An Economic Analysis of NextNav's Proposal for the Reallocation of Spectrum and the Modification of Rules in the Lower 900 MHz Band

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Executive Summary

NextNav, Inc. (NextNav) has filed a Petition for Rulemaking with the Federal Communications Commission (FCC) that seeks to reconfigure the 902 MHz to 928 MHz frequency range (the "Lower 900 MHz band") to support a high-power terrestrial license and terrestrial positioning, navigation, and timing (PNT) network.[1] FCC Rules for the Lower 900 MHz have been in place for decades during which hundreds of millions of devices have been deployed in the band. In addition to NextNav's current PNT operations, the Lower 900 MHz currently supports a diverse ecosystem of critical services, including: military operations; industrial, scientific, and medical (ISM) devices; electronic toll collection and other traffic management applications licensed under Part 90; hundreds of thousands of licensed Part 97 amateur radio operators; as well as hundreds of millions of unlicensed Part 15 devices.

NextNav requests dramatic rule changes that would allocate 15 megahertz of Lower 900 MHz band spectrum for high-power 5G broadband (a 5-megahertz uplink at 902-907 MHz and a 10-megahertz downlink at 918-928 MHz). NextNav argues that such a reorganization is necessary to support terrestrial PNT as an economically viable backup solution for GPS. In support of its position, NextNav filed an economic report prepared by the Brattle Group that estimated the value of the new terrestrial PNT network to be $14.6 billion.[2] NextNav subsequently filed a supplement to the economic report prepared by the Brattle Group to address various criticisms on the record.[3]

This analysis considers the economic implications of the NextNav proposal and (1) estimates the costs associated with the proposal; (2) observes that NextNav's current PNT offering, which it touts as a backup for GPS, and other alternative PNT solutions outside of the Lower 900 MHz band reduces the potential economic benefits of the proposal; and (3) assigns a lower value to the proposed creation of a new 15-megahertz channel. This analysis concludes that NextNav's proposed re-banding provides *no net economic benefit* to the American people. Instead, this study concludes that the costs to the nation far outweigh any possible benefits.

The Costs of the NextNav Petition Are High.

It is important to consider the costs of the NextNav proposal as well as its benefits. NextNav is far from the only licensee or user of the Lower 900 MHz band. In fact, this band is heavily used by both licensed and unlicensed incumbents and these operations produce enormous economic benefits for the country. The NextNav proposal would dramatically change the Lower 900 MHz band to the detriment of consumers and businesses that have relied on the availability of a wide range of services in the band. Current users would be forced to do one of the following: (1) suffer

[1] NextNav Petition for Rulemaking, WT Docket No. 24-240, Apr. 16, 2024 (NextNav Petition); see also NextNav, "Rules Supplement to NextNav Inc. Petition for Rulemaking," June 7, 2024 (NextNav Rules Supplement).
[2] Coleman Bazelon and Paroma Sanyal, Brattle Group, "Public Benefits of Reconfiguring the Lower 900 MHz Band to Support a Backup and Complement to GPS," (2024) (Brattle Group Study).
[3] Coleman Bazelon and Paroma Sanyal, Brattle Group, "Brattle Supplemental Report: Public Benefits of Reconfiguring the Lower 900 MHz Band to Support a Backup and Complement to GPS." (2025).

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.

Accordingly, the NextNav proposal would result in substantial economic costs, including retuning or replacing systems across the nation and hundreds of millions of devices. While a precise measure of consumer harm is not available, the cost to retune and to replace Part 15 devices—such as the RFIDs that underlay warehouse and fulfillment centers, alarms and security systems, and lighting and electrical systems—alone is estimated at between $27 and $33 billion. Furthermore, electronic tolling systems that generate more than $23 billion in revenue annually would suffer substantial reductions in system performance, resulting in lost revenues for states and the disruption of tolling services on the nation's highways. The cost associated with replacing tolling transponders, upgrading roadside facilities, and subsequent revenue leakage would be at least $6.8 billion.

Other costs associated with the dislocation of the NextNav proposal include: (1) costs of replacing equipment for the millions of devices using the band other than those described above; (2) reductions in the quality of service for these devices in the Lower 900 MHz band; (3) the high costs of offering services; (4) the unavailability of alternative bands for certain services, such as electronic tolling; (5) the certainty of near-term consumer disruption; and (6) the uncertainty of the availability of technological solutions to address harmful interference or operate in a smaller frequency range. **Taken together, this study estimates that direct and indirect costs will amount to many tens of billions of dollars.**

NextNav's Proposal Results in Few Benefits.

In contrast, few economic benefits result from NextNav's proposal. Importantly, it is inappropriate to assume that realizing the value to the country of having a GPS backup solution requires the FCC to grant the proposal for two reasons. First, the FCC's existing 900 MHz rules already permit NextNav to build such a system and it has begun doing so. As NextNav attests in SEC filings, its existing system, TerraPoiNT, is a "terrestrially-based network" that "offers positioning [and] navigation" with capabilities to serve "as a more robust primary solution or as a backup in the event of GPS disruptions."[4] Second, NextNav is not the only viable option as a GPS backup. At least a dozen competitive providers other than NextNav can offer PNT services without the need to change rules in the Lower 900 MHz band. Consequently, the Brattle Group report's estimation and the supplemental report's further justification of the value of a backup PNT service is irrelevant to the NextNav Petition since backup PNT services can be made available without any rule changes. Accordingly, this factor should be dismissed and should not have an associated value in the benefit calculation.

The NextNav Petition's proposal to create a new 15-megahertz block of spectrum for commercial wireless, however, should be recognized as creating economic value. Based on comparable allocations, I estimate the value of the 15-megahertz frequency range to be in the range of

[4] NextNav Inc., Annual Report (Form 10-K), Mar. 13, 2024 (NextNav 2023 10-K).

$1.2-2.1 billion. However, this proposed new block is not internationally harmonized and does not line up with a 3GPP 5G NR band, which could decrease the value further.[5] Moreover, government stations and ISM devices would remain primary in the band, and these primary statuses would further diminish the value of the proposed new frequency range. Because I cannot quantify the effect of these factors, I have not further adjusted downward the value of proposed licenses.

Taken together, this study estimates an economic benefit associated with NextNav's proposal of no more than $1.2-2.1 billion, but estimates the economic costs of the NextNav proposal in the tens of billions of dollars. Therefore, the proposal's costs far outweigh its benefits, and this study concludes that the NextNav proposal is not in the public interest.

[5] For example, there is only 3 megahertz of downlink overlap between NextNav's proposal and the 900 MHz n8 band. See 3GPP TS 38.101-1, Table 5.2-1.

I. Introduction

NextNav, Inc. (NextNav) has made a proposal to the Federal Communications Commission (FCC) through a Petition for Rulemaking to reorganize the Lower 900 MHz band, from 902 MHz to 928 MHz.[6] The Wireless Telecommunications Bureau and the Office of Engineering and Technology of the FCC sought public comment on the NextNav proposal.[7] This paper considers the economic implications of the NextNav proposal.

Current FCC rules in the Lower 900 MHz band have been in place for decades, and American businesses and consumers have purchased and used hundreds of millions of devices that rely on the current rules. NextNav requests dramatic rule changes that include: (1) allocating 15 megahertz of spectrum for new high-power terrestrial license (a 5-megahertz uplink at 902-907 MHz and a 10-megahertz downlink at 918-928 MHz) with far greater power limits and interference protections for these new licensees than current rules afford; (2) converting its current licenses, which have less spectrum coverage, less geographic coverage, lower power limits, and less interference protection, into these new high-power terrestrial licenses; (3) shifting incumbent licensees and uses to the 907-918 MHz portion of the band—in between the proposed new high-power service's uplink and downlink; and (4) reducing interference protections for the remaining users in this part of the band.

NextNav is far from the only licensee or user of the Lower 900 MHz band—existing 900 MHz operations produce enormous economic benefits for the country. The NextNav proposal would dramatically change the Lower 900 MHz band to the detriment of consumers and businesses that have relied on the availability of a wide range of services in the band. In addition to NextNav, the Lower 900 MHz band is home to:

- Military and other federal operations;
- Industrial, scientific, and medical (ISM) devices;
- Licensed Part 90 non-multilateration location and monitoring service (non-M-LMS) devices, including electronic tolling licensees;
- Licensed Part 97 amateur radio operations;
- Unlicensed Part 15 devices, including hundreds of millions of industrial devices supporting the logistics, transportation, and medical industries, along with many others.

Incumbents in the band have demonstrated on the FCC record that they would be harmed by the significant changes NextNav seeks in the Lower 900 MHz band, due to the increased levels of interference that would result, and by the loss of usable spectrum inherent in the NextNav proposal. These users 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 band; or (3) discontinue operations.

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[6] NextNav Petition; see also NextNav Rules Supplement.
[7] FCC, DA 24-776, released Aug. 6, 2024.

This analysis examines the record and examines both the economic costs and benefits of NextNav's proposed band plan. First, in Section II, this analysis outlines both the international and domestic regulatory framework relevant to the Lower 900 MHz band given the significant incumbent uses in the band. Next, Section III estimates the cost of NextNav's proposal by examining the current services and devices that currently rely on the Lower 900 MHz band. Section IV then estimates the benefits associated with NextNav's proposal. After weighing the limited benefits against the significant costs, this analysis concludes that it would produce more costs than benefits and that it is not in the public interest to move forward with NextNav's proposal.

