July 17, 2025

Via ECFS

Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street NE
Washington, DC 20554

Re: Promoting the Development of Positioning, Navigation, and Timing Technologies and Solutions (WT Docket No. 25-110); NextNav Petition for Rulemaking, Enabling Next-Generation Terrestrial Positioning, Navigation, and Timing and 5G: A Plan for the Lower 900 MHz Band (902-928 MHz), Public Notice (WT Docket No. 24-240)

Dear Ms. Dortch:

Attached is the *Brattle Second Supplemental Report* prepared by the Brattle Group ("Supplemental Report") responding to the *Economic Analysis of NextNav's Proposal* prepared by Harold Furchtgott-Roth ("HFR Filing").[1] In its Supplemental Report, the Brattle Group concludes that the Commission should give the HFR Filing no weight as it contains significant methodological shortcomings and lacks substantive merit. Most importantly, the HFR Filing's "sticker shock" conclusion erroneously presumes that both licensed and unlicensed users would need to either dramatically alter or discontinue their operations in the lower 900 MHz band.

The Supplemental Report establishes that NextNav's proposal to enable 5G-based positioning, navigation, and timing in the lower 900 MHz band would impose minimal costs on current users of the band while generating substantial national benefits, potentially amounting to tens of billions of dollars. The Supplemental Report demonstrates that HFR's contrary conclusions rely on extreme, unsupported, and highly speculative assumptions, significant methodological weaknesses, and a disregard for standard industry practices.

[1] Harold Furchtgott-Roth, *An Economic Analysis of NextNav's Proposal for the Reallocation of Spectrum and the Modification of Rules in the Lower 900 MHz Band* (Apr. 2025), *attached to* Comments of the International Bridge, Tunnel & Turnpike Ass'n, WT Docket No. 25-110 (filed Apr. 28, 2025); Harold Furchtgott-Roth, *An Economic Analysis of NextNav's Proposal for the Reallocation of Spectrum and the Modification of Rules in the Lower 900 MHz Band* (Apr. 2025), *attached to* Letter from Mark F. Muriello, Vice President, Policy & Government Affairs, International Bridge, Tunnel & Turnpike Ass'n to Marlene H. Dortch, Secretary, FCC, WT Docket No. 24-240 & RM-11989 (filed Apr. 29, 2025) (identical study).

As the Supplemental Report explains, the HFR Filing bases its cost estimates on the inaccurate premise that current licensed and unlicensed users of the lower 900 MHz band would be forced to suffer interference, move to an entirely different band, or discontinue operations altogether. This premise is simply not true. Most notably, the HFR Filing disregards the technical analyses already in the record demonstrating that 5G operations will not cause unacceptable interference to unlicensed devices, which can continue operating across the entire band under NextNav's proposal *at zero incremental cost*.

The HFR Filing also fails to account for the fact that current tolling-related equipment is either using frequencies that would not overlap with the proposed 5G operations or can be retuned at relatively minimal cost. In addition, the HFR Filing treats all costs as new, ignoring the business-as-usual ongoing capital refresh and lifecycle management and technological obsolescence that should be the baseline for any cost estimate. It also grossly exaggerates potential loss of tolling revenues, relying on assumptions about the speed and scale of service degradation that lack any reasonable foundation.

The Supplemental Report, by contrast, provides a careful, evidence-based assessment that shows zero cost to unlicensed users, minimal costs to tolling operators, and benefits in the tens of billions of dollars. Based on the record, including this Supplemental Report, it is clear that the economic merits of NextNav's proposal withstand scrutiny. Further, NextNav's proposal will enable a much-needed, market-based terrestrial backup and complement to GPS, addressing an urgent national security and public safety priority, at no cost to taxpayers. As NextNav has previously stated, the time for delay and obstruction has come to an end, and the path forward is clear: the Commission should promptly issue a Notice of Proposed Rulemaking to enable 5G-based 3D PNT in the lower 900 MHz band.

Respectfully submitted,

/s/ Renee Gregory

Renee Gregory
Vice President of Regulatory Affairs
NextNav Inc.
11911 Freedom Drive, Suite 200
Reston, VA 20190
rgregory@nextnav.com

Brattle Second Supplemental Report

REPLY TO THE HAROLD FURCHGOTT-ROTH FILING, AN ECONOMIC ANALYSIS OF NEXTNAV'S PROPOSAL FOR THE REALLOCATION OF SPECTRUM AND THE MODIFICATION OF RULES IN THE LOWER 900 MHZ BAND

PREPARED BY

Coleman Bazelon

Paroma Sanyal

PREPARED FOR

NextNav Inc.

JULY 17, 2025

Brattle

NOTICE

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The report reflects the analyses and opinions of the authors and does not necessarily reflect those of The Brattle Group's clients or other consultants.

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Executive Summary

A core principle of sound spectrum policy is that spectrum should be assigned to its highest and most valuable use—that is, the use that generates the greatest overall benefit to society. This principle is rooted in economic efficiency: the repurposing of spectrum should occur when the net benefits (*i.e.*, benefits minus costs) of doing so are positive. Importantly, the value of spectrum lies not only in its current usage, but in its potential to support services that maximize economic and social welfare. Thus, the central question for policymakers is whether the benefits of making spectrum available for a new use outweigh the costs imposed on current users.

In the case of the Lower 900 MHz band (902–928 MHz), the benefits of slightly adjusting the configuration of the licensed portion of the band are large, while the costs are relatively small. The proposal—which would make 15 MHz of low-band spectrum available for resilient terrestrial Positioning, Navigation, and Timing ("PNT") and terrestrial 5G—would unlock tens of billions of dollars in benefits, while requiring transition costs that are modest and manageable (and vastly overstated by opponents of this proposal). This indicates that a well-reasoned spectrum policy would advocate for reconfiguring the Lower 900 MHz band.

In our report previously submitted to the FCC ("Brattle Report"), we estimated the benefit of a terrestrial GPS backup. Recently a submission by Harold Furchtgott-Roth ("HFR Filing") presented potential costs and benefits. This report examines the HFR Filing and concludes that any costs are likely orders of magnitude lower than the benefits of the proposed slight reconfiguration of the licensed portion of the Lower 900 MHz band. We demonstrate that the cost to current users of the band is minimal, while the benefits amount to tens of billions of dollars.

Benefits

The benefits of slightly reconfiguring the licensed portion of the Lower 900 MHz band fall into two primary categories: those derived from establishing a resilient terrestrial GPS backup, and those generated by enabling high-value terrestrial mobile services.

1. *Benefits from a Terrestrial GPS Backup*

In The Brattle Report, we estimated the benefit of a terrestrial GPS backup using two well-established economic valuation methods:

- The *Insurance Valuation Framework*, assessed the value of risk mitigation against disruptions to GPS. It estimated the expected avoided losses from rare but high-impact events (*e.g.*, solar storms, jamming). Using this model, we calculated the 20-year net present value of civilian benefits at **$10.8 billion**.

- The *Willingness-to-Pay Approach*, proxied military valuation for a terrestrially based GPS backup technology using Department of Defense ("DoD") investment in the M-Code encrypted GPS system. We conservatively attributed only 50% of this cost to domestic defense needs and estimated a military benefit of **$3.8 billion**.

2. *Broader Consumer Surplus and Welfare Benefits*

Making spectrum available for terrestrial mobile services yields enormous consumer welfare gains. We note that consumer surplus from mobile wireless services is typically 10–20 times higher than producer surplus. Given the soaring demand for mobile data and the opportunity to meet that demand with low-band spectrum, the aggregate value of the proposed reconfiguration could far exceed the **$14.6 billion** in direct GPS benefits—potentially placing the total benefits in the many tens of billions of dollars.

3. *The HFR Filing's Benefits Calculations are Incorrect*

The HFR Filing assigns no value to a terrestrial backup for GPS – an oversight that is difficult to justify given GPS's critical role and widespread use across virtually every sector of the economy, and the immense economic losses that would result from a failure. Additionally, the submission overlooks dynamic and forward-looking benefits, such as strategic deterrence and the growing demand for advanced connectivity. The filing values the benefits at only $1 - $2 billion as a result of slightly reconfiguring the licensed portion of the Lower 900 MHz band to enable the delivery of high-value mobile broadband services, a misevaluation that ignores the billions of dollars in additional consumer surplus from improved 5G service.

Costs

The HFR Filing estimates that the reconfiguration would impose billions of dollars in costs. These estimates are much too high due to flawed assumptions, methodological errors, and failure to account for standard industry practices.

1. *Equating Unlicensed and Licensed Devices in Cost Analysis Introduces a Serious Methodological Flaw in the Cost Estimation*

The HFR Filing inappropriately treats licensed and unlicensed devices similarly when estimating costs. This approach reflects a significant analytical flaw.

- Unlicensed devices like those operating under FCC Part 15 rules typically use the Lower 900 MHz band for low-power, short-range applications. These devices are designed to operate opportunistically and coexist with other users, and technical analysis from NextNav in the record demonstrates that 5G operations will not cause unacceptable interference to unlicensed devices, which can continue to operate across the entire band under NextNav's proposal.

- In contrast, licensed devices, such as toll transponders and toll readers in gantries, operate under specific frequency authorizations and enjoy interference protection from other users. Those licenses can continue to operate in the Lower 900 MHz band on the same frequencies or retune toll readers to nearby frequencies in the band without replacing equipment. To the extent that coexistence with licensed operations requires retuning or other equipment-related costs, NextNav has committed to reasonable accommodations, including financial and technical support, that contribute to a smooth transition to an optimized Lower 900 MHz band plan.

