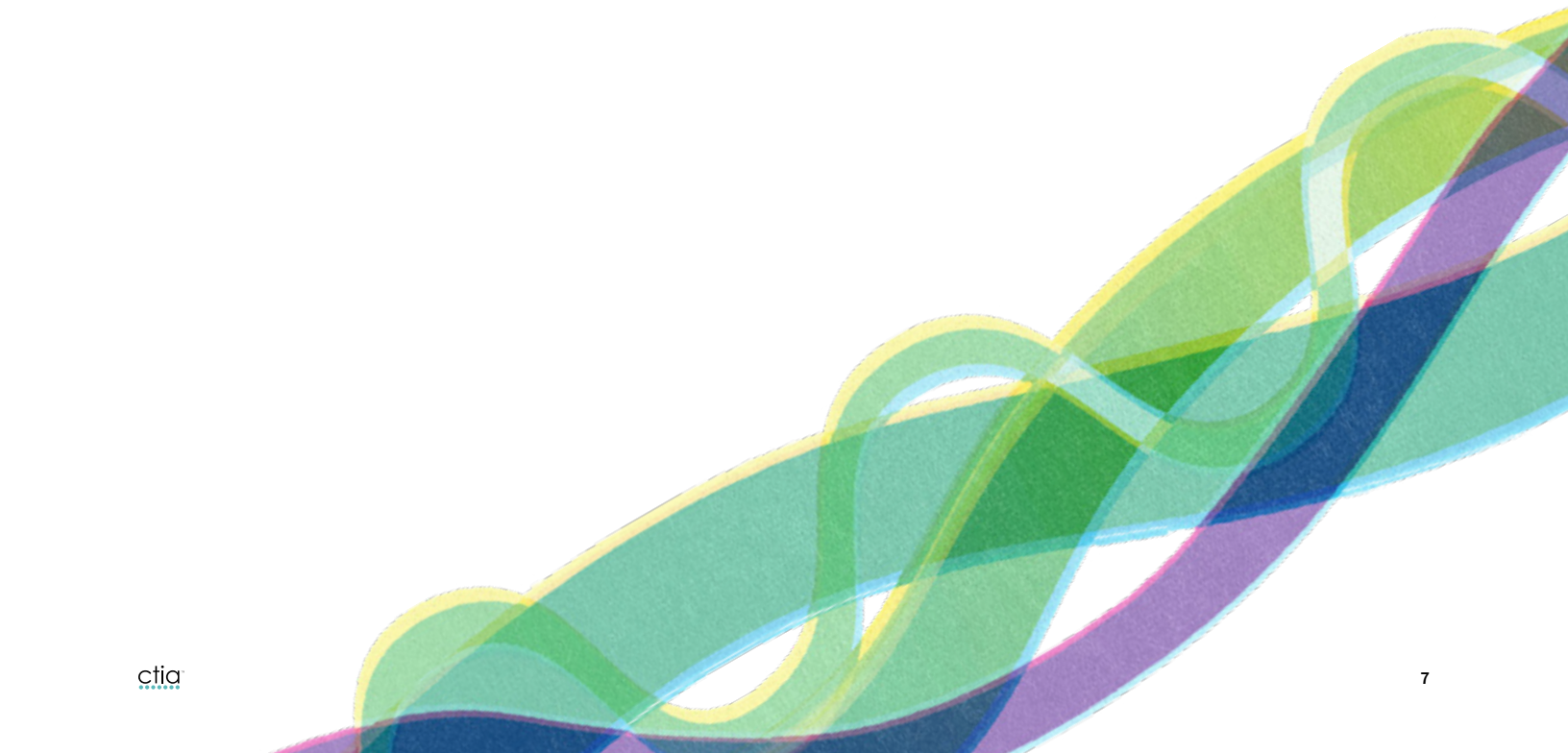
The proliferation of 5G networks already using lower 3 GHz spectrum in nearly 50 countries abroad, with over 30 countries demonstrating successful coexistence with the same military radar systems that are used in the U.S., strongly suggests that established static coordination techniques can enable full-power, licensed commercial use in the band. This real-world evidence is more convincing than any computer model of lower 3 GHz sharing. Actual evidence of existing operations around the world shows that full power 5G networks can utilize this band without disrupting military systems.

The most efficient path forward for the U.S., and that consistent with international trends, would be to segment the 3 GHz band at 3.3 GHz. Military systems could either retune existing equipment or otherwise relocate below 3.3 GHz. Commercial wireless providers would then be strictly limited to the 150 megahertz above 3.3 GHz to avoid interference.