II. Background

The current Lower 900 MHz landscape reflects a combination of international allocations under the International Telecommunication Union (ITU), federal statutes, allocations between federal and non-federal users, and FCC rules. The Lower 900 MHz band spans the range from 902 MHz-928 MHz. The FCC's Table of Frequency Allocations[8] reflects both the ITU Region 2 spectrum allocation as well as the U.S. spectrum allocation for both federal and non-federal users.

A. ITU Region 2 Allocation

The NextNav petition should be considered not only in the context of FCC rules but also within the structure of ITU frequency allocations. The ITU Region 2 (including the United States) authorizes several services in the Lower 900 MHz band with footnotes 5.150 (radiocommunications services in this band must accept interference from ISM applications),[9] 5.325 (radiolocation as one of the primary allocations in the United States),[10] and 5.326.[11]

FIXED (primary)

Amateur

[8] FCC Online Table of Frequency Allocations, revised Jan. 31, 2025, available at https://www.fcc.gov/sites/default/files/fcctable.pdf (FCC Table of Frequency Allocations).

[9] "The following bands . . . [including] 902-928 MHz in Region 2 (centre frequency 915 MHz) . . . are also designated for industrial, scientific and medical (ISM) applications. Radiocommunication services operating within these bands must accept harmful interference which may be caused by these applications. ISM equipment operating in these bands is subject to the provisions of No. 15.13." Int'l Telecomm. Union [ITU] Radio Reg. 5.150, p.63 (2024), available at https://www.itu.int/pub/R-REG-RR-2024 (ITU Radio Reg.).

[10] "*Different category of service*: in the United States, the allocation of the band 890-942 MHz to the radiolocation service is on a primary basis (see No. 5.33), subject to agreement obtained under No. 9.21." ITU Radio Reg. 5.325, p. 102.

[11] "*Different category of service*: in Chile, the band 903-905 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis, subject to agreement obtained under No. 9.21." ITU Radio Reg. 5.326, p. 102.

Mobile except aeronautical mobile (fn 5.325A)[12]

Radiolocation

Under the ITU allocation, radiocommunications services, including radiolocation, are not primary and must accept interference from ISM applications.

B. U.S. Allocation

The U.S. Allocation is divided between federal and non-federal users. For federal users, the primary allocation is for radiolocation with footnotes US218 (Location and Monitoring Service (LMS) must accept interference from federal radiolocation services and from ISM),[13] US267 (geographic limitations on amateur radio transmissions),[14] US275 (amateur radio as secondary),[15] and G11 (federal radio services, both fixed and mobile, are allowed on a secondary basis).[16] Federal users include the Department of Defense and other federal agencies.[17] For instance, military and civilian agencies use the Lower 900 MHz band for sensitive wind profile radars to monitor severe weather conditions.

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[12] "*Different category of service*: in Argentina, Brazil, Costa Rica, Cuba, Dominican Republic, El Salvador, Ecuador, the French overseas departments and communities in Region 2, Guatemala, Paraguay, Uruguay and Venezuela, the frequency band 902-928 MHz is allocated to the land mobile service on a primary basis. In Mexico, the frequency band 902-928 MHz is allocated to the mobile, except aeronautical mobile, service on a primary basis. In Colombia, the frequency band 902-915 MHz is allocated to the land mobile service on a primary basis." ITU Radio Reg. 5.325A, p. 102.

[13] "The band 902-928 MHz is available for Location and Monitoring Service (LMS) systems subject to not causing harmful interference to the operation of all Federal stations authorized in this band. These systems must tolerate interference from the operation of industrial, scientific, and medical (ISM) equipment and the operation of Federal stations authorized in this band." FCC Table of Frequency Allocations, p. 313.

[14] "In the band 902-928 MHz, amateur stations shall transmit only in the sub-bands 902-902.4, 902.6-904.3, 904.7-925.3, 925.7-927.3, and 927.7-928 MHz within the States of Colorado and Wyoming, bounded by the area of latitudes 39° N and 42° N and longitudes 103° W and 108° W." FCC Table of Frequency Allocations, p. 319.

[15] "The band 902-928 MHz is allocated on a secondary basis to the amateur service subject to not causing harmful interference to the operations of Federal stations authorized in this band or to Location and Monitoring Service (LMS) systems. Stations in the amateur service must tolerate any interference from the operations of industrial, scientific, and medical (ISM) devices, LMS systems, and the operations of Federal stations authorized in this band. Further, the amateur service is prohibited in those portions of Texas and New Mexico bounded on the south by latitude 31° 41' North, on the east by longitude 104° 11' West, and on the north by latitude 34° 30' North, and on the west by longitude 107° 30' West; in addition, outside this area but within 150 miles of these boundaries of White Sands Missile Range the service is restricted to a maximum transmitter peak envelope power output of 50 watts." FCC Table of Frequency Allocations, p. 320.

[16] "Federal fixed and mobile radio services, including low power radio control operations, are permitted in the band 902-928 MHz on a secondary basis." FCC Table of Frequency Allocations, p. 381.

[17] "The Navy operates air search and surveillance radar systems onboard ships and aircraft carriers in this band. Radio wave propagation characteristics make the band ideal for the detection of fast-moving targets over water. The military agencies use this band for tracking radar systems for aeronautical flight-testing and to monitor the position of missiles, drones, and manned aircraft. Security systems used for perimeter protection and intrusion detection are operated by the military agencies. Military and civilian agencies operate wind profiler radars that monitor and provide warnings of severe weather conditions through the measurement of wind speed and direction at various altitudes. The Federal agencies also operate radio frequency identification (RFID) systems in this band used for container tracking and port security." NTIA, "902-928 MHz," available at https://www.ntia.doc.gov/files/ntia/publications/compendium/0902.00-0928.00_01MAR14.pdf (NTIA, "902-928 MHz").

For non-federal users, no use is listed in the table of allocations as either primary or secondary,[18] but four types of services are listed under the FCC rule parts:

Radiofrequency Devices (Unlicensed) (Part 15)

ISM Equipment (Part 18)

Private Land Mobile (Part 90)

Amateur Radio (Part 97).

Under the FCC non-federal allocation, radiocommunications services, including LMS, must accept interference from both federal applications and ISM applications.

C. Current FCC Rules

One of the first allocations of the Lower 900 MHz band was for unlicensed Part 15 devices in 1985.[19] Ten years later, in 1995, the FCC adopted rules for LMS in the Lower 900 MHz.[20] There are two types of LMS licensees in the Lower 900 MHz band: (1) exclusive spread-spectrum "multilateration" LMS (M-LMS), which can locate moving objects over a wide geographic area; and (2) and non-exclusive narrowband "non-multilateration" LMS (non-M-LMS), which transmit data at a particular point.

The original 1995 LMS rules, found in Part 90 of the FCC's rules, specified that LMS operations must "not cause interference to and must tolerate interference from [ISM] devices and radiolocation Government stations that operate in the 902-928 MHz band."[21] Furthermore, Section 90.353 provided that M-LMS licenses must "demonstrate through actual field tests that their systems do not cause unacceptable levels of interference to 47 CFR part 15 devices."[22]

Part 15 unlicensed devices continued to be authorized to use the Lower 900 MHz but were not afforded interference protection rights, and the FCC provided that such devices could not cause harmful interference to LMS licensees or other licensed systems.[23]

Section 90.361 further states: "These operations [Part 15 and Part 97] will not be considered to be causing harmful interference to a multilateration LMS system [under several circumstances]."[24] Under these circumstances, the rules effectively mean that M-LMS operations have little protection from Part 15 (unlicensed devices) and Part 97 (amateur radio) devices in those bands.

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[18] FCC Table of Frequency Allocations.
[19] Authorization of Spread Spectrum and Other Wideband Emissions Not Presently Provided for in the Commission's Rules and Regulations, 101 FCC 2d 419 (1985); FCC, FCC No. 89-103, released Apr. 18, 1989.
[20] 60 FR 15253, Mar. 23, 1995.
[21] Ibid.; 47 CFR 90.353(a).
[22] Ibid.; 47 CFR 90.353(d).
[23] Ibid.; 47 CFR 90.361.
[24] Ibid.

The FCC observes that there are two M-LMS licensees (NextNav's subsidiary Progeny and Telesaurus) and approximately 1,500 active non-M-LMS licensees, which are primarily used to operate electronic tolling systems as well as other traffic management applications.[25]

During the past 30 years, many Part 90 services, Part 97 services, radiolocation Government stations, and many Part 15 devices and services have deployed in the Lower 900 MHz band. Those services have developed in part because of the expectation of continuing rules protecting those operations from interference caused by other devices and services including M-LMS services.

The LMS rules, including 47 CFR 90.353, have been slightly modified several times by the Commission including in 1997,[26] 2007,[27] and 2010.[28] At the beginning of LMS operations, and at each subsequent instance of reviewing the LMS rules, the FCC has never altered the initial interference regimen for LMS operations:

1. LMS licensees do "not cause interference to and must tolerate interference from" Part 90 non-LMS systems and devices and radiolocation Government stations in the Lower 900 MHz band;[29] and
2. M-LMS licenses "will be conditioned upon the licensee's ability to demonstrate through actual field tests that their systems do not cause unacceptable levels of interference to 47 CFR part 15 devices."[30]
3. Effectively for many purposes, M-LMS licenses accept interference from Part 15 and Part 97 devices.[31]

Exhibit 2.1 presents a table summary of the various provisions of limitations on M-LMS licenses in the Lower 900 MHz band under current FCC rules.