2. *Cost Methodology Relies on Extreme Assumptions, Resulting in Unreliable Estimates*

The HFR Filing cost estimates are flawed due to their reliance on worst-case assumptions that are inconsistent with NextNav's proposal.

- Specifically, the HFR Filing assumes that if NextNav's proposal were adopted, current users of the Lower 900 MHz band would be forced to do one of the following: (1) suffer interference and relocate into a narrower frequency range within the Lower 900 MHz band; (2) relocate to a spectrum band outside the Lower 900 MHz band; or (3) discontinue operations altogether. With respect to tolling operators, NextNav has never suggested that they be forced to suffer interference, relocate out of the band or discontinue operations. Rather, NextNav has consistently and repeatedly stated on the record that, for all types of licensed non-M-LMS (non-Multilateration Location and Monitoring Service) systems, NextNav is committed to working with incumbent operators to develop coexistence solutions.

- To the extent that coexistence requires retuning and other equipment-related costs, NextNav has committed to reasonable accommodations, including financial and technical support, that contribute to a smooth transition to an optimized lower 900 MHz band plan.

3. Had the NextNav Technical Study Been Considered, the HFR Filing Would have Concluded that the Cost to Unlicensed Devices is Approximately Zero

- The HFR Filing ignores the NextNav Technical Study which concluded that 5G operations will not cause unacceptable levels of interference to unlicensed Part 15 devices in the 902-928 MHz band, and that NextNav's proposal would allow Part 15 devices to continue operating across the entire band. Thus, the cost should be zero.

- In addition to ignoring the NextNav Technical Study which concludes that Part 15 devices would not have to relocate or be reconfigured, the HFR Filing relies heavily on a third-party cost projection (from Digi International) for estimating the cost of a reconfiguration of Part 15 devices, which, again would not actually be required. The assumptions in the third-party report, such as the percentage of devices that could be reconfigured, are not scrutinized and cannot be independently verified.

4. Costs Do Not Account for Technological Obsolescence of Budgeted Replacement Cycles

- The HFR Filing treats all estimated costs as incremental, ignoring the business-as-usual ongoing capital refresh and lifecycle management and technological obsolescence that should be the baseline for any comparison. Advancements in technology will inevitably lead to the replacement of the existing installed base of both licensed and unlicensed devices in the Lower 900 MHz band in the next 5 – 10 years regardless of any band reconfiguration. Ignoring this technological obsolescence and budgeted infrastructure upgrade cycles significantly overstates costs.
- The submission grossly overstates the tolling revenues potentially lost from the reconfiguration and relies on overstated assumptions about the speed and scale of service degradation to calculate costs.

5. Fundamentally Flawed Conclusion Drawn from a Revealed Preference Argument

- The HFR Filing argues that the "revealed preferences of current users of the Lower 900 MHz that are spread throughout the Lower 900 MHz band are that the current configuration of the band is preferable to operating in just the 907-918 MHz portion or to leaving the band entirely." But most fundamentally, the HFR Filing ignores the fact that

no current users, licensed or unlicensed, will have to vacate the band, and that Part 15 devices will be able to continue to operate across the entire Lower 900 MHz band. Even setting those facts aside, this assertion is not a reliable indicator of optimal spectrum use or true user preferences in the face of constrained choices. It ignores a multitude of spectrum policy precedents, where legacy use did not imply optimal use.

Summary

When analyzed, the benefits of improving the current configuration of the Lower 900 MHz band by making it available for high-value uses—including GPS backup and 5G services—clearly outweigh any costs identified by the HFR Filing. This report makes clear that:

- The opportunity cost of maintaining command-and-control M-LMS rules for the band is substantial.
- The costs for licensed tolling users in the band are minimal, particularly when accounting for their continued ability to operate in the Lower 900 MHz band on the same frequencies or to retune toll readers to nearby frequencies in the band without replacing equipment, technology refresh, coexistence, and planned upgrades. In addition, licensed users have received commitments for reasonable accommodations, including financial support, that contribute to a smooth transition to an optimized Lower 900 MHz band plan.
- The cost to unlicensed users should be zero.
- The benefits to consumers are in tens of billions of dollars.
- The consumer and strategic benefits are enduring, extending across sectors and into national security.

Thus, in line with long-standing principles of spectrum policy, and supported by NextNav's coexistence engineering studies and economic modeling, the case for slightly reconfiguring the licensed portion of the Lower 900 MHz band seems compelling. It represents a clear opportunity to advance both the public interest and the long-term efficiency of U.S. spectrum use.

I. Introduction

A foundational principle of effective spectrum policy is that spectrum should be assigned to its highest and most beneficial use—that is, the use that delivers the greatest net value to society. This approach is grounded in the concept of economic efficiency: spectrum should be repurposed when the overall benefits, after accounting for associated costs, are positive.[1] Crucially, spectrum's value is not limited to its current application, but extends to its potential to enable services that enhance both economic productivity and social well-being. Accordingly, the key consideration for policymakers is whether the societal gains from repurposing spectrum exceed the costs borne by existing users.

The NextNav proposal will make available a 15 MHz spectrum block (902-907 MHz uplink and 918-928 MHz downlink) for terrestrial Positioning, Navigation, and Timing ("PNT") services and 5G services.[2] NextNav, which currently operates in the band utilizing its Multilateration Location and Monitoring Service ("M-LMS") licenses, argues that such modernization is necessary to deploy a scalable, commercially viable terrestrial backup to the GPS.[3] The proposed change would unlock tens of billions of dollars in benefits, while requiring transition costs that are modest. We find that the benefits of slightly reconfiguring the licensed portion of the band are large, while the costs are relatively small. This indicates that a well-reasoned spectrum policy would advocate for reconfiguring the Lower 900 MHz band.

[1] See, Federal Communications Commission (FCC), "A Groundbreaking Auction to Realign Use of the Public's Airwaves," accessed July 14, 2025, https://www.fcc.gov/about-fcc/fcc-initiatives/incentive-auctions. See also, Statement of Chairman Pai, "The C-Band – Repurposing Mid-Band Spectrum for 5G," February 6, 2020, https://docs.fcc.gov/public/attachments/DOC-362335A1.pdf.

[2] *See*, FCC, "In the Matter of Enabling Next-Generation Terrestrial Positioning, Navigation, and Timing and 5G: A Plan for the Lower 900 MHz Band (902-928 MHz), Petition for Rulemaking of NextNav, Inc., WT Docket No. 24-240, Apr. 16, 2024, https://nextnav.com/wp-content/uploads/2024/04/Petition-for-Rulemaking-of-NextNav-Inc.pdf, ("NextNav Petition").

[3] *See*, NextNav Comments filed at the FCC, "In the Matter of Enabling Next-Generation Terrestrial Positioning, Navigation, and Timing and 5G: A Plan for the Lower 900 MHz Band (902-928 MHz," WT Docket No. 24-240, https://www.fcc.gov/ecfs/document/109060100813880/1.

In April 2025, Harold Furchtgott-Roth submitted a filing ("HFR Filing") opposing NextNav's Petition for Rulemaking to modernize the Lower 900 MHz band.[4] This Second Supplemental Report by Brattle responds to issues raised in the HFR Filing and shows that the benefits of slightly reconfiguring the licensed portion of the Lower 900 MHz band for high-value uses clearly outweigh any costs identified by the HFR Filing.

Section II presents the benefits of reconfiguring the Lower 900 MHz band, including a summary of the Brattle Group's previous analysis and omissions in the HFR Filing. Section III critiques the cost estimates presented in the HFR Filing and shows that methodological flaws and extreme assumptions embedded in the assumptions render the cost estimates incorrect and vastly overstated, as the cost to unlicensed users should be zero, and licensed tolling users may have to make only modest adjustments and have received commitments for reasonable accommodations, including financial and technical support to enable a smooth transition to an optimized band plan. Section IV concludes.

II. Benefits of Reconfiguring the Lower 900 MHz Band: Overview of Brattle's Economic Framework and Omissions in the HFR Filing

A. Benefits from a Terrestrial GPS Backup

In the Brattle Report, we estimated the benefits of a terrestrial GPS backup using two well-established economic valuation methods:

[4] *See*, Harold Furchtgott-Roth, "An Economic Analysis of NextNav's Proposal for the Reallocation of Spectrum and the Modification of Rules in the Lower 900 MHz Band," prepared for E-ZPass Group, the International Bridge, Tunnel, and Turnpike Association, and Neology, Inc, attached to Letter from Mark F. Muriello, Vice President, Policy & Government Affairs, International Bridge, Tunnel & Turnpike Ass'n to Marlene H. Dortch, Secretary, filed under FCC, "WTB and OET Seek Comment on NextNav Petition for Rulemaking, WTB 24-240, WTB RM-11989," April 29, 2025, https://www.fcc.gov/ecfs/document/1042983929938/2, and also attached to Comments of the International Bridge, Tunnel & Turnpike Ass'n, WT Docket No. 25-110, filed Apr. 28, 2025, ("HFR Filing").