Static coordination techniques likely already being used abroad, such as retuning, compression, and frequency coordination, can ensure important government missions continue without interference, while unlocking 150 megahertz of additional spectrum to provide 5G the capacity needed to secure continued U.S. economic growth, and all of its associated benefits.

Additionally, as military systems are upgraded, such as the scheduled replacement of AWACS radars starting in 2027, new radars can be designed to coexist with 5G deployments around the world. Other countries are already using the chosen AWACS successor in L-band spectrum, below the 3 GHz band—the U.S. should do the same and design the system to coexist with extensive 5G deployments here and abroad.[31] Such a process could be accelerated by leveraging Spectrum Relocation Fund revenues from an auction of lower 3 GHz spectrum.

With over 70 countries deploying 5G in the lower 3 GHz band, the military already has to coordinate with existing 5G networks abroad. Given the trend toward commercializing the lower 3 GHz, the military must plan to coexist with 5G operations in this band around most of the globe. Real-world evidence shows incumbent U.S. military radar systems are successfully coexisting alongside full-power, lower 3 GHz 5G networks abroad without resorting to a complex dynamic sharing regime. The U.S. should make the same accommodations domestically to benefit the nation's economy, ensure that U.S. companies can maintain their global wireless innovation leadership, and provide American consumers with the best mobile connectivity available.



Endnotes

1. GSMA, "Lower 3.5 GHz in the US: Expanding spectrum for industry, jobs and growth" (July 2023) (hereinafter, "GSMA, Lower 3.5 GHz in the US"); CCS Insight, "Coexistence of Military Communications and Public 5G Networks in the lower 3 GHz Spectrum Range: A Global Perspective" (July 2023) (hereinafter, "CCS Insight, Coexistence of Military and 5G").

2. CCS Insight, Coexistence of Military and 5G.

3. CCS Insight, Coexistence of Military and 5G.

4. Val Elbert, Enrique Duarte Melo, Chi Hung Chong, and Johnny Henderson, "Accelerating the 5G Economy in the US," Boston Consulting Group (April 2023), https://api.ctia.org/wp-content/uploads/2023/04/accelerating-the-5g-economy-in-the-us-1.pdf.

5. Coleman Bazelon and Paroma Sanyal, "How Much Licensed Spectrum Is Needed to Meet Future Demands for Network Capacity?," Brattle Group (April 2023), https://api.ctia.org/wp-content/uploads/2023/04/Network-Capacity-Constraints-and-the-Need-for-Spectrum-Brattle.pdf.

6. GSMA, Lower 3.5 GHz in the US.

7. Janette Stewart, Chris Nickerson and Juliette Welham, "Comparison of total mobile spectrum in different markets," Analysys Mason (Sept. 2022), https://api.ctia.org/wp-content/uploads/2022/09/Comparison-of-total-mobile-spectrum-28-09-22.pdf; Doug Brake, "China Commits to 5G Mid-band Spectrum with 6 GHz Allocation: U.S. Needs Clear Response," CTIA (June 2023), https://www.ctia.org/news/china-commits-to-5g-mid-band-spectrum-with-6-ghz-allocation-u-s-needs-clear-response/.

8. Ibid.

9. See CTIA, "Repurposing Government Spectrum for Licensed Commercial Use: A Win-Win for Wireless Providers and Federal Agencies" (Aug. 2020), https://api.ctia.org/wp-content/uploads/2020/08/Win-win_8-06.pdf.

10. DLA Piper, "Global Coexistence in the Lower 3 GHz band" (July 2023) (hereinafter, DLA Piper, Global Coexistence")

11. "Manual of Regulations and Procedures for Federal Radio Frequency Management | Chapter 3: International Matters," National Telecommunications and Information Administration (January 2022 Revision of the January 2021 Edition), https://www.ntia.gov/sites/default/files/2023-03/complete_manual_january_2022_revision.pdf; GSMA, Lower 3.5 GHz in the US.

12. CTIA commissioned testing of 5G signals in El Paso, Texas

13. "Manual of Regulations and Procedures for Federal Radio Frequency Management | Chapter 3: International Matters," National Telecommunications and Information Administration (January 2022 Revision of the January 2021 Edition), https://www.ntia.gov/sites/default/files/2023-03/complete_manual_january_2022_revision.pdf.

14. J. Michael Gilmore, "Director, Operational Test and Evaluation AN/TPQ-53 (Q-53) Counterfire Radar Initial Operational Test and Evaluation Report," Director, Operational Test and Evaluation (October 2015), https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Science_and_Technology/16-F-0250_(REPORT)_IOTE_Report_on_the_AN-TPQ-53_Counterfire_Radar.pdf.