D. NextNav's Proposed Changes to the FCC Rules in the Lower 900 MHz Band

The NextNav petition would dramatically change practically all rules that apply to the Lower 900 MHz band. The net effects would be to increase protection for NextNav's M-LMS licenses; reduce protection for all other incumbent operations; create a new 5-megahertz uplink band (902-907 MHZ) and a 10-megahertz downlink band (918-928 MHz) for a new nationwide 15-megahertz high-power terrestrial and TPNT license; and relegate remaining users of the Lower 900 MHz band to a narrower 907-918 MHz band. I summarize the proposed rule changes in Exhibit 2.2.

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[25] FCC, DA-24-776, p. 2.
[26] 62 FR 52044, Oct. 6, 1997.
[27] 72 FR 35198, June 27, 2007.
[28] 75 FR 19284, Apr. 14, 2010.
[29] 47 CFR 90.353(a).
[30] Ibid.; 47 CFR 90.353(d).
[31] Ibid.

III. The Economic Costs of Granting the NextNav Petition Are Extremely High.

If a band of spectrum were vacant or fallow, the increase in consumer benefits associated with a new allocation of that spectrum would simply be the consumer benefits of that new allocation. That is effectively the approach of the Brattle Group study, which acknowledges that it does not measure the loss of consumer benefits from limitations on existing users of the Lower 900 MHz band that would result from the NextNav proposal.[32]

But the Lower 900 MHz band is anything but vacant or fallow. NextNav currently offers services in the band, but so too do countless other entities that make far more extensive use of the band. Federal stations and ISM devices are primary to LMS services in the Lower 900 MHz band. Even under the NextNav proposal, the federal stations and ISM devices would remain primary throughout the Lower 900 MHz band. Non-M-LMS transportation services, including electronic tolling services operated by state and municipal tolling authorities across the country, make substantial use of the band worth tens of billions of dollars annually. Many millions of Part 15 devices also populate the band, and are at the core of the country's industrial, logistical, and medical operations.

Changing FCC rules as proposed by NextNav would substantially disrupt the current service offerings in the Lower 900 MHz band. The economic costs of the NextNav proposal are substantial including the following: losses of some existing services; diminution in the quality of services that remain; requirements to replace some equipment and to retune other equipment; and requirements for some users to seek and to pay for new spectrum and new equipment in other bands of spectrum, if available. The exact costs in each of these areas is not fully reflected in the record, but those costs reflected in the record of Docket 24-240 are in the many tens of billions of dollars.

A. Under Current FCC Rules, the Lower 900 MHz Band Supports Hundreds of Millions of Devices Providing Valuable Services That Benefit Practically Every American Business and Consumer.

Below, I review various categories of users of the Lower 900 MHz band under current FCC rules. As noted in Section II above, each of these categories is either primary (government stations and ISM) in the Lower 900 MHz band or is a category that has rights to interference protection against M-LMS services, such as those offered by NextNav.

[32] "The Lower 900 MHz band has a mix of incumbents comprising federal users, site-based operations in distinct geographic areas and Part 15 devices. This analysis focuses on benefits of reconfiguring this band. Those benefits would ultimately be weighed against the costs of the reconfiguration in evaluating the net benefits of the proposal to society." Coleman Bazelon and Paroma Sanyal, Brattle Group, "Public Benefits of Reconfiguring the Lower 900 MHz Band to Support a Backup and Complement to GPS," (2024) (Brattle Group Study).

1. The Lower 900 MHz Band Today Has, and Will Continue to Have, Primary Allocation for Important Industrial and Military Devices.

As discussed above, federal stations and ISM devices are primary to LMS services in the Lower 900 MHz band. Some entities—such as the Navy,[33] the industrial sector, the scientific sector, and the medical sector—use equipment and services in the Lower 900 MHz band as an integral part of ongoing operations. It is difficult to estimate an exact contribution factor for the Lower 900 MHz band for each of these sectors. The FCC record does not produce a specific number, but supports the conclusion that their value is substantial.

2. The Lower 900 MHz Band Today Supports Tens of Millions of Transportation Devices.

Non-M-LMS services are widely used across the country, including for electronic tolling operations on highways. According to the International Bridge, Tunnel and Turnpike Association (IBTTA), there are 120 million electronic toll tags currently in circulation for vehicles (mostly private vehicles)—accounting for 5 billion transactions annually that are read at tens of thousands of tolling stations, many using the Lower 900 MHz band.[34] Importantly, the E-ZPass tolling network relies on the Lower 900 MHz band, which manages 59 million transponders, as well as the Central United States Interoperability Hub which operates 23 million transponders.[35]

These widespread electronic tolling operations produce significant revenue for state and local governments to then invest in transportation operations and infrastructure. IBTTA reports 2023 toll revenue of more than $23 billion on American roads in 33 states.[36]

The benefits of transportation services in the Lower 900 MHz band extends beyond toll revenues. The non-M-LMS services that support electronic tolling also substantially improve traffic flow, reduce traffic congestion, and reduce traffic accidents as compared to traditional cash transactions at toll booths.[37] Several states have studied the efficiencies created by electronic tolling. For instance, in New Jersey, as far back as 2000, electronic tolling saved approximately 2.1 million vehicle-hours per year.[38] If people value their personal time at $30 an hour, then this amounts to $63 million dollars saved in New Jersey alone.[39] I have not found reliable information on time saved from electronic tolling in other states, but New Jersey doubtlessly accounts for only a minority of time saved.

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[33] NTIA, "902-928 MHz."
[34] Comments of IBTTA, WT Docket No. 24-240, Sept. 5, 2024, p. 4 (Comments of IBTTA).
[35] Ibid.
[36] Ibid.
[37] Ibid., pp. 5-6.
[38] Intelligent Transp. Sys., U.S. Dept. of Transp., "Implementation of the E-ZPass Electronic Toll Collection System on the New Jersey Turnpike Reduced Delay for All Vehicles by 85 Percent Saving Approximately 2.1 Million Hours Per Year," Sept. 7, 2001, https://www.itskrs.its.dot.gov/2007-b00421.
[39] The average wage for all occupations in the United States in May 2023 was $31.48. U.S. Bureau of Labor Statistics, https://www.bls.gov/oes/current/oes_nat.htm#00-0000.

In addition, electronic tolling systems, as compared to cash-based toll plazas, significantly reduce the probability of traffic accidents.[40] For instance, a 2012 study shows Orlando's deployment of an open-road tolling system reduced crashes at a toll plaza by 22%.[41] Electronic tolling in the Lower 900 MHz band therefore prevents property damage, injuries, and fatalities.

Furthermore, electronic tolling in the Lower 900 MHz band also provides significant environmental benefits. As IBTTA notes, electronic tolling significantly reduces or eliminates stop-and-go driving associated with cash toll plazas.[42] This, in turn, significantly reduces fuel consumption, reduces emissions, and lower air pollution. For instance, a 2001 study evaluating the New Jersey Turnpike showed that E-ZPass reduced delay for all vehicles by about 85 percent, saving an estimated 1.2 million gallons of fuel each year.[43] One recent study found that electronic toll collection can reduce black carbon emissions by half as compared to manual toll collection.[44] A reduction in emissions reduces the associated risk of cancer, especially in metropolitan areas.[45] A reduction in emissions is also associated with a reduction in premature births. The difference-in-difference models suggest that prematurity fell by 10.8 percent among mothers within 2 km of a toll plaza, while the incidence of low birth weight fell by 11.8 percent.[46]

The NextNav Petition states that it "is completing technical analyses intended to guide outreach to non-M-LMS users on the potential impacts and mitigation measures, including by paying for retuning or relocation,"[47] but the FCC record demonstrates that nothing short of an entire overhaul, with massive resultant disruption, would be the cost.

3. The Lower 900 MHz Band Today Supports Hundreds of Millions of Unlicensed Consumer and Enterprise Devices.

The FCC's rules also recognize that the band holds special importance for unlicensed operations, providing protection for Part 15 devices in the Lower 900 MHz band. Not surprisingly, hundreds

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[40] Intelligent Transp. Sys., U.S. Dept. of Transp., "In Florida, the Addition of Open Road Tolling (ORT) to an Existing Electronic Toll Collection (ETC) Mainline Toll Plaza Decreased Delay by 50 Percent for Manual Cash Customers and by 55 Percent for Automatic Coin Machine Customers, and Increased Speed by 57 Percent in the Express Lanes," May 30, 2008, https://www.itskrs.its.dot.gov/2008-b00553.

[41] J. Klodzinski et al., "Evaluation of Impacts of Open Road Tolling on Main-Line Toll Plaza," J. of the Transp. Rsch. Bd., Vol. 2012 Issue 1 (Jan. 2007), available at https://www.researchgate.net/publication/245561796_Evaluation_of_Impacts_of_Open_Road_Tolling_on_MainLine_Toll_Plaza.

[42] Comments of IBTTA, p. 7-8.

[43] Intelligent Transp. Sys. Joint Program Off., "The E-ZPass electronic toll collection system on the New Jersey Turnpike reduced delay for all vehicles by 85 percent saving an estimated 1.2 million gallons of fuel each year and eliminating approximately 0.35 tons of VOC and 0.056 tons NOx per weekday," Sept. 7, 2001, https://web.archive.org/web/20241004021614/https:/www.itskrs.its.dot.gov/2001-b00210.