- *The Insurance Valuation Framework* (for Civilian Use Cases):[5] This framework assessed the value of risk mitigation against disruptions to GPS. It treated the terrestrial PNT system as an insurance policy against adverse events (such as solar storms, jamming, cyberattacks or spoofing) that can cause GPS outages, and estimated the expected avoided losses from rare but high-impact adverse events. Expected annual economic losses from 1-day, 7-day, and 30-day GPS outages were weighted by their respective probabilities and aggregated to calculate the fair insurance premium. Using this model, we calculated the 20-year net present value of civilian benefits at **$10.8 billion**.

    - *The Willingness-to-Pay Approach* (for Military Resiliency):[6] This method estimates how much the Department of Defense ("DoD") is willing to pay for enhanced GPS resiliency, using its investment in the M-code and Next Generation Operational Control System (OCX) as a proxy. According to GAO estimates, the OCX system cost $7.7 billion as of 2023. We conservatively attributed only 50% of this cost to domestic defense needs and estimated a military benefit of **$3.8 billion**.

The estimated benefits presented in the Brattle report are deliberately conservative, reflecting multiple adjustments made to account for the scope of the deployment of a terrestrial backup to GPS and the value of NextNav's solution across various sectors of the economy. For example,

- *Geospatial Coverage Adjustment*: Since NextNav's solution will utilize 5G infrastructure, Brattle limits its geographic benefit estimate to areas currently served by 4G LTE (proxy for near-term 5G), resulting in reductions of 27.3% to 50.7% in some sectors.[7]

- *Seasonal and Functional Adjustments*: [8] For agriculture, Brattle adjusts for seasonal activity (only during planting season) and limits the benefit to soil mapping applications, assuming more precise Real-Time-Kinematic-dependent operations (e.g., precision agriculture) would not benefit. Thus, only applications that NextNav's solution can

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[5] *See*, Coleman Bazelon and Paroma Sanyal, "Public Benefits of Reconfiguring the Lower 900 MHz Band to Support a Backup and Complement to GPS," p. 27, filed under FCC, "WTB and OET Seek Comment on NextNav Petition for Rulemaking, WTB 24-240, WTB RM-11989," prepared for NextNav, October 21, 2024 ("Brattle Report").

[6] *See*, Brattle Report, p. 29.

[7] For example, for maritime, we assume a 49.3% overlap between 4G coverage and the U.S. marine highways (excluding Alaska). This implies a reduction of value by 50.7% as 50.7% of the marine highways are not covered by the 4G network. For location-based services, oil and gas, mining, surveying, electricity we find a 72.7% overlap with the 4G network. This implies a reduction in value of 27.3%, as 27.3% of the area is not covered by the 4G network. *See,* Brattle Report, Appendix B, Table B1.

[8] *See*, Brattle Report, Appendix B, Section B3, pp. 43-45.

support (*e.g.*, yield mapping, logistics tracking) are included, while those requiring centimeter-level precision are excluded.

- *Domestic Adjustment for Military Value*:[9] Instead of attempting to quantify the full military value of a terrestrial GPS backup, the Brattle Report only uses the DoD investment in the M-code and the associated OCX system which enables encrypted and jam-resistant GPS signals. Additionally, Brattle conservatively allocates only 50% of this value for protection of the Homeland within the U.S. borders.[10]

B. Broader Consumer Surplus and Welfare Benefits

In addition to the benefits derived from a terrestrial GPS backup, enabling 5G operations in the Lower 900 MHz band will also generate large 5G service related benefits. The wireless industry will face a spectrum deficit driven by explosive growth in mobile data consumption, fueled by 5G adoption and 6G evolution, streaming, IoT, and emerging technologies like virtual reality (VR). In previous work we estimated that by 2027, the industry will face a 400 MHz spectrum deficit.[11] As demand continues to outpace supply, carriers risk network congestion, slower speeds, and reduced service quality. Additional low-band spectrum is essential to expand capacity, improve coverage—especially in rural and underserved areas—and support innovation across industries. Spectrum is essential for enabling growth in mobile-dependent sectors such as artificial intelligence, video streaming, and advanced virtual and augmented reality, and bolstering supporting industries that underpin wireless infrastructure, including construction, electronics maintenance, and network services. Spectrum is valuable because it is the fundamental enabler of wireless connectivity; without sufficient spectrum, the full economic and societal benefits of mobile technologies cannot be realized.

Making spectrum available for terrestrial mobile services yields enormous consumer welfare gains. Consumer surplus—the difference between what consumers are willing to pay and what they actually pay—is a key indicator of economic welfare. In the context of mobile wireless services, previous work has shown that consumer surplus can be 10 to 20 times greater than

[9] *See*, Brattle Report, Section III, pp. 28 – 29.

[10] *See*, Brattle Report, Section III, p. 29.

[11] See, Coleman Bazelon and Paroma Sanyal, "How Much Licensed Spectrum Is Needed to Meet Future Demands for Network Capacity?" Prepared for CTIA, April 17, 2023, p. 4, https://www.ctia.org/news/how-much-licensed-spectrum-is-needed-to-meet-future-demands-for-network-capacity.

producer surplus.[12] This implies that the benefits to consumers far exceed the profits earned by service providers. Given the soaring demand for mobile data and the opportunity to meet that demand with low-band spectrum, the aggregate value of the proposed updates to the Lower 900 MHz band could far exceed the $14.6 billion in direct GPS benefits—potentially placing the total benefits in the many tens of billions of dollars.

C. The HFR Filing's Benefits Calculations are Incorrect

The HFR Filing states that the value of the services currently deployed in the Lower 900 MHz band is conservatively estimated in the tens of billions of dollars.[13] This claim overstates both the size and certainty of the economic value of current services in the Lower 900 MHz band, and is methodologically unsound. That is an overall or gross-benefit perspective: it measures the entire economic pie that exists when the band is used under current rules. To answer how consumer benefits might change requires an incremental-benefit test—comparing the world with and without updates to the Lower 900 MHz band. Because NextNav has shown that the introduction of 5G operations in the band will not result in unacceptable interference to unlicensed devices and has committed to working with licensed incumbent operators to develop coexistence solutions within the band, the consumer benefit should be unaffected.

Additionally, the HFR Filing's comparison of the aggregate benefits of current services in the Lower 900 MHz band with NextNav's current revenues is a false comparison. Framing the Lower 900 MHz band's value by overall benefits of currently deployed services obscures the real policy question: What additional (or forgone) value would a slight reconfiguration of the licensed portion of the band create relative to the current status? To evaluate this properly, one must assess the benefits of enabling a terrestrial GPS backup and the consumer welfare gains from making 15 MHz of spectrum available for terrestrial mobile use and compare those benefits with the cost of doing so.

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[12] In addition to the direct economic value generated by the spectrum (as reflected in the value), *i.e.* the producer's surplus, there are welfare benefits to consumers of the services enabled by the spectrum. "For mobile wireless services, economists estimated that the total social benefits from licensed spectrum are at least 10 to 20 times the direct economic value of the spectrum." *See,* Coleman Bazelon and Giulia McHenry, "Mobile Broadband Spectrum: A Vital Resource for the Economy," Prepared for CTIA, May 11, 2015, p. 1, https://api.ctia.org/docs/default-source/default-document-library/brattle_spectrum_051115.pdf.

[13] *See*, HFR Filing, p. 15.

a. The HFR Filing Assigns Zero Value to NextNav's Proposed Backup GPS Solution

The HFR Filing assigns no value to a terrestrial backup for GPS — an oversight that is problematic given GPS's critical role and widespread use across virtually every sector of the economy, and the immense economic losses that would result from a GPS failure. The HFR Filing contends that the value of a GPS backup system should not be attributed to NextNav's proposal, arguing that existing FCC rules already permit such services and that alternative providers can offer PNT solutions without regulatory changes. However, this perspective overlooks the critical importance of a widescale, near-term, market-driven terrestrial GPS backup that has a clear path to incorporation in end-user devices, which NextNav has proposed.

Disruptions to GPS can have cascading effects across various sectors, including transportation, finance, and emergency services. The U.S. Department of Homeland Security states that:

"PNT services have become an invisible but essential utility for critical infrastructure operations across many sectors, including the electric power grid, communications infrastructure, transportation, agriculture, financial services, and emergency services. Therefore, disruption of or interference with PNT systems has the potential to cause adverse impacts on individuals, businesses, and the nation's economic and military security."[14]

A resilient PNT system of systems also serves as a strategic deterrent against potential adversaries who might seek to exploit vulnerabilities in GPS-dependent systems. The establishment of a terrestrial backup enhances national resilience, ensuring continuity of critical services during disruptions. This strategic value, while challenging to quantify, is a crucial consideration in spectrum policy decisions. Therefore, investing in a terrestrial backup system is not merely a commercial endeavor but a strategic imperative.

b. Neglect of Dynamic and Forward-Looking Benefits from Spectrum Optimization

The analysis fails to account for the dynamic benefits of optimizing the Lower 900 MHz band, such as the facilitation of advanced connectivity services. Low-band spectrum is particularly valuable for its propagation characteristics, making it ideal for expanding mobile broadband coverage, especially in rural and underserved areas, as well as offering coverage indoors and in

[14] *See*, U.S. Department of Homeland Security Science and Technology Directorate, "Resilient Positioning, Navigation, and Timing (PNT) Reference Architecture (Version 1.0)", June 9, 2022, p. iii, https://www.dhs.gov/sites/default/files/2022-06/22_0609_st_resilient_pnt_ra.pdf.

dense urban areas. By enabling the deployment of 5G services, the slight reconfiguration of the licensed portion of the Lower 900 MHz band could support emerging technologies like autonomous vehicles, telemedicine, and smart infrastructure, driving innovation and economic growth as discussed earlier. The HFR filing values these benefits at only $1 - $2 billion.[15] This misvalues the spectrum because enabling the delivery of high-value mobile broadband services in the Lower 900 MHz band would generate billions of dollars in additional consumer surplus as discussed earlier.