15. DLA Piper, Global Coexistence.

16. DLA Piper, Global Coexistence.

17. DLA Piper, Global Coexistence.

18. In Taiwan, lower 3 GHz 5G was initially deployed by four operators. Since two mergers initiated earlier this year, three entities will be operating in lower 3 GHz: Chunghwa Telecom, Taiwan Mobile combined with Taiwan Star, and FarEast Tone combined with Asia Pacific Telecom.

19. Norah O'Donnell, "The state of the U.S. Navy as China builds up its naval force and threatens Taiwan," CBS News (March 19, 2023), https://www.cbsnews.com/news/u-s-navy-readiness-as-china-builds-up-naval-force-threatens-taiwan-60-minutes-2023-03-19/.

20. DLA Piper, Global Coexistence; at least Smart Philippines and Globe Telecom have deployed active 5G in the n78 band, see HBR radiofrequency technologies, "Philippines" (visited July 2023), https://halberdbastion.com/intelligence/countries-nations/philippines.

21. DLA Piper, Global Coexistence.

22. DLA Piper, Global Coexistence.

23. CCS Insight, Coexistence of Military and 5G.

24. GSMA, Lower 3.5 GHz in the US.

25. DLA Piper, Global Coexistence.

26. DLA Piper, Global Coexistence; CCS Insight, Coexistence of Military and 5G.

27. Loren Thompson, "The Air Force's Aged Fleet of AWACS Radar Planes is in 'Hospice Care,'" Forbes (Oct. 2022), https://www.forbes.com/sites/lorenthompson/2022/10/20/the-air-forces-aged-fleet-of-awacs-radar-planes-is-in-hospice-care-it-needs-new-planes-as-soon-as-possible/?sh=578967d15e3b; Thomas Newdick, "Air Force Orders First E-7 Jets To Replace Aging E-3 Sentry," The Drive (March 2023), https://www.thedrive.com/the-war-zone/air-force-orders-first-e-7-jets-to-replace-aging-e-3-sentry.

28. Bridie Bryant, "Multi-Role Electronically Scanned Array (MESA) Surveillance Radar," Northrop Grumman, https://www.northropgrumman.com/what-we-do/air/multi-role-electronically-scanned-array-mesa-surveillance-radar/; Key.Aero "Popular Mesa Radar Can Trace Its Origin Back Nearly Two Decades (Aug. 2021), https://www.key.aero/article/mesa-radar-can-trace-its-origin; Northrop Grumman, "Multi-role Electronically Scanned Array (MESA) Surveillance Radar" (accessed July 2023), https://sldinfo.com/wp-content/uploads/2014/03/MESA-Radar.pdf (noting benefits of L-band operation).

29. See "Thoughts on a Next-Gen AWACS," Restless Technophile: On current and near-future war machines (June, 2020), https://therestlesstechnophile.com/2020/06/15/thoughts-on-a-next-gen-awacs/; Christian Wolff, "Waves and Frequency Ranges, radartutorial.eu (visited July 2023), https://www.radartutorial.eu/07.waves/Waves%20and%20Frequency%20Ranges.en.html.

30. For example, the Military Airborne Collision Avoidance System (MILACAS), based on ADS-B technology, provides similar functionalities as SKE. Honeywell, "MILACAS-XR TCAS II Processor" brochure (2017), https://aerospace.honeywell.com/content/dam/aerobt/en/documents/learn/products/terrain-and-traffic-awareness/infographics/N40-1916-000-000-MILACAS-ig.pdf. MILACAS relies on spectrum in the 1 GHz band, rather than lower 3 GHz. Honeywell, "MILACAS-XR TCAS II Processor" brochure (2016), https://aerospace.honeywell.com/content/dam/aerobt/en/documents/learn/products/terrain-and-traffic-awareness/brochures/N61-1634-000-000-MILACAS-XR-bro.pdf. MILACAS is already in use today see Northrop Grumman, "Northrop Grumman's KC-30 Team Selects Honeywell's Military Certified Formation Flying System to Ensure Safer In-Flight Operations" (July, 2007), https://news.northropgrumman.com/news/releases/northrop-grumman-s-kc-30-team-selects-honeywell-s-military-certified-formation-flying-system-to-ensure-safer-in-flight-operations. See also Joseph Trevithick and Tyler Rogoway, "AC-130J Ghostrider Could Get Huge Upgrade From AESA Radar," The Drive (May 2023), https://www.thedrive.com/the-war-zone/ac-130j-ghostrider-could-get-huge-capability-leap-from-aesa-radar.

31. Mark Pourzenic, "Royal Australian Air Force Boeing E-7A Wedgetail," Aviation Spotters Online (April 11, 2023), http://aviationspottersonline.com/royal-australian-air-force-boeing-e-7a-wedgetail/; DLA Piper, Global Coexistence.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