[44] Intelligent Transp. Sys., U.S. Dept. of Transp., "Electronic Toll Collection Can Reduce Black Carbon Emissions by up to 50 Percent Compared to Manual Toll Collection,". Aug. 24, 2022, https://www.itskrs.its.dot.gov/2022-b01669.

[45] Intelligent Transp. Sys., U.S. Dept. of Transp., "The Implementation of an Electronic Toll Collection (ETC) System Reduced Harmful Emissions of Airborne Particulate Matter And Associated Cancer Risk by 49.3 Percent," Mar. 30, 2021, https://www.itskrs.its.dot.gov/2021-b01545 (finding that particulate matter and associated cancer risk was reduced by nearly 50 percent at ETC systems in Taiwan).

[46] J. Currie and R. Walker, "Traffic Congestion and Infant Health," Am. Econ. J.: Applied Econ., Vol. 3, No. 1 (Jan. 2011), pp. 65-90, https://www.jstor.org/stable/25760246.

[47] NextNav Petition, p. 31.

of millions of Part 15 devices—used by consumers and enterprisers alike—have deployed in the band in reliance on these rules.[48]

The FCC record demonstrates that a remarkably wide range of industries use unlicensed devices that rely on the Lower 900 MHz band, including transportation, utilities, retail and logistics, agriculture, healthcare, industrial automation, home automation, environmental monitoring, building and home security, [49] telecommunications,[50] medical,[51] military,[52] Internet of Things, airlines, retail,[53] manufacturing,[54] and supply chain operations.[55] The Lower 900 MHz band is especially useful for this wide range of industries due to its unique propagation characteristics. Relative to radios that operate the 2.4 GHz, 5 GHz, and 6 GHz spectrum bands that often are used for unlicensed spectrum, signals in the Lower 900 MHz band have a much longer range.

The Lower 900 MHz supports several forms of unlicensed devices, such as Radio Frequency Identification (RFID) devices,[56] Wi-Fi devices, devices that use the Z-Wave protocol (often used for Internet of Things and home automation), devices that use LoRaWAN technology, and devices that use Wi-Fi HaLow technology.

RAIN RFID. Perhaps the most economically intensive user of the Lower 900 MHz band are RAdio frequency IdentificatioN (RAIN) RFID devices. Approximately 80 billion RAIN RFID tags are deployed in the United States,[57] and 40 billion of those are in retail.[58] Many of these tags are "ubiquitous throughout the Lower 900 MHz band."[59]

Accenture reports that in 2021 adoption of RFID had reached 93% of retailers surveyed in North America,[60] as RFID tags are ubiquitous in specific areas of retail such as clothing. In 2022, consumer retail spending in clothing stores exceeded $292 billion,[61] much of it using RAIN RFID.

RFID in the Lower 900 MHz band is also widely used in warehouses. With RFID, workers and even automated robots can locate items in a warehouse without relying on barcodes or line-of-

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[48] Comments of Digi International Inc., WT Docket No. 24-240, Sept. 5, 2024, p. 1 (Comments of Digi International Inc.).
[49] Ibid; Comments of SIA, WT Docket No. 24-240, Sept. 4, 2024.
[50] Comments of PrePass Safety Alliance, WT Docket No. 24-240, Sept. 5, 2024 (Comments of PrePass Safety Alliance).
[51] Comments of PrePass Safety Alliance, "Medical uses of 902-928 Band."
[52] Comments of PrePass Safety Alliance, "Military uses of 902-928 Band."
[53] Comments of the U.S. Chamber of Commerce, WT Docket No. 24-240, Sept. 5, 2024.
[54] Ibid.
[55] Comments of ACT | The App Association et al., WT Docket No. 24-240, Sept. 20, 2024.
[56] Joint Comments of RAIN Alliance Inc. and Aim Inc., WT Docket No. 24-240, Sept. 5, 2024, p. 4 (Joint Comments of RAIN Alliance and Aim).
[57] Ibid.
[58] Reply Comments of Avery Dennison Corp., WT Docket No. 24-240, Sept. 20, 2024 (Reply Comments of Avery Dennison Corp.).
[59] Joint Comments of RAIN Alliance and Aim, p. 4.
[60] Accenture, "A New Era for RFID in Retail," p. 4 (2021), https://www.accenture.com/content/dam/accenture/final/a-com-migration/r3-3/pdf/pdf-155/accenture-rfid-in-retail.pdf.
[61] See Census Bureau, Excel Workbook "Sales: (1992-2022)," https://www.census.gov/data/tables/2022/econ/arts/2022restated/annual-report.html.

sight technologies. RFID also enables real-time inventory management and is the basis of new innovations such as drones accessing packages in warehouses.

RFID is also central to package delivery services such as UPS which ships over 5.7 billion parcels per year. UPS has publicly announced the use of RFID on earnings calls.[62] UPS automatically insures package shipments for $100 each. UHF RFID, primarily in the Lower 900 MHz band, is being used to protect UPS against over $500 billion in financial exposure.[63] The federal government, such as the U.S. Navy, also uses RFID technologies for supply management.[64]

The proposed NextNav rule changes "would severely disrupt, if not force the termination of, the operations of RAIN RFID systems."[65] Transitioning RAIN RFID devices to other bands would have substantial "economic and operational burdens,"[66] and the costs would be particularly pronounced in retail and in logistics where costs would increase and the quality of service would fall.[67]

Wi-Fi HaLow. The Lower 900 MHz band is also where long-range Wi-Fi HaLow (IEEE 802.11ah)[68] is based.[69] In several recent real-world trials, devices utilizing Wi-Fi HaLow technology were found to have longer reach and better penetration than many other IoT systems and because the technology can leverage standard Wi-Fi systems for upgrades and open standards devices, it was also more cost-effective than alternatives.[70] In 2024, there were 10.8 million Wi-Fi HaLow device shipments and this number is expected to grow to over

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[62] In 2024 Q1, UPS said: "Smart Package, Smart Facility, our RFID solution, is a great digital example. We are moving from a scanning network to a sensing network. Following last year's Phase 1 deployment to our preload operations, this year, we are installing RFID readers in over 40,000 U.S. package cards, with a balance to be completed in 2025. Package card readers will enable us to further reduce our misloads, which will improve efficiency and the customer experience." The Motley Fool, "United Parcel Service (UPS) Q1 2024 Earnings Call Transcript," Apr. 23, 2024, https://www.fool.com/earnings/call-transcripts/2024/04/23/united-parcel-service-ups-q1-2024-earnings-call-tr/; In 2024 Q4, UPS said, "In addition to what Carol mentioned earlier, especially with RFID tagging, we've got an opportunity to pull customers in where the stickiness just becomes a real big discussion and decision if they ever want to really disconnect from that technology because it's going to not just help delivery of packages, but also their back office environment, which we're really excited about" and "We brought over—and if you heard Carol in her opening comments, she highlighted this, but 15 retailers that we've already onboarded and I would—large enterprise retailers in the United States that really—that love the RFID capability because they have inbound visibility to what's hitting their docks, and it allows them then to spread their workforce and how they inbound that volume." The Motley Fool, "United Parcel Service (UPS) Q4 2024 Earnings Call Transcript," Jan. 30, 2025, https://www.fool.com/earnings/call-transcripts/2025/01/30/united-parcel-service-ups-q4-2024-earnings-call-tr/.

[63] Claire Swedberg, RFID Journal, "UPS Delivers Next Phase in Smart Package/Smart Facility Initiative with RFID," July 10, 2024, https://www.rfidjournal.com/news/ups-delivers-next-phase-in-smart-package-smart-facility-initiative-with-rfid/221158/.

[64] Daisy Thornton, Federal News Network, "NAVSUP piloting new RFID inventory system, integrating with Marine Corps solution," Nov. 7, 2024, https://federalnewsnetwork.com/defense-main/2024/11/navsup-piloting-new-rfid-inventory-system-integrating-with-marine-corps-solution/.

[65] Reply Comments of Avery Dennison Corporation.

[66] Ex Parte of Avery Dennison, WT Docket No. 24-240, Nov. 21, 2024.

[67] Reply Comments of Avery Dennison Corp.

[68] IEEE, 802.11ah 2016, https://ieeexplore.ieee.org/document/7920364.

[69] Comments of CTA, WT Docket No. 24-240, Sept. 5, 2024 (Comments of CTA).

[70] Claire Swedberg, RFID Journal, "Trials Find Wi-Fi HaLow Offers High Performance IoT Connectivity," Aug. 7, 2024, https://www.rfidjournal.com/news/trials-find-wi-fi-halow-offers-high-performance-iot-connectivity/221399/.