III. Cost Estimates in the HFR Filing are Grossly Overestimated

The HFR Filing estimates that the slight reconfiguration of the licensed portion of the Lower 900 MHz band would impose billions of dollars in costs. These estimates are inapplicable due to flawed assumptions, methodological errors, and failure to account for standard industry practices.

A. Equating Unlicensed and Licensed Devices in Cost Analysis Introduces a Serious Methodological Flaw in the Cost Estimation

The HFR Filing inappropriately treats licensed and unlicensed devices similarly when estimating costs. This approach reflects a significant analytical flaw.

Unlicensed devices like those operating under FCC Part 15 rules typically use the Lower 900 MHz band for low-power, short-range applications. The Lower 900 MHz band is a shared spectrum environment where unlicensed devices coexist with other users. These devices employ techniques such as frequency hopping and spread spectrum to withstand interference and deliver best-effort operations. This coexistence has allowed a range of technologies to operate in the band. These devices are designed to operate opportunistically and coexist with other users. Technical analyses from NextNav in the record demonstrate that 5G operations will not cause

[15] *See*, HFR Filing, p. 28.

unacceptable interference to unlicensed devices, which can continue to operate across the entire band under NextNav's proposal.[16]

The HFR Filing states without evidence or technical analysis that the NextNav proposal "would severely disrupt, if not force the termination of, the operations of unlicensed Radio frequency Identification ("RAIN") RFID systems," and have "substantial economic and operational burden."[17] Passive tags such as the RAIN RFID tags are extremely inexpensive and often disposable. As explained earlier, the NextNav Technical Study shows that "in practical applications, 5G operations will not cause unacceptable levels of interference to RAIN devices."[18] Given that these devices are designed to operate in the presence of interference, we understand that any potential limited 5G interference should not lead to any significant negative impact. Additionally, given the short lifecycle of these tags, a slight reconfiguration of the licensed portion of the Lower 900 MHz band is unlikely to "cause" any tag replacement and hence any incremental replacement cost should be zero.

In contrast, licensed devices, such as toll transponders and toll readers in gantries, operate under specific frequency authorizations and enjoy interference protection from other users. Those licensees can continue to operate in the Lower 900 MHz band on the same frequencies or retune toll readers to nearby frequencies in the band without equipment replacement. To the extent that coexistence requires retuning or other equipment-related costs, NextNav has committed to reasonable accommodations, including financial and technical support, that contribute to a smooth transition to an optimized lower 900 MHz band plan.

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[16] *See*, Dr. John Kim, JongHak Jung, Dr. Arun Raghupathy, Dr.Tolis Papathanassiou, and David Gell, "5G NR and Unlicensed Part 15 Technologies in the Lower 900 MHz Band," February 27, 2025, NextNav Study submitted at the FCC's proceeding: "5G NR and NextNav Petition for Rulemaking, Enabling Next-Generation Terrestrial Positioning, Navigation, and Timing and 5G: A Plan for the Lower 900 MHz Band (902-928 MHz), Public Notice," WT Docket No. 24-240, https://nextnav.com/wp-content/uploads/2025/02/NextNav-Technical-Study-Feb.-27-2025-2.pdf, ("NextNav Technical Study"), *See also*, , Dr. John Kim, JongHak Jung, Dr Tolis Papathanassiou, Tom Tran and Hasan Umair, "Supplement to NextNav's Engineering Study on 5G NR and Unlicensed Part 15 Technologies in the Lower 900 MHz Band," July 9, 2025, https://www.fcc.gov/ecfs/document/107092298605731/1, ("Supplement to NextNav Technical Study").

[17] *See*, HFR Filing, p. 13.

[18] *See,* NextNav Technical Study, p. 40.

B. Had the NextNav Technical Study Been Considered, the HFR Filing Would have Concluded that the Cost to Unlicensed Devices is Approximately Zero

1. The HFR Filing Ignores Continued Coexistence with Unlicensed Devices Across the Entire Lower 900 MHz Band

The HFR Filing ignores the NextNav Technical Study, which demonstrated that 5G operations will not cause unacceptable levels of interference to unlicensed Part 15 devices in the 902-928 MHz band, including, but not limited to RAIN RFID devices, and that NextNav's proposal would allow Part 15 devices to continue operating across the entire band.[19] The HFR Filing does not even consider the possibility of coexistence, while offering no technical support for its assumption that coexistence is not possible. The Report cites a US Chamber of Commerce filing to claim that there is no feasible coexistence solution, but that filing also offers no technical analysis to support its conclusions.[20] By contrast, the NextNav Technical Study concluded that deploying 5G in the 902–928 MHz band "will not materially alter this emissions landscape" and adds negligible additional interference to unlicensed devices.[21] The study also found that a 5G network will be better for coexistence by introducing less emissions into the band than already-authorized M-LMS operations. The analysis covered five major unlicensed technologies—LoRaWAN, RAIN RFID, Wi-Fi HaLow, Wi-SUN, Z-Wave—showing inherent resilience and adaptability for coexistence.[22] Thus the harm or cost from the reconfiguration to unlicensed devices should be zero.

2. The HFR Filing Relies Heavily on a Third-Party Cost Study for Part 15 Devices and Adopts Incorrect Cost Estimates that are Based on Unsupported Assumptions

As discussed above, the NextNav Technical Study clearly demonstrates that 5G operations in the band will not cause unacceptable levels of interference to unlicensed devices, implying that the cost to these unlicensed users will be zero. The HFR Filing does not account for any coexistence possibility and relies heavily on third-party cost projections from Digi International, which claim that billions of dollars would be needed to replace or retune unlicensed Part 15 devices, again

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[19] *See*, NextNav Technical Study. *See also*, Supplement to NextNav Technical Study.

[20] *See,* HFR Filing, FN 88, p. 17.

[21] See, NextNav Technical Study, p. 1.

[22] *See,* NextNav Technical Study, pp. 2, 22-28.

based on an unsupported technical assumption that coexistence is not possible.[23] If the HFR Filing had aimed to provide a robust estimate of reconfiguration costs, setting aside the fact that reconfiguration would not actually be required for unlicensed devices, it would have incorporated standard cost assumptions, including increased potential for remote retuning and typical equipment replacement cycles. It does not do that, and hence the Part 15 cost estimates should be disregarded entirely.

a. Assumptions on Remote Retuning Grossly Inflate Cost Estimates

A significant share of Part 15 devices—especially enterprise-class IoT hardware—are now designed with software-defined radios "SDRs") or programmable chipsets that support firmware upgrades and remote reconfiguration capabilities.[24] For example, Zebra's management utilities allow administrators to monitor devices and apply firmware updates to barcode scanners and RFID readers remotely.[25] Numerous vendors in the smart building, logistics, and automation sectors have confirmed that remote management tools are widely used to update frequency settings and modify protocols, amongst other things. The Digi International filing provides no clear source for its estimate that only 35% of devices can be upgraded via software.[26] The estimate only discusses the 5 year transition window and not the technology lifecycle of various Part 15 devices, and does not provide support for why only 35% of the installed base are capable of software updates. Given rapid advances in technology, it is likely that this number will increase even in the near-term. If a significant portion of these devices can be remotely retuned, then any cost would be significantly lower than that quoted in the HFR Filing. This possibility is not accounted for in the HFR Filing making the cost estimates unreliable.

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[23] *See*, Comments of Digi International Inc. filed under FCC, "WTB and OET Seek Comment on NextNav Petition for Rulemaking, WTB 24-240, WTB RM-11989," p. 20, September 5, 2024, https://www.fcc.gov/ecfs/document/10905196640078/1, ("Digi International Comments").

[24] *See*, Kim Sawyer, "Software Defined Radios and Their Applications," May 3, 2024, accessed June 19, 2025, https://www.xetawave.com/post/software-defined-radios-and-their-applications.

[25] *See*, Zebra, "Lower Your Total Cost of Ownership with Remote Management," accessed June 19, 2025, https://www.zebra.com/us/en/software/scanner-software/remote-management.html#:~:text=With%20Zebra%2C%20you%20can%20choose%20from%20two,for%20Linux%20or%20Windows%20Management%20Instrumentation%20(WMI).&text=In%20three%20easy%20steps%2C%20you%20can%20configure,parameters%2C%20update%20firmware%20and%20query%20asset%20data.