100 million device shipments in 2029.[71] The Wi-Fi HaLow device market size is estimated to reach a revenue of $1.5 billion by 2030.[72]

Additional Unlicensed Technologies. Furthermore, the marketplace for Z-Wave products alone, which are heavily dependent on the Lower 900 MHz band, is estimated at nearly $13 billion.[73] Likewise, there are tens of millions of devices that employ LoRaWAN and millions of LoRaWAN gateways across the United States in the Lower 900 MHz band.[74] In addition, tens of millions of alarm system devices use the Lower 900 MHz band.[75]

Other new technologies reliant on the Lower 900 MHz band were showcased in the CES 2024 show. With rules that have been in place for decades, engineers can and do develop and offer services in the Lower 900 MHz band with predictable outcomes. New products are constantly being developed in the Lower 900 MHz band. WISPA notes "2,000 filings in just the past 18 months for new [Part 15] technologies and devices intended for use in this band."[76]

In addition, the Lower 900 MHz band also supports unlicensed Part 15 devices to provide fixed wireless in rural and hard-to-reach areas that are otherwise difficult to serve.[77]

4. The Lower 900 MHz Band Today Supports Hundreds of Thousands of Amateur Radio Operators.

Part 97 amateur operators commonly use the Lower 900 MHz band on a secondary basis.[78] More than 700,000 Americans are licensed amateur radio operators.[79]

B. The Complexity of Assessing Economic Benefits in the Lower 900 MHz Band

The consumer benefits and producer benefits associated with the Lower 900 MHz band are complex for many reasons:

- Many different technologies and devices—some based exclusively on Part 15 rules, some based on Part 90 rules, and many based on a combination of these and other FCC rules—use the band;

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[71] ABI Research, "How Wi-Fi HaLow Is Poised to Transform the IoT Market," (2024), https://www.morsemicro.com/abiresearch.
[72] IndustryARC, "Wifi HaLoW Devices Market – Forecast (2025-2031)," https://www.industryarc.com/Report/19425/wifi-halow-devices-market.html.
[73] Comments of CTA; Pooja Tayade, "Z-Wave Products Market Analysis, Coherent Market Insights," (Feb. 2024), https://www.coherentmarketinsights.com/market-insight/z-wave-products-market-6117.
[74] Comments of LoRa Alliance, WT Docket No. 24-240, Sept. 5, 2024, at pp. 3-4.
[75] Ex Parte of U.S. Chamber of Commerce et al., WT Docket No. 24-240, Oct. 30, 2024, p. 3 (Ex Parte of U.S. Chamber of Commerce et al.).
[76] Comments of WISPA, WT Docket No. 24-240, Sept. 5, 2024, p. 3.
[77] Ibid. at p. 5.
[78] The large number of different types of users and the different types of licensing structures result in a complex web of property rights in those licenses that mean that no single type of license or user has unambiguously superior claims to use of the band.
[79] ARRL, "FCC License Count," Jan.10, 2025, https://www.arrl.org/fcc-license-counts.

- Often, consumers do not pay directly for the service associated with the spectrum in the Lower 900 MHz band as they do with wireless cellular services, and consequently a willingness-to-pay measure is elusive for many but not all services in the Lower 900 MHz band;[80]
- Many of the services in the Lower 900 MHz band are purchased by businesses to make retail and logistics operations more efficient, improve healthcare technology, and improve transportation services, with resulting lower prices to consumers. But no good measure of the effects of spectrum in the Lower 900 MHz lowering consumer prices is available;
- Many of the services and devices in the Lower 900 MHz band are part of the Internet of Things, creating widespread network benefits for consumers.

These factors mean that substantial care is needed in evaluating the economic value of the current allocation and rules for the Lower 900 MHz band. By any measure, the value is at least in the tens of billions of dollars, and quite likely substantially more, and certainly much more than the less-than *$4 million* that NextNav generates for all of its services, including PNT services.

C. Granting the NextNav Petition Would Undermine Existing Lower 900 MHz Operations, Require Equipment Changes, and Eliminate Equipment and Services That Would Cost Users Tens of Billions of Dollars.

The large number of comments in Docket 24-240 from incumbent licensees and users of the Lower 900 MHz band reflects the range of harms that those users perceive from the NextNav proposal.[81] The exact harms for each user are difficult to quantify, but the cost of retuning and replacing Part 15 devices alone is between $27 billion and $33 billion. In addition, the tolling industry estimates that the cost of replacing tolling transponders, retuning electronic tolling roadside readers, and the subsequent revenue leakage during the transition period to be at least $6.8 billion.

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[80] It might be possible to measure consumer willingness to pay for security and alarm services in the band, but I have not found sufficient information for measurement.

[81] There were 1,871 comments as of January 9, 2024. See WT Docket No. 24-240, https://www.fcc.gov/ecfs/search/search-filings/results?q=(proceedings.name:(%2224-240*%22)); see, e.g., Comments of E-ZPass Group, WT Docket No. 24-240, Sept. 5, 2024, pp. 9-17 ("NextNav's proposal would . . . undo the success that is electronic toll collection and upend Americans' seamless toll experience on U.S. roadways, harming drivers, businesses, and public agencies and governments, with substantial impact on the environment as well."); Comments of the International Bridge, Tunnel & Turnpike Association, WT Docket No. 24-240, Sept. 5, 2024, pp. 9-22 ("NextNav's proposal presents significant risks to electronic tolling operations that will be virtually impossible to mitigate without significant performance degradation."); Comments of CTA, p. 3, ("[T]he proposals in the NextNav Petition, including the reconfiguration of the band, increase in power levels, and the removal of certain testing requirements, could adversely affect the permissionless innovations currently in the band and those to come."); Comments of Cardinal Health WT Docket No. 24-240, Sept. 5, 2024, p. 1 ("[G]ranting NextNav's petition would have major implications for global medical and pharmaceutical supply chains" and "patients that rely on [RFID] applications would be jeopardized due to NextNav's desire to take precedence over RFID and claim priority to the FCC.").

1. Protecting Primary Allocations

Government stations and ISM applications have a primary allocation in the Lower 900 MHz band and would continue to be primary even under the NextNav proposal.[82] For example, the Department of Energy, NOAA, the Environmental Protection Agency, and NASA rely on wind profile radars (WPRs) in the Lower 900 MHz band. These systems operate at what is known as the 915 MHz boundary layer to "resolve the three-dimensional vector wind."[83]

The proposal asserts that "NextNav commits to protect federal users" but offers no explanation of how a new high-power terrestrial licensee in the Lower 900 MHz band would effectuate that commitment. Absent any specificity of how NextNav would ensure that operations within primary allocations will be protected, the market value of a Lower 900 MHz high-power terrestrial license would likely trade at a substantial discount relative to the value of licenses operating on a primary basis.

2. Equipment Retuning and Replacement Costs

Electronic Tolling. The electronic tolling industry foresees significant costs associated with replacing transponders if NextNav's proposal were implemented. The U.S. Department of Transportation's (DOT) Federal Highway Administration (FWHA) produced a study in 2021 that looked at the cost of converting current toll systems to a single protocol to promote nationwide interoperability.[84] Part of the study evaluated how much cost would be incurred to change the entire transponder base to a single protocol and examined three current transponder protocols (6c, SeGo, and TDM (E-ZPass)). The FHWA study concluded that converting the entire base to 6c transponders would come at a cost of $600 million and the other options were even more expensive. Costs include the base product cost, but also the costs of shipping and handling over a hundred million transponders. Furthermore, one must consider the cost of outreach to a wide consumer base to convince them to switch out their devices. Response rates would be low initially and would require continued outreach. There will also be the additional costs for electronic tolling companies to responsibly recycle the millions of tags that were previously in circulation.

IBTTA members estimate even higher costs associated with replacing all the 120 million transponders currently in circulation. IBTTA members estimate the following costs associated with replacing each transponder: $5.63 for new transponder; $1.50 for patron notification letter; $4.50 for transponder distribution; $0.20 for disposal of old transponder. This brings the total cost per transponder to $11.83. Multiplying by the 120 million transponders in circulation results in $1.42 billion in costs associated with replacement. Taking into consideration the FWHA estimates, I estimate the cost for replacing tolling transponders to be approximately $1 billion.

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[82] NextNav Rules Supplement.

[83] NOAA Physical Scis. Laboratory, "Wind Profilers," https://psl.noaa.gov/data/obs/instruments/WindProfilerDescription.html#:~:text=Wind%20profilers%20are%20Doppler%20radars,1a.

[84] FWHA, "Nationwide Electronic Toll Collection Interoperability, Publication No. FHWA-HOP-21-023," (Mar. 2021), https://ops.fhwa.dot.gov/publications/fhwahop21023/fhwahop21023.pdf.

The tolling industry also foresees additional costs in replacing equipment due to roadside upgrades at tolling plazas. The FHWA Nationwide Interoperability Study estimated the cost of upgrading roadside facilities to be $300 million.[85] When there are hardware upgrades to roadside systems and toll gantries, the cost of the hardware is not the most significant part. Other elements that need to be considered are traffic management so that workers can be safe as they upgrade the facility, loss of revenue because a lane is out of service, and the cost of the engineers and technicians who must travel and perform the work.

Part 15. The cost for retuning and replacing equipment would also be high for Part 15 devices. Digi International focuses just on the Part 15 devices and estimates that the costs of replacing and retuning Part 15 equipment to allow them to remain in the 907 MHz-918 MHz portion of the band if the FCC were to grant the NextNav petition would be between $27 billion and $33 billion.[86] Digi International's assumptions include that 35% of devices can be retuned remotely, 55% will require a truck roll to retune, and 10% will need to replaced.[87] If a higher percentage of equipment needs to be replaced, the costs are substantially higher. This estimate includes both equipment costs and the cost of replacing and retuning the equipment. Many Part 15 devices are owned by consumers and small businesses, and FCC acceptance of the NextNav proposal would lead to these consumers and small businesses paying some or even all of the cost of replacing equipment.