[26] *See*, Digi International Comments, p. 19.

b. Cost Estimates Ignore the Planned Replacement Leading to Overestimates Costs

The cost estimates also ignore the replacement cycle of devices already in use. The expected replacement cycle for enterprise IoT hardware ranges from a few years up to a decade, depending on use case and environment. In fast-paced sectors like logistics, retail, and warehousing, devices are refreshed relatively frequently (roughly every 3–5 years). [27] Consequently, a significant portion of the fleet would naturally phase out during a transition period. Given the technology lifecycle, most of the stock would be replaced in the next 3 – 5 years with updated technology and capable of software upgrades. This is not accounted for in the estimates, rendering them fundamentally flawed. However, it is important to reiterate that, based on NextNav's technical analyses in the record, the cost impact on unlicensed devices—such as those operating under Part 15—should be zero.

c. The Filing Completely Ignores International Evidence on Successful Unlicensed Operations Using Smaller Bandwidth

NextNav's technical analyses have concluded that unlicensed operations will be able to operate across the full 26 MHz of the Lower 900 MHz band after the reconfiguration. If, however, unlicensed users choose to operate within a smaller portion of that spectrum band, that would still align with typical unlicensed usage patterns observed in other countries, where operations often occur over narrower bandwidths. The HFR Filing fails to consider the fact that outside of the U.S., such devices operate in a much narrower frequency ranges without any perceived degradation in service quality. In Europe, Japan, India and most countries in the world, the UHF frequency bands allocated to passive RFID such as those using for Part 15 devices or RFID readers are much smaller than in the U.S. [28] For instance, in the U.K. it is in the range of 865.6 – 867.6 MHz and 915 – 921 MHz, in Germany it is between 865.6 - 867.6 MHz, in Japan it is between 916.7 - 920.9 MHz and 916.7 - 923.5 MHz, and in India it is between 865 – 867 MHz.[29]

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[27] *See,* RF Gen, "Hardware 101: A Definitive Crash Course in Enterprise Mobility," accessed June 19, 2025, https://www.rfgen.com/blog/hardware-101-a-definitive-crash-course-in-enterprise-mobility/#:~:text=Add%20to%20this%20the%20fact,to%20three%20years%20as%20well.

[28] *See*, GS1, "Regulatory Status for Using RFID in the EPC Gen2 (860 to 960 MHz) Band of the UHF Spectrum," June 4, 2021, https://www.gs1.org/sites/gs1/files/uhf_regulations.pdf, ("Regulatory Status for Using RFID in the EPC Gen2 (860 to 960 MHz) Band of the UHF Spectrum").

[29] *See*, Regulatory Status for Using RFID in the EPC Gen2 (860 to 960 MHz) Band of the UHF Spectrum.

C. Cost Methodology Used for Licensed Devices Relies on Extreme Assumptions, Resulting in Unreliable Estimates

The HFR Filing cost estimates are flawed due to their reliance on worst-case assumptions that are inconsistent with NextNav's proposal. Additionally, the HFR Filing does not distinguish between toll gantry readers and toll transponders. In tolling systems, transponders and gantry readers play complementary roles. Gantry-mounted toll readers, whose antennae are typically positioned overhead at toll plazas or along highways, communicate wirelessly with toll transponders using licensed spectrum in the Lower 900 MHz band. Toll transponders are small devices, such as EZ-Pass transponders, that are installed in vehicles. Toll transponders emit identification signals when they are interrogated by toll readers. When a vehicle passes beneath a gantry, the system identifies the toll transponder, records the vehicle's passage, and charges the appropriate toll. Below we discuss why there is a zero to minimal cost of NextNav's proposal to either toll readers or toll transponders used in the tolling industry.

1. Dependence on Extreme Assumptions Lead to Incorrect Cost estimates

Specifically, the HFR submission assumes that if NextNav's proposal were adopted, current users of the Lower 900 MHz band would be forced to do one of the following: (1) suffer interference and relocate into a narrower frequency range within the Lower 900 MHz band; (2) relocate to a spectrum band outside the Lower 900 MHz band; or (3) discontinue operations altogether. NextNav has never suggested that tolling operators be forced to suffer interference, relocate out of the band or discontinue operations. Rather, NextNav has consistently and repeatedly stated on the record that it is committed to working "with non-M-LMS licensees operating systems in the Lower 900 MHz band to develop coexistence solutions."[30]

Tolling operators can continue to operate in the Lower 900 MHz band on the same frequencies or retune toll readers to nearby frequencies in the band without replacing equipment. To the extent that coexistence requires retuning and other equipment-related costs, NextNav has committed to reasonable accommodations, including financial and technical support, that contribute to a smooth transition to an optimized lower 900 MHz band plan.

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[30] *See*, "Comments of NextNav Inc." filed :In the Matter of Promoting the Development of Positioning, Navigation, and Timing Technologies and Solutions," FCC, WT Docket No. 25-110, April 28, 2025, p. 22,https://www.fcc.gov/ecfs/document/10428207122908/1,

2. Toll Reader Costs are Likely to be Minimal

According to the International Bridge, Tunnel & Turnpike Association ("IBTTA"), the common electronic tolling frequencies are concentrated around 915 MHz.[31] As IBTTA noted, "NextNav seems to be avoiding direct conflict with the 915 MHz spectrum used today by US toll operations."[32] Therefore the impact of 5G operations should be minimal, if any.

In terms of potential interference, for instance from signal bleed, their survey found that only 7% of the deployed equipment face no risk of interference from the proposed slight reconfiguration of the licensed portion of the Lower 900 MHz band.[33] Additionally, a majority of electronic toll collection ("ETC") systems—including multi-protocol toll readers—are already designed with spectral agility and can coexist with minor regulatory adjustments or operational separations. In addition, an IBTTA report shows that 96% of the deployed toll readers support multiple protocols.[34] There are three major tolling protocols – TDM, 6C and SeGo.[35] The frequencies over which the TDM protocol operates (concentrated around 915 MHz) do not overlap with 5G and thus should not require any change in operations. 6C and SeGo can support multiple channels and can tune to a specific channel.[36] We understand that for these protocols, any deployed toll reader equipment that experiences interference from 5G operations, could be retuned. From the IBTTA report we know that at least 43% of the toll readers have a current maintenance and retuning schedule, and 21% are unsure about a set schedule.[37] Thus the toll readers already on a retuning schedule should not be considered in the cost estimate. This implies that only 53% of all

[31] *See*, IBTTA, "Proposed Reorganization of the Lower 900 MHz Band: Issues and Implications for Tolling from the NextNav FCC Petition," IBTTA Spring 2024 Board of Directors Meeting., June 7, 2024, p. 2, https://www.ibtta.org/sites/default/files/documents/2024/900-MHz-Survey-2024-0605-0736.pdf, ("IBTTA 2024 BOD Presentation").

[32] *See*, IBTTA 2024 BOD Presentation, p. 2.

[33] *See*, IBTTA 2024 BOD Presentation, p. 9.

[34] *See*, IBTTA 2024 BOD Presentation, p. 7.

[35] *See*, Mark Muriello, "Electronic Tolling Interoperability: Setting the Record Straight and Preparing for the Future," IBTTA, June 16, 2022, accessed June 18, 2025, https://www.ibtta.org/insights/electronic-tolling-interoperability-setting-record-straight-and-preparing-future#:~:text=IBTTA%20encourages%20the%20long%20view,and%20user%2Dbased%20project%20finance, ("IBTTA - Electronic Tolling Interoperability").

[36] *See*, Kapsch Traffic.com, "Janus Multi-Protocol Reader 2.4," March 6, 2023, https://www.kapsch.net/_Resources/Persistent/25e33ef1ad08d3409f3ee7f6b1bca50609e710aa/Janus_MPR_2.4_Manual.pdf.

[37] *See*, IBTTA 2024 BOD Presentation, p. 7.

toll readers may have to be retuned.[38] This would cost significantly less than replacing or retuning all of the equipment.

3. Claims of Lost Revenue Are Severely Flawed

The HFR Filing's claims about lost tolling revenue rely on unsupported assertions about the likelihood, speed and scale of any service degradation, and a failure to recognize ordinary course of business replacement and upgrade cycles and existing alternative technologies.[39] It first assumes disruption, contrary to the technical discussion of tolling technologies above, and then presumes that if tolling systems were disrupted, the industry would rely on Automated License Plate Recognition ("ALPR") systems alone, resulting in major revenue leakage.

However, even if one were to set aside NextNav's coexistence commitments to licensees and estimate potential lost tolling revenue, the calculation would need to account for factors such as availability of alternative technologies, technological obsolescence, standard refresh cycles, and the broader context of ongoing system upgrades—rather than assuming static or isolated equipment replacement needs. The HFR filing does not specify these effects, let alone quantify any of these costs. Below, we briefly discuss the flaws in the HFR Filing's claims of lost revenue. These flaws make any lost revenue claim by the HFR Filing unreliable.

The HFR Filing does not discuss the multiple technologies that are used today for electronic tolling. To electronically toll a vehicle, a toll agency must detect the vehicle's passage at a tolling point, gather identifying information to link it to the vehicle owner or driver, and facilitate payment collection. When a vehicle is registered with an account at the toll agency, various technologies can be used to recognize the vehicle and associate it with the corresponding account.[40] Generally, tolling agencies already deploy ALPR as a fallback method, and it is complemented by built-in business rules and enforcement protocols that limit revenue loss.[41] The broader adoption of ALPR technology—driven by the shift from gated toll plazas to open

[38] Calculation: 53% = (.93 * (1-.43))*100% where .93 reflects the 93% of equipment that may face the risk of interference according to the IBTTA report cited in the text.

[39] *See*, HFR Filing, p. 18.

[40] *See,* Federal Highway Administration, "Nationwide Electronic Toll Collection Interoperability," U.S. DOT, Publication No. FHWA-HOP-21-023, March 2021, p.25, https://ops.fhwa.dot.gov/publications/fhwahop21023/fhwahop21023.pdf, ("FHWA Nationwide Electronic Toll Collection Interoperability Study").

[41] See, HFR Filing, p. 18.

road tolling ("ORT") and all-electronic tolling ("AET")—enables agencies to identify vehicles using license plate images rather than relying solely on transponder readings.[42]

The HFR Filing claims that while the ALPR accuracy is in the mid-90% range, the revenue collection is much lower due to "business leakage throughout the invoicing and collections process," and assumes that "transponder-based revenue transactions were to fall from today's 80% to a range of 50%-70% due to harmful interference."[43] But these claims do not withstand scrutiny.

Once again, the HFR Filing bases its estimates of extreme assumptions that are unsupported by evidence. The HFR Filing assumes that under the NextNav proposal, all toll transponder transactions would need to be replaced by ALPR for a period of time, and then calculates a five-year revenue loss based on that premise. This assumption is fundamentally flawed. The filing entirely overlooks the fact that currently-deployed toll readers and toll transponders can coexist with 5G, and that even if certain toll readers require retuning, we understand that such adjustments could be implemented through intermittent lane closures (even just overnight ones)—without requiring a full-scale shift to ALPR technology over the next five years. It is also highly unrealistic to suggest that the transition would take five years or that ALPR would become the sole method of toll collection during that period. Similar to the current practice, we understand that ALPR can continue its fallback role and supplement the main toll reader system.

4. Claims of Consumer Disruption Are Overstated

The HFR Filing states without evidence that implementing NextNav's proposal would necessitate deploying new software—and, in some cases, entirely new hardware—across hundreds of millions of devices, including all consumer toll transponders. The Filing further claims that such a transition would span multiple years, with no clear timeline for completion, and would cause substantial consumer disruption.[44]

The extreme assumption of replacing hardware and new software installation is incorrect as tolling-related devices (both toll readers and toll transponders) either are using frequencies which do not overlap with the proposed 5G channels or could be retuned if necessary (toll readers). Therefore, a large-scale toll reader and toll transponder transition is not necessary for the TDM devices. For other protocols such as Passive 6C or SeGo, which currently have limited deployment compared to TDM, retuning of toll readers could be easily implemented at a very

[42] *See*, FHWA Nationwide Electronic Toll Collection Interoperability Study, p.4.

[43] See, HFR Filing, p. 18.

[44] *See*, HFR Filing, p. 19.

low cost, and we understand that no transponders will need to be replaced since toll reader retuning alone will ensure these transponders operate correctly. In addition, actual examples in the industry in transitioning between tolling systems show that the consumer cost may not be as significant as those claimed by the HFR Filing. For instance, experiences from the transition to cashless tolling systems, including on the Illinois Tollway, demonstrate minimal service disruptions and no sustained revenue loss on the scale projected by the HFR Filing.[45] Additionally, if we factor in the lifecycle replacement pattern, the costs would be even lower.

It is also worth noting that IBTTA itself has stated that "[t]oll transponders and today's tolling protocols are only an interim bridge to a future that will migrate to new vehicle communications capabilities. V2X and 5G/6G technologies will render RFID toll transponder protocols obsolete in the future."[46] Asserting uncertainty in the Lower 900 MHz ecosystem and claiming significant disruption to consumers while simultaneously positioning the future of tolling elsewhere appears somewhat inconsistent.

The HFR Filing also makes unsupported claims about purported loss of service quality and performance, consumer disruption costs and the impact of uncertainty on the 900 MHz ecosystem.[47] While the HFR Filing suggests that the degradation would lead to persistent operational inefficiencies and additional hidden costs to businesses and consumers over time, it fails to provide any facts or analysis to support those assertions.

5. Additional Cost Claims are Not Supported by Evidence

In a slide presentation provided in the course of meetings with FCC officials, purporting to summarize the HFR filing, slide 6 lists "additional costs" including higher financing costs, time lost, increased emissions, and more traffic accidents and fatalities as a result of disruptions to electronic tolling operations.[48] No supporting evidence is provided for the claims, and they are not substantiated within the HFR Filing itself. For instance, on the traffic flow issue, the HFR Filing states that the non-M-LMS services that support electronic tolling "substantially improve traffic flow, reduce traffic congestion, and reduce traffic accidents" and save travel time.[49] However,

[45] See, Toll Road News, "Illinois Tollway: Cashless Tolling Here To Stay Following Successful Shift During Covid-19 Pandemic," February 25, 2021, https://tollroadsnews.com/mailbag/illinois-tollway-cashless-tolling-here-to-stay-following-successful-shift-during-covid-19-pandemic/

[46] *See,* IBTTA - Electronic Tolling Interoperability.

[47] *See*, HFR Filing, pp. 17-18.

[48] See, HFR *Ex Parte*, p. 6.

[49] *See*, HFR Filing, p. 10.

this comparison is against cash transactions at toll booths. Given that one alternative would be to more heavily rely on ALPR technology, as argued by the HFR Filing, has similar characteristics to toll readers and transponders for all the features responsible for smoother traffic flows, there should be minimal impact on time savings, congestion, or accident rates. However, it is worth reiterating that the fallback to ALPR is a strawman that has been set up without any evidence that the tolling industry will need to use this technology as a result of the NextNax proposal.

D. Costs Do Not Account for Technological Obsolescence or Budgeted Replacement Cycles

The HFR Filing treats all estimated costs as incremental, ignoring ongoing capital refresh, lifecycle management, and technological obsolescence, in addition to the relatively modest updates required to ensure coexistence described above, which would consist primarily of retuning existing tolling readers if necessary. Setting that aside, advancements in technology will also inevitably lead to the replacement of the existing installed base of licensed tolling transponders in the Lower 900 MHz band in the next 5 – 10 years regardless of any band reconfiguration.[50] Ignoring this technological obsolescence and budgeted infrastructure upgrade cycles significantly overstates costs.

1. Technological Obsolescence is Not Considered

Before discussing the estimates of cost, it is important to recognize that the current toll reader and toll transponder technology is unlikely to represent the future of tolling. According to the IBTTA itself, advancements in vehicle-to-infrastructure ("V2X") communication and next-generation 5G/6G connectivity are expected to make today's tolling transponders obsolete, in favor of direct, in-vehicle tolling systems.[51] Taking a long-term perspective, as more vehicles become 5G-enabled, reliance on current toll reader and toll transponder will naturally decline over time. By contrast, the HFR Filings estimates do not consider technology improvements and are based on needing to completely replicate the current ecosystem.

[50] Many toll agencies will proactively swap out units around the 8–10 year mark to prevent failures – E-ZPass Maryland, for instance, mails free replacements for transponders older than 8 years. *See*, DriveEZMD, "E-ZPass Maryland Transponder Replacement Program," accessed June 17, https://driveezmd.com/acct-types/transponder-swap-program/#:~:text=E,as%20soon%20as%20it%20arrives.

[51] *See,* IBTTA - Electronic Tolling.

2. Lifecycle Refresh Cycles and Technology Upgrades for Toll Readers and Transponders Are not Considered, Leading to Inflated Cost Estimates, Which Should Be Zero or Near Zero for Transponders

The HFR Filing estimates that all toll transponders that are in use today would need to be replaced, but it omits technical considerations that negate the need to replace transponders and also the reality of lifecycle refresh cycles, and technology upgrades.[52] Note, as we have discussed earlier, a large segment (half or more) of toll transponders uses TDM technology (*e.g.* E-ZPass) whose frequencies do not overlap with the proposed 5G frequencies and therefore will not need to be replaced.[53] In addition, neither Passive 6C nor SeGo toll transponders will need to be replaced since toll reader retuning alone will ensure these transponders operate correctly. Thus, there may be some very limited cost associated with tolling transponders for edge cases. At the same time, advancements in transponder technology will inevitably lead to the replacement of the existing installed base in the next 5 – 10 years. The HFR Filing does not properly account for how toll transponders operate or the natural replacement cycle, and thus its projected replacement costs are significantly overstated.

3. Budgeted Infrastructure Upgrade Cycles for Tolling Infrastructure Are Not Accounted for Leading to Incorrect Cost Estimates

The HFR Filing also omits any consideration of already anticipated infrastructure replacement cycles, budgeted upgrades and equipment depreciation.[54] Tolling infrastructure is not static; rather, it evolves with ongoing planned capital investment. Toll readers and back-office systems are subject to regular replacement schedules, often spanning 5–10 years. A more accurate representation of tolling system economics requires looking at real-world agency experience. As reported in capital improvement plans by agencies such as the New Jersey Turnpike Authority ("NJTA") and the Metropolitan Transportation Commission ("MTC"), scheduled hardware and

[52] *See*, HFR Filing, p. 17.

[53] The HFR Filings states that there are 120 million transponders in operation in the U.S. today. Of these at least 60 million are E-ZPass transponders that use TDM and will face no interference from the 5G operations. *See*, HFR Filing, p.20. *See also*, E-ZPass Group, "E-ZPass Statistics: 2005 – 2022," accessed July 14, 2025, https://www.e-zpassiag.com/about-us/statistics.