In addition, a sample of companies that manufacture IoT and smart home devices in the Lower 900 MHz band further estimate significant retuning and replacement costs. Four different IoT and smart home device companies each estimated replacement costs to be hundreds of millions of dollars, with one company estimating that it would cost at least $750 million to replace devices in the Lower 900 MHz band.

3. Loss or Reduction in System Performance and Service Quality

The NextNav proposal would reduce the current level of system performance and service quality in the Lower 900 MHz band.

Electronic Tolling. The record reflects a substantial reduction in the quality of toll collection services from the NextNav proposal.[88] This reduction in system performance has significant repercussions for the tolling industry, especially in relation to revenue leakage. The use of RFID transponders provides the toll industry with the greater certainty, least cost, and most timely financial posting of transactions. With high accuracy and reliability, toll tags can collect revenue at highway speeds with minimal and predictable revenue leakage from missed transactions at the toll plaza. Electronic toll systems are designed to deliver a 99.95% accuracy rate for vehicle identification, making transponder-based transactions highly certain in collecting revenue successfully. Interference from NextNav's proposed services would require the tolling industry to rely on the fallback measure of Automated License Plate Recognition (ALPR), which requires

[85] Ibid.
[86] Comments of Digi International Inc., p. iii.
[87] Ibid., p. 20.
[88] "Toll technology engineers see no evidence of feasible coexistence solutions, and it will be nearly impossible to mitigate without significant performance degradation." Ex Parte of U.S. Chamber of Commerce et al., p. 2.

video recognition of the license plate rather than using an RFID transponder. Various factors can impact the accuracy and successful collection of ALPR transactions, including unreadable plates, unavailable addresses, and undeliverable addresses. ALPR accuracy rates are typically in the mid-90% range, with collection rates on those transactions being significantly lower.

Toll operators will default to more costly and uncertain ALPR transactions because of the harmful interference encountered from the implementation of NextNav's proposed solution. Currently, IBTTA reports of the $23 billion in U.S. toll revenue collected annually, that 20% of the toll transactions are processed through non-tag transactions such as ALPR. According to industry performance experience, non-transponder-based transactions realize a significantly lower conversion into successful revenue collection than tag-based transactions, due to business leakage throughout the invoicing and collections process. If the current rate of transponder-based revenue transactions were to fall from today's 80% to a range of 50%-70% due to harmful interference, the incremental annual a revenue leakage is projected to range between $1.10 billion and $3.45 billion per year. Over the course of five years, without consideration of increases in traffic or toll rates, the incremental revenue loss due to interference from the proposed NextNav system may reach between $5.5 billion and $17.25 billion.

Part 15. Digi International also states that retuning would result in "these radios . . . los[ing] 60% of their performance capability due to the loss of available bandwidth."[89] Digi International also finds that frequency hopping techniques for Part 15 devices might not work in the compressed 11 MHz band in which NextNav proposes to relocate incumbent users.[90]

Although replacement equipment costs are a one-time expense, reduction in the quality of service can linger for long periods of time. Consequently, the consumer losses from a reduction in the quality of service should be measured not just over one year but over the duration of the reduction. For example, a reduction in the quality of service of 50% that lingers for five years when discounted at a 10% discount rate is equivalent to the loss of the value of 1.9 years of service.

4. The Higher Cost of Offering Services

In a competitive market, businesses offer services at the lowest competitive costs. Businesses that currently rely in part on devices and services in the Lower 900 MHz band would find ways to accommodate the equipment replacement costs and reduced quality of service described above. Accommodations would inevitably include paying higher costs which would be passed along as higher prices to consumers. These are the same consumers who would also have been directly affected by the proposed changes in the Lower 900 MHz rules and already have incurred some or all of the costs of replacing or retuning consumer-owned equipment.

[89] Comments of Digi International Inc., p. iii.
[90] Ibid., p. 16.

5. Revealed Preference and the Unavailability or Unattractiveness of Alternative Bands

Although hundreds of millions of devices based on Part 15, Part 90, and Part 97 rules use the Lower 900 MHz band, those rules also permit operations in other spectrum bands. It is reasonable to enquire whether equipment dislocated by the proposed NextNav rules would relocate as follows: (1) in the narrower 907-918 MHz band; (2) in a band outside the Lower 900 MHz band; or (3) cease operations.

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.

Some comments focus on the lack of availability of other bands for services that operate currently in the Lower 900 MHz band. For instance, IBTTA explains that other bands are not available for tolling services.[91] The propagation characteristics of the Lower 900 MHz band are uniquely well-suited for roadway management. Higher frequencies are not well-suited for electronic tolling because the Lower 900 MHz band has the benefit of low path loss and cable loss, which makes signal propagation in the Lower 900 MHz better at handling adverse weather conditions, such as rain, snow, or fog. Many roadway management operations, such as Automatic Vehicle Identification deployments at weigh station sites, simply would not work using spectrum with inferior propagation.

Likewise, amateur radio operators all see no attractive alternative bands for their operations.[92]

Some providers of unlicensed technologies similarly explain that the Lower 900 MHz band fills a critical role that other bands cannot. For instance, the Z-Wave ecosystem, which is used for many smart home devices, relies on the Lower 900 MHz band. The Z-Wave Alliance explains that this is because "[o]ther open bands are already too congested to accommodate the traffic of the Z-Wave devices."[93] In addition, the propagation characteristics of the Lower 900 MHz band enable deeper building penetration for smart home devices.

6. Consumer Disruption

Adoption of NextNav's proposal would require implementing new software—and even in some instances new hardware—in hundreds of millions of devices. This will require a multi-year transition. No one knows how long that transition would last. However, it's apparent that it will have significant consumer disruption, due to service disruption, consumer confusion, and significant costs passed onto consumers.

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[91] Comments of IBTTA, pp. 22-24.

[92] "The difficulty is that there are no other bands known to be available, and in fact, some of the Amateur operations in this band are here because they were displaced when a portion of the 420-450 MHz band North of 'Line A' was closed to the Amateur Service some years ago. Others were displaced from the same band when new Federal Government defense radars were initiated and continued Amateur secondary operations would have interfered with their operation." Comments of ARRL, WT Docket No. 24-240, Sept. 5, 2024, p. 3.

[93] Comments of Z-Wave Alliance, WT Docket No. 24-240, Sept. 5, 2024, p. 12.

The tolling industry explains the significant implications of the foreseeable consumer disruption. NextNav's proposal would require the currently 120 million tolling tags in circulation to be replaced. There will be a significant lag in adoption as consumers must switch out the tags in their cars. Consumers will not understand why they need to switch out the tag and therefore a significant portion of households will likely require multiple touchpoints before they implement the switch. Some consumers will simply not replace their transponder, reducing the market share of transponder-based transactions, which are the most certain and lowest-cost revenue collection method. Furthermore, many consumers will inevitably use outdated tags, resulting in additional confusion and loss of consumer confidence when they receive a bill in the mail.

7. Uncertainty of Future Outcomes

A common theme in the comments in the FCC record is uncertainty about the future if the NextNav petition is granted. There is uncertainty about the following: (1) whether certain devices will be allowed to operate in the proposed new high-power terrestrial service bands, the new LMS band, or neither; (2) whether equipment will need to retuned, replaced, or migrated out of the Lower 900 MHz band entirely; (3) the costs of any transition; (4) the reduction in the quality of service; (5) whether and when NextNav or the FCC would compensate incumbent users or assist with a transition; and (6) and whether investors and users will support investments in new spectrum bands if the FCC can at whim chaotically reallocate a band whose allocation and rules have been settled for decades.

In a perfect economic world, there would be a market to purchase insurance to cover the risk of the costs of changes in government regulations, such as the sweeping changes proposed by NextNav. But there is no such market for regulatory insurance. Instead, consumers and businesses must individually pay for the unknown stream of costs and risks they face associated with regulatory changes, including those proposed by NextNav.

IV. The Economic Benefits of Granting the NextNav Petition Are Substantially Lower Than Its Costs.

The previous section discussed the cost of the NextNav Petition, noting that the FCC record suggests that the costs of returning and replacing just the Part 15 devices in the Lower 900 MHz band alone would be between $27 billion and $33 billion.[94] Further, the costs resulting from replacing tolling transponders, upgrading roadside facilities, and subsequent revenue leakage is expected to total at least $6.8 billion. There would also be large costs from reductions in the quality of service, consumer welfare losses from high prices for services, the unavailability of alternative bands, the near-term consumer confusion and harm from the disruption of services in the Lower 900 MHz band, and the costs associated with greater uncertainty about future service offerings.

[94] Comments of Digi International, p. iii.

This section discusses the potential economic value of the changes proposed in the NextNav petition. As discussed below, that value cannot reasonably include the economic value of a GPS backup system because (1) current FCC rules already allow such a system and NextNav claims that its current system, TerraPoiNT, is backup GPS-capable and (2) many alternatives to NextNav for such a system exist that do not require the FCC to grant the petition.

The NextNav petition would, however, create one economic value that should be considered: the addition of a new 15-megahertz nationwide high-powered terrestrial license. The value of such a license as the primary service in such a license would be between $1.2 and $2.1 billion. As government stations and ISM operations will remain primary in the band, the market value of such a license would be substantially less.

As shown in the previous section, the loss in consumer welfare from reallocating the Lower 900 MHz band and changing FCC rules would be tens of billions of dollars, substantially greater than the market value of the creation of the 15-megahertz nationwide high-power terrestrial license. Therefore, the cost of granting the petition is substantially higher than its benefits.