[54] *See*, HFR Filing t, p. 17.

software upgrades are a routine part of toll operations.[55] For instance, in 2022, TransCore was awarded $1.1 billion for modernization of New Jersey's tolling infrastructure and replacing the current tolling infrastructure with a modernized system.[56] In January 2025, MTC earmarked $341 million in its budget for "electrical and mechanical systems, operational improvements, open-road tolling equipment and other projects."[57] Therefore, any equipment costs that overlap substantially with these scheduled updates should be discounted entirely. Additionally, expected, but not yet scheduled, upgrades should also be taken into account. Governments invest substantial resources in infrastructure upgrades, including electronic tolling systems. Since these upgrades occur on a regular schedule, they should be factored into any estimates of replacement costs.

E. Fundamentally Flawed Conclusion Drawn from a Revealed Preference Argument

The HFR Filing argues that the "revealed preferences of current users of the Lower 900 MHz that are spread throughout the Lower 900 MHz band are that the current configuration of the band is preferable to operating in just the 907-918 MHz portion or to leaving the band entirely."[58] This assertion is not a reliable indicator of optimal spectrum use or true user preferences in the face of constrained choices. It is important to note that devices operating in the Lower 900 MHz band did not choose their current configuration; rather, they are operating within the band plan that was made available to them. The current distribution of users may reflect path dependence and limited flexibility, not genuine preference for the current band configuration. Thus, rather than interpreting the present distribution as a sign that the existing configuration is "preferable," it should instead be seen as a reflection of legacy constraints.

[55] *See*, Jane Edwards, "TransCore Awarded $1.1B in New Jersey Toll Infrastructure Modernization Contracts ," ExecutiveBiz, November 16, 2022, accessed June 16, 2025, https://executivebiz.com/article/transcore-get-1-1b-in-new-jersey-toll-infrastructure-modernization-contracts, ("TransCore Awarded $1.1B"). *See also*, Metropolitan Transportation Commission, "Tolls Fund Bridge Maintenance, Upgrades for Drivers, Transit Riders," January 21, 2025, accessed June 16, 2025, https://mtc.ca.gov/news/tolls-fund-bridge-maintenance-upgrades-drivers-transit-riders?," ("Tolls Fund Bridge Maintenance, Upgrades for Drivers, Transit Riders").

[56] *See*, TransCore Awarded $1.1B.

[57] *See*, Tolls Fund Bridge Maintenance, Upgrades for Drivers, Transit Riders.

[58] *See*, HFR Filing, p. 19.

IV. Conclusion

The proposed slight reconfiguration of the licensed portion of the Lower 900 MHz band presents an important and timely opportunity to put spectrum to its highest and most socially valuable use. Our analysis confirms that the proposed plan to enable 5G and resilient GPS backup services in this band meets that standard. The benefits, including a robust GPS backup and tens of billions of dollars in consumer surplus from enhanced wireless services, far exceed the costs, which are modest, manageable, and vastly overstated by opponents.

Critics of the proposal, most notably the HFR Filing, rely on flawed methodologies that exaggerate transition costs while overlooking or undervaluing key categories of benefit. For instance, the failure to assign any value to a terrestrial GPS backup system ignores the widespread dependence on GPS across nearly every sector of the economy, as well as the catastrophic implications of even short-term disruption. Similarly, dismissing the benefits of low-band spectrum for 5G disregards well-established findings that mobile broadband produces consumer surplus many times greater than its market price.

The economic analysis presented in the HFR Filing suffers from flaws that render its cost conclusions unreliable and its policy implications misleading. Chief among the issues is a complete disregard for the potential of coexistence, a failure to distinguish between the nature of licensed and unlicensed devices, reliance on unrealistic cost assumptions, and the omission of fundamental economic principles such as capital replacement, asset depreciation, and technological adaptability.

The cost assumptions presented in the HFR Filing rely on worst-case scenarios that do not reflect either the technical realities of the band or the commitments made by proponents. NextNav has publicly committed to working with incumbent licensed users to develop coexistence solutions, including reasonable financial and technical support that contributes to a smooth transition to an optimized band plan. Unlicensed devices, meanwhile, are designed for opportunistic use and coexistence, and NextNav's technical studies confirm that 5G operations in the band will not cause unacceptable levels of interference to unlicensed devices, which can continue to operate across the entire band.

The HFR Filing also fails to consider standard industry practices such as equipment refresh cycles and technological obsolescence. Many of the unlicensed devices will likely be upgraded in the

next 3 – 5 years as part of their normal replacement cycle, and licensed systems cited are due for upgrades within the next 5 to 10 years. As such, the transition to an optimized band configuration would align with pre-planned capital expenditures and should not be treated as an entirely new or extraordinary burden. By omitting this critical context, cost projections lose credibility and mislead stakeholders about the true implications of the band reconfiguration. Just as significantly, the argument that current use of the band reflects optimal use fails under scrutiny. Users have not "chosen" the existing band plan—they have adapted to it as presented.

Thus, slightly reconfiguring the licensed portion of the Lower 900 MHz band offers substantial net benefits. Maintaining the current M-LMS command-and-control framework imposes a significant opportunity cost by preventing more efficient uses of spectrum. In contrast, the costs of reconfiguration are modest—licensed tolling users can continue to use or retune existing toll readers and toll transponders and have been offered financial and technical support to ease the process. For unlicensed users, reconfiguration imposes zero cost. The consumer benefits from this shift are immense, totaling in the tens of billions of dollars, and the advantages are long-lasting, extending across multiple sectors and enhancing national security. Therefore, in keeping with long-standing principles of spectrum policy—and grounded in empirical evidence and economic modeling—the case for expedited reconfiguring of the Lower 900 MHz band is compelling. It presents a clear and timely opportunity to serve the public interest and improve the long-term efficiency of U.S. spectrum utilization.

Appendix A: Technical Reply to the Criticisms Raised in the HFR Filing

The HFR Filing levels two primary criticisms against the Brattle analysis and we address each of these below.

A. Measurement of Military Value

The HFR Filing claims that *"The Brattle Group report and supplemental report have conceptual flaws including a measurement of military value associated with a backup GPS system on a global basis even though the NextNav proposal is for a U.S. based system without global reach."*[59]

While the HFR Filing alleges that the Brattle study contains "conceptual flaws," it fails to substantiate this claim with detailed analysis or concrete examples. The report offers only a single example—one that is demonstrably incorrect. As noted above, the HFR Filing claims that the Brattle military value associated with a backup GPS system estimate is a global value, although the NextNav solution will provide a terrestrial GPS backup within the U.S. We explicitly account for this in the Brattle Report. We only assign half of the M-code GPS military OCX control system cost to the U.S., expressly limiting the value to domestic benefits: "…we assume a 50 percent allocation of the cost to U.S. operations."[60]

In fact, the use of this M-Code OCX cost proxy and the 50% discount makes the Brattle estimates conservative in several ways. Instead of attempting to quantify the full military value of a terrestrial GPS backup (which would involve speculative assessments of mission-critical applications), the Brattle Report's discounted estimate likely understates the actual benefit since the U.S. DoD funds global systems primarily for national interests. Brattle's estimate does not include benefits that the military may derive from encrypted terrestrial signals in GPS-denied or urban canyon environments where satellite coverage is intermittent, or the strategic deterrence value from a terrestrial resilient PNT redundancy. By focusing only on the DoD's OCX investment, the Brattle report deliberately omits more speculative—but real—categories of value that could push military benefits much higher. Additionally, given the current global environment, if

[59] *See*, HFR Filing, FN 95, p. 21.

[60] *See*, Brattle Report, Section III, p. 29.

geopolitical risk were incorporated more dynamically (*e.g.*, with a higher probability weighting of GPS outage in military theaters), the military value of a backup would likely rise considerably.

In sum, the Brattle report's military benefit estimate is conservative because it uses a lower-bound proxy (OCX cost) rather than a full-spectrum valuation, it discounts this value by 50% to account for the use of the technology on the 5G network within the U.S. borders based on NextNav's domestic deployment, it ignores substantial classes of direct and indirect defense benefits, it excludes strategic, deterrence, and operational resilience factors, and it does not apply upward adjustments for the current or expected threat environment.

B. Estimating Geo-Spatial Overlap

The second criticism raised by the HFR Filing against the Brattle report concerns the issue of geospatial overlap. The HFR Filing claims that "*some of its technical assumptions appear to be incorrect such as the assumed geospatial overlap*."[61]

We assume that since NextNav's PNT solution is going to be integrated with one or more partners' 5G network, it will benefit various sectors only in the areas where the 5G network is available.[62] We use current 4G network coverage to proxy the reach of 5G networks in the near future.[63] The overlap percentages we use in the report are as follows.

- For agriculture there is a 98.8% overlap between farmland and the 4G LTE network, and we use this percentage as an initial adjustment to the value of NextNav's PNT solution for the agricultural sector before further adjusting for seasonality and requirements for precision agriculture.[64]

- For maritime the overlap between navigable waterways and the 4G LTE network is 49.3% and the value of NextNav's PNT solution is adjusted by this percentage overlap, *i.e.*, the value is reduced by 50.7%.[65]

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[61] *See*, HFR Filing, FN 95, p. 21.

[62] *See,* Brattle Report, p. 24.

[63] *See,* Brattle Report, p. 24.

[64] The agricultural adjustment ultimately is 6.39%, *i.e.* a reduction of 93.61%. This accounts for the cropping season adjustment and the more limited use of the NextNav technology, *i.e.* it cannot be used for high-precision agriculture. *See*, Brattle Report, p. 24 and FN, 70.

[65] *See,* Brattle Report, Appendix B, Table B1.