A. The Economic Benefit of a GPS Backup System Cannot Be Assigned to the NextNav Petition.

NextNav's economic analysis depends on the proposition that the only way to create a backup to GPS is to grant its petition. This is incorrect because:

1. The reforms proposed in the NextNav Petition are not necessary for backup GPS using the Lower 900 MHz band, as NextNav already offers PNT services capable of backup GPS under current FCC rules and NextNav's licenses—the petition is not necessary to permit it to build a GPS backup system;
2. NextNav mischaracterizes the results of governmental studies in support of its position;
3. Other PNT options can serve as a GPS backup without the disruption that would be caused by the NextNav petition—the FCC record is clear that NextNav is not the only option and also not the best option;
4. The NextNav proposed rule changes do not require a new high-power terrestrial licensee to build out a backup GPS network.

All of the other elements of the NextNav proposal create substantial economic costs, as reviewed in the previous section. NextNav incorrectly presents the Brattle Group report on the benefits of a backup GPS system as support for its proposal.[95] Because the backup GPS is available from NextNav and more than a dozen competitors under current FCC rules, the Brattle Group's report

[95] NextNav Letter, WT Docket No. 24-240, Oct. 24, 2024. 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. Because the Brattle Group was asked to address a question—the value of GPS backup—that is irrelevant to the FCC's consideration of the NextNav Petition, I have not criticized it in detail. In addition, some of its technical assumptions appear to be incorrect such as the assumed geospatial overlap.

and the Brattle Group's supplemental report are in fact irrelevant to whether FCC rules in the Lower 900 MHz band should be changed.

1. Reconfiguring the Lower 900 MHz Band Is Not Necessary for a Backup GPS System to Be Provided by NextNav or Any Other Provider.

In its Petition, NextNav does not claim that current FCC rules in the Lower 900 MHz band preclude the deployment or offering of PNT services. Instead, NextNav states that it has not delivered this value to the country because it is unprofitable for it to do so.[96] It is important to understand this distinction because it means that the FCC should not assign the value of a nationwide PNT backup system to the NextNav petition because the changes proposed are not necessary for such a system.

In its Form 10-K filing for the calendar year ending December 31, 2023, NextNav describes at length how it is already in the business of providing PNT services in the 902 MHz-928 MHz band. NextNav states that it is "the market leader in delivering resilient, next generation, complementary positioning, navigation and timing ('PNT') solutions."[97] It describes its TerraPoiNT system as "a terrestrially-based network designed to overcome the limitations inherent in the space-based nature of GPS," and it explains that "TerraPoiNT overcomes these limitations through a network of wide area location transmitters that broadcast an PNT signal on our licensed 900 MHz LMS spectrum."[98] NextNav's Form 10-K states the TerraPoiNT "can be configured to provide NIST-traceable timing services independently of GPS," and with these capabilities can deliver "backup in the event of GPS disruptions" or even "a more robust primary solution"[99]

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[96] "NextNav's next-generation PNT network is being designed to operate as an integral component of 5G technologies and deployments. But, despite the compelling need for robust terrestrial PNT services and previous incremental FCC actions to enable terrestrial PNT in the Lower 900 MHz Band, it is not economically feasible to deploy a widescale, standalone terrestrial PNT network." Next Nav Petition, p. ii.

[97] NextNav 2023 10-K, p. 34.

[98] Ibid.

[99] "We deliver differentiated PNT solutions through our network-based Pinnacle and TerraPoiNT solutions. Our Pinnacle system provides accurate altitude service to any device with a barometric pressure sensor, including most off-the-shelf Android and iOS smartphones, appropriately specified Internet of Things ('IOT') devices, as well as vehicles and other equipment. In 2021, we launched our Pinnacle network in partnership with AT&T Services, Inc. ('AT&T') for FirstNet®, the nationwide, interoperable public safety broadband network. Our Pinnacle network covers over 90% of commercial structures over three stories in the U.S., and in addition to FirstNet®, our network is being used for enhanced 911 ('E911') by Verizon Communications, Inc. ('Verizon'), and a growing number of devices operating on the remaining national cellular network providers. Pinnacle has also been adopted by a growing number of public safety apps, commercial apps, and is available on multiple app development platforms. Our Pinnacle network is an important component of our PNT resiliency services, and is being evaluated as a persistent PNT characterization platform. We believe that continuing integration of our Pinnacle service into devices and applications will support revenue growth over the coming year.

"Our TerraPoiNT system is a terrestrially-based, network designed to overcome the limitations inherent in the space-based nature of GPS. GPS is a faint, unencrypted signal, which is often unavailable indoors, distorted in urban areas, and vulnerable to both jamming and spoofing. TerraPoiNT overcomes these limitations through a network of wide area location transmitters that broadcast an PNT signal on our licensed 900 MHz LMS spectrum. Unlike GPS, the TerraPoiNT signal can be reliably received indoors and in urban areas, is difficult to jam or spoof compared to GPS, and can support signal authentication (e.g., encryption). Further, the TerraPoiNT signal can embed Pinnacle

Similarly, NextNav touts its current Lower 900 MHz PNT solution in its petition. NextNav stated: "NextNav has developed a PNT offering designed to be compatible with everyday consumer devices and small-form-factor, cost-effective enterprise devices."[100] NextNav explains that this technology is "resilient" and provides "accurate altitude using a purpose-built sensor network and the barometric sensors in phones, tablets, and many other devices and applying differential barometric techniques to determine the receiver's z-axis location."[101] The NextNav petition even cites the FCC's 2016 praise of an earlier version of the NextNav technology under rules available in 2016.[102]

Furthermore, the NextNav petition cites a 2021 DOT report as additional evidence that NextNav's current PNT solution performs well. In fact, NextNav reports that its PNT solution placed first in the 2021 DOT report out of 12 different PNT technologies.[103] The DOT demonstration test was in 2020 using then-existing FCC rules in the Lower 900 MHz band. In 2021, NextNav also demonstrated "TerraPoiNT's timing precision and resilience in a Department of Homeland Security Science & Technology Directorate assessment,"[104] presumably with existing FCC rules in the Lower 900 MHz band.

Accordingly, nothing in these descriptions of its current services suggest that the FCC rules for the Lower 900 MHz band are an impediment to either the testing or the deployment of complementary

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information to provide a full 3D PNT solution. TerraPoiNT offers positioning, navigation and can be configured to provide NIST-traceable timing services independently of GPS. We believe that these capabilities, whether as a more robust primary solution or as a backup in the event of GPS disruptions, are essential due to the economy's reliance on GPS for location and precision timing. GPS resiliency is increasingly a U.S. national security priority, and is rising in priority in the European Union, non-European Union countries in Eastern Europe and in other parts of the world due to both the demonstrated vulnerability and lack of local control of space-based signals and systems, highlighted by recent events in Ukraine, the Middle East and elsewhere. Critical infrastructure, including communications networks and power grids, require a reliable GPS signal for accurate timing. A failure of GPS could be catastrophic, and there is no comprehensive, terrestrial backup that is widely deployed today. TerraPoiNT received the highest scores in testing by the U.S. Department of Transportation (the 'DoT') reported in 2021 regarding potential PNT backup solutions, in each category tested, and was the only solution evaluated capable of providing the full set of services provided by GPS.

"As of March 2024, TerraPoiNT is deployed and available, with metro-wide service in the San Francisco Bay Area and select services available in 92 total markets nationally. It is also in use by the National Aeronautics and Space Administration ('NASA') at its Langley Research Center in Hampton, VA for drone operations research and at its Ames facility in Mountain View, CA, leveraging our network in the Bay Area." Ibid.

[100] NextNav Petition, p. 11.

[101] Ibid.

[102] "NextNav's [TBS-based Timing-as-a-Service ('TaaS')] provides high-precision timing and frequency in GPS-challenged areas, such as Indoors and Urban Canyons and as a backup to GPS in other areas. The TaaS system can deliver very precise time and frequency synchronization. The received TBS signals from multiple terrestrial transmitters (30 W [ERP]) is significantly more powerful than space based GPS signals and provides for geographic redundancy of the signal. . . . As a ground-based system, TBS is insensitive to space weather phenomena. The sub-1 GHz signals penetrate buildings well, enabling deep indoor time and frequency coverage. The high-power TBS signals are more difficult to jam than GPS, and multiple beacon overlap provides geographic redundancy mitigating a single beacon being jammed. Signal encryption and authentication protect against spoofing." Ibid., p. 12.

[103] Ibid. See U.S. Dep't of Transp., "FY2018 NDAA Section 1606 Report to Congress," Jan. 21, 2021, available at https://www.volpe.dot.gov/our-work/resiliency-global-positioning-system-gps (DOT NDAA Section 1606 Report).

[104] NextNav Petition, p. 13.

PNT services in the Lower 900 MHz Band. Similarly, NextNav did not indicate in its Form 10-K filings that either TerraPoiNT or Pinnacle requires new FCC rules or a dedicated 15-megahertz channel. In fact, the NextNav Form 10-K presents its "Strategy" without any reference to seeking a change in FCC rules or the band plan for the Lower 900 MHz band.[105] Only in the last sentence is there a hint that NextNav's ambitions to evolve TerraPoiNT would require FCC approval, and then only "to provide other types of 5G NR-based two-way voice and data transmission services while maintaining or improving our PNT capabilities."[106] The primary change that NextNav emphasizes for TerraPoiNT is a need for additional investment, not a need for changes in FCC rules.[107]

NextNav presents many risk factors facing the company,[108] but none of those risk factors include the inadequacy of existing FCC rules for NextNav to offer PNT services or a need for the FCC to create a dedicated 15-megahertz band specifically for NextNav. NextNav notes, however, that the Lower 900 MHz band is shared with many other users, and NextNav is required not to interfere with other users.[109]

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[105] Ibid., p. 2.
[106] Ibid., p. 5.
[107] "The expansion of the TerraPoiNT network build-out will require significant investment; however, as with our Pinnacle system, we anticipate exploring partnership opportunities as part of that deployment. We believe that the evolution to 5G NR may increase the number of such potential opportunities." Ibid.
[108] Ibid., pp. 12-29.
[109] "Our FCC licenses authorize the use of radio frequencies that are shared with other radio services, which could result in harmful interference and impairment to our use of our licensed spectrum.

"Our LMS licenses authorize us to use the upper portion of the 902-928 MHz band. This spectrum is a shared frequency band that is used for a number of purposes both by individuals, businesses and the federal government. Other services that are authorized to use these frequencies include federal radiolocation systems; industrial, scientific and medical devices; licensed amateur radio operations; and certain unlicensed devices. Our use of the spectrum is subject to FCC requirements that our operations must accept harmful interference from other uses of the spectrum that have more senior rights to the spectrum. We have been successful thus far in using our LMS spectrum to operate location services without experiencing material impairment of our location services caused by more senior spectrum uses, but no certainty exists that we will be able to continue to do so. Moreover, for certain specialized uses, including non-PNT-related two-way voice and data uses, the use of our spectrum would be subject to additional regulatory review, approvals and/or limitations. More senior uses of the 902-928 MHz band could become more numerous or could alter the characteristics of their transmissions in ways that could increase the interference to our location services, resulting in diminished coverage, consistency and accuracy of our location services.

"In addition, we are required to refrain from causing unacceptable levels of harmful interference to unlicensed wireless devices. The FCC issued a decision in 2013 that concluded that, based on field tests, we had successfully demonstrated that our location services did not cause unacceptable levels of harmful interference to such unlicensed wireless devices. Third-party challenges to the FCC decision, are still pending. Further, changes in our operations could alter the transmission characteristics of our location services, potentially requiring us to provide further demonstrations that our location services do not cause unacceptable levels of harmful interference to those unlicensed devices. No certainty exists that the FCC would conclude in the future that we remained successful in making such a demonstration a second time. If we are unable to make this demonstration to the satisfaction of the FCC, we may not be able to make changes to our operating characteristics, potentially preventing the future implementation of desirable innovations." Ibid., p. 23.

Rather than blame any restriction imposed by FCC rules, NextNav explains there is simply not a revenue model for its preferred standalone PNT system:

GPS is free to users (limiting price), so there is limited incentive for equipment and software developers to incorporate PNT-specific protocols into the vast array of user devices utilizing PNT services (limiting subscribers). Because of these limitations on price and subscribers, generating sufficient revenue in sufficient time to cover the capital and operating expenditures necessary to build and maintain an at-scale, terrestrial, PNT-only network is not commercially viable.[110]

NextNav's petition asks the FCC to solve the company's private profitability challenge by granting it valuable new spectrum rights that it can lease or sell to other companies, at the expense of the other users of the Lower 900 MHz band.[111] Remarkably, NextNav concedes that even if the FCC grants the petition, little of the 15-megahertz capacity is actually needed for PNT, and "the vast majority" of the capacity would be for commercial high-power terrestrial services, not for PNT.[112]

2. NextNav Mischaracterizes Governmental Studies.

In addition, many of NextNav's assertions lack credibility due to the fact that they mischaracterize several government studies. For instance, in its Petition for Rulemaking, NextNav mischaracterizes the results of an EU study on PNT. As indicated by NextNav, the EU does recommend a dedicated PNT spectrum band,[113] but the EU points to the U.S. LMS service band of NextNav at 902-928 MHz and *existing* service rules in the band:

As discussed in sections 5.6 and 5.7, there is a strong advantage in the dedicated spectrum band for terrestrial PNT services within the EU, something that at the moment is not available. This approach already exists in the U.S., with a 902-928 MHz frequency band, dedicated to the Location and Monitoring Service. Not only does this offer better legal protection against RFI but also allows

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[110] Ibid., pp. ii-iii.

[111] "But there is a path to a widescale terrestrial PNT network if the FCC updates the rules for the Lower 900 MHz Band in a manner that allows it to be used for 5G so that the PNT network will be integrated within NextNav partners' broadband networks.

"Indeed, using the Lower 900 MHz Band in terrestrial, mobile-broadband networks creates a unique, economically viable opportunity to meet the urgent need for widescale terrestrial PNT services without substantial federal investment. This rulemaking petition's proposed re-banding and accompanying rule modifications would create 15 megahertz of frequency-division-duplex spectrum within the Lower 900 MHz Band to support terrestrial PNT and 5G broadband. Revising the rules would enable NextNav's next-generation ('NextGen') terrestrial PNT network to use widely adopted 5G technology to extend PNT reach where GPS and other space-based systems are limited and otherwise complement GPS, including as a backup if necessary, while also supplementing the country's mobile broadband capacity. Using a 10-megahertz downlink spectrum block, NextGen can—uniquely for a terrestrial PNT system—reliably supply integrated, highly accurate, and consistent 3D positioning indoors and outdoors, along with precision timing." Ibid., p. iii.

[112] "Further, as NextNav's NextGen PNT solution uses a small amount of capacity in the 10-megahertz downlink, mobile network providers can use the vast majority of the downlink capacity for broadband, making the spectrum appealing for integration into existing networks and thereby accelerating the availability of terrestrial PNT services. The 15-megahertz band plan is necessary for this broadband deployment, which enables an at-scale PNT network to be deployed efficiently, providing a unique path to resolving the coverage, cost, and user device issues that have prevented broad terrestrial PNT usage to date." Ibid., pp. iii-iv.

[113] Ibid., p. 14.

for more transmission power—reducing the chance of RFI, extending the signal range and in-building penetration.[114]

The NextNav Petition selectively quotes from these sentences to give the exact opposite impression:

There is a strong advantage in the dedicated spectrum band for terrestrial PNT services within the EU, something that at the moment is not available. . . . Not only does this offer better legal protection against [RF interference ("RFI")] but also allows for more transmission power—reducing the chance of RFI, extending the signal range and in-building penetration.[115]

NextNav states that other countries are ahead of the United States in implementing terrestrial PNT.[116] But some of the cited documents do not support this position. In particular, the United Kingdom[117] and the EU do not appear to be ahead of the United States in terrestrial PNT, with the EU pointing to the United States as having the lead with the Lower 900 MHz band and existing rules.[118]

3. There Are Many Alternative GPS Backup Systems That Would Impose Far Lower Costs on the Country.

Even if NextNav now asserts that only its NextGen solution offers real backup GPS, there are other alternatives for backup GPS that undermine the value the Brattle Group assigns to NextNav. Indeed, NextNav reports in its Form 10-K for 2023 that it faces "intense competition in our market from multiple sources, especially from competitors that offer their location services for free, which could make it difficult for us to acquire and retain customers and end users." NextNav observes, "We face competition from multiple sources," [119] and it highlights three forms of competitors:

1. eLORAN (Hellen Systems tested in 2021 DOT Report)
2. LEO Satellite systems (satellites in the 2021 DOT Report)
3. A wide range of commercial location system competitors

Also, in January 2021, DOT released its FY2018 NDAA Section 1606 Report to Congress that reviewed different vendors offering PNT services.[120] Based on a Request for Information, DOT received information from 21 different vendors and tested 11 vendors offering PNT services:

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[114] Lukasz Bonenberg et al., European Commission Joint Research Centre, "Assessing Alternative Positioning, Navigation and Timing Technologies for Potential Deployment in the EU," JRC132737 (2023), https://tinyurl.com/2c9otc7b (JRC Report).
[115] NetxNav Petition, p. 14.
[116] "It is worth noting that many other countries have recognized the need for terrestrial systems as part of their national PNT capabilities and are ahead of the United States in deploying solutions to complement and supplement space-based PNT. For example, Australia, China, the European Union, Iran, Russia, Saudi Arabia, South Korea, and the United Kingdom have each taken several prominent steps to improve their terrestrial PNT options." Ibid.
[117] Press Release, UK Dep't for Sci., Innovation, and Tech., "Critical Services to Be Better Protected from Satellite Data Disruptions Through New Position, Navigation and Timing Framework," Oct. 18, 2023, https://tinyl.io/AQv1.
[118] JRC Report, p. 78.
[119] NextNav 2023 10-K, p. iii.
[120] DOT NDAA Section 1606 Report.

1. Echo Ridge
2. Hellen Sys (using an eLORAN system)
3. NextNav
4. OPNT
5. Phasor Lab
6. Satelles
7. Serco
8. Seven Solns
9. Skyhook
10. TRX
11. UrsaNav

On July 3, 2024, DOT announced the award of $7 million to nine vendors for another round of testing of Complementary Positioning, Navigation and Timing Technologies.[121] The nine vendors listed are the following:

1