- For telematics, we estimate that the overlap between the 4G LTE network coverage and roads is 92.1% and use this to adjust the value, *i.e.*, we reduce the value by 7.9%.[66]

- For the remaining sectors, we estimate the overlap between 4G LTE coverage and the total U.S. land is 72.7% and adjust the value estimates accordingly, *i.e.*, we reduce the value by 17.3%.[67]

It is worth noting that the overlap adjustments may be conservative for certain sectors. For example, in the case of location-based services, the use of NextNav's PNT solution is likely to be concentrated in populated areas—*i.e.*, areas where 4G LTE coverage is 99% or higher. Nonetheless, we apply a uniform area-based overlap adjustment that implicitly assumes the location-based services are as likely to be used in rural Montana as in New York City, reducing values by 72.7%.

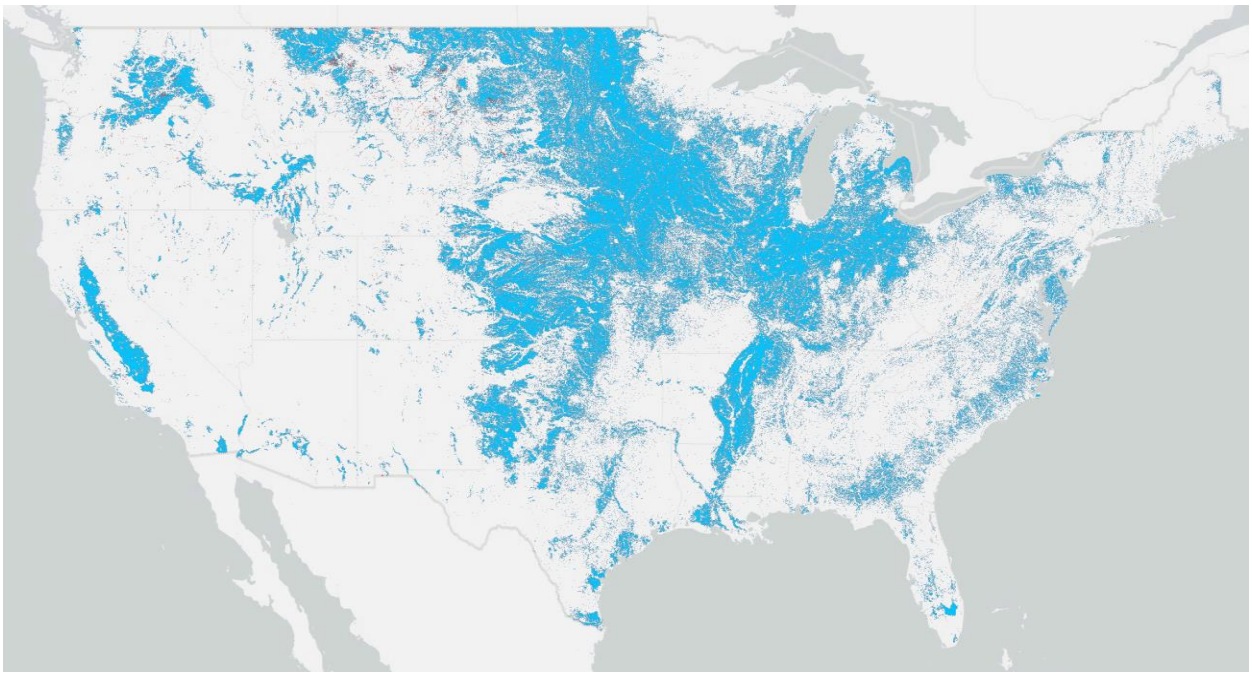
Without specific details about what aspects of our overlap assumptions are claimed to be incorrect, it's difficult to respond directly to these criticisms from the HFR Filing. In this report we provide the overlap maps and charts (Appendix B) to help visualize the overlap coverage areas to help clarify our methodology and provide a transparent basis for evaluation.

[66] *See,* Brattle Report, Appendix B, Table B1.

[67] *See,* Brattle Report, Appendix B, Table B1.

Appendix B: Geo-Spatial Overlap Maps and Charts

A. Overlap of Farmland and the 5G Network



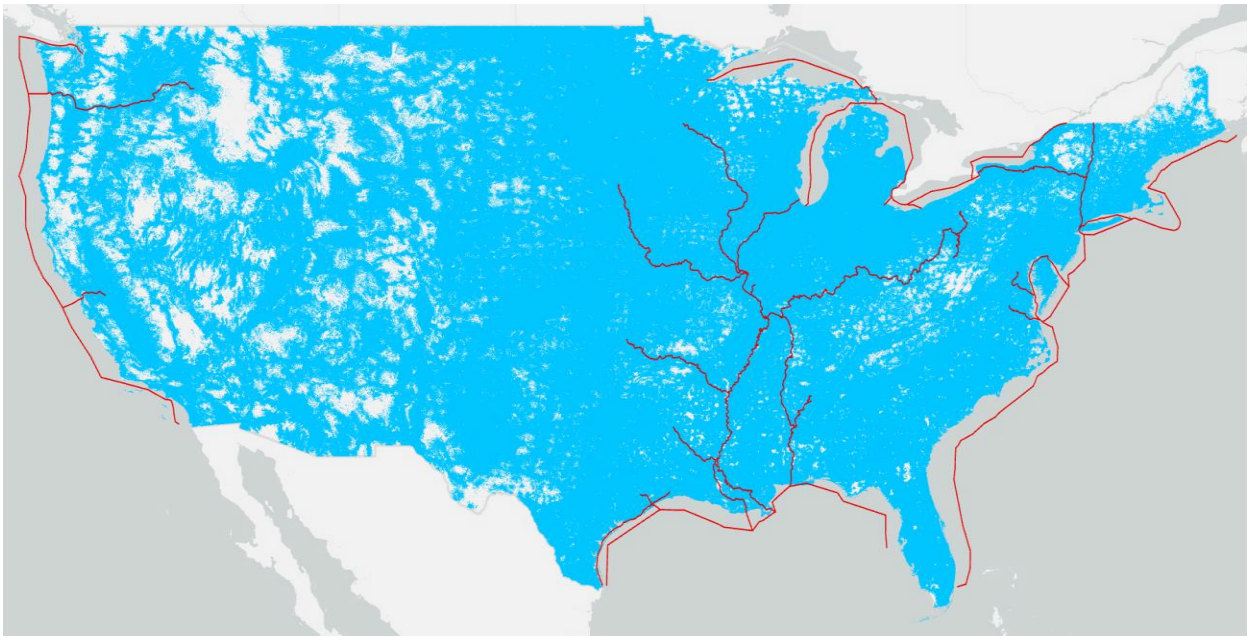
Sources and Notes

The blue denotes the overlap areas between the 5G network and the farmland. The grey denotes the farmland areas not covered by the 5G network.

To obtain this overlap, we overlay the 4G network geospatial data obtained from the FCC's Broadband Data Collection (BDC) as of December 2023 with farmland data from the U.S. Department of Agriculture (USDA) to obtain an estimate of the percentage of farmland covered by 4G. We use current 4G network coverage to proxy the reach of the 5G networks in the near future. We note that the BDC 4G-LTE broadband coverage reporting requirements are 5 Mbps downlink and 1 Mbps uplink, which are much higher than required for PNT requirements. The BDC coverage maps underestimate potential PNT areas. Nonetheless, we conservatively find that 98.8% of farmland is covered by the current 4G network. Note that using the December 2024 data would show a higher percentage overlap.

Sources: National Agricultural Statistics Service and Agricultural Research Service, U.S. Department of Agriculture, "USDA CroplandCROS Cropland Data Layer," data as of 2023, https://croplandcros.scinet.usda.gov/, ("USDA Cropland Data Layer"). *See also*, FCC, "Broadband Map: Mobile," available as of December 31, 2023, https://broadbandmap.fcc.gov/area-summary/mobile?version=dec2023&zoom=4&tech=tech4g&env=0. For information on the FCC's BDC data, *see*, FCC, "Broadband Data Collection: Specifications for Data Downloads from the National Broadband Map," June 28, 2024, https://us-fcc.app.box.com/v/bdc-data-downloads-output.

B. Overlap of Maritime waterways and the 5G Network



Sources and Notes

The blue denotes the 5G network coverage (as proxied by the current 4G coverage). The red lines denote the navigable waterways. As seen in the map, portions of the Great Lakes and the portion of oceans counted under the maritime waterways (for example, in the Gulf of Mexico) are not covered by the 5G network.

For the maritime sector, we overlay the 4G network geospatial data obtained from the FCC's Broadband Data Collection as of December 2023 with waterways mapping data from the U.S. Department of Transportation. We find that 49.3% of waterways are covered by the 4G network.

Sources: U.S. Department of Transportation Maritime Administration, "United States Marine Highway Routes," last updated January 31, 2024, https://www.maritime.dot.gov/grants-finances/marine-highways/us-marine-highway-program-routes-map See also, FCC, "Broadband Map: Mobile," available as of December 31, 2023, https://broadbandmap.fcc.gov/area-summary/mobile?version=dec2023&zoom=4&tech=tech4g&env=0. For information on the FCC's BDC data, see, FCC, "Broadband Data Collection: Specifications for Data Downloads from the National Broadband Map," June 28, 2024, https://us-fcc.app.box.com/v/bdc-data-downloads-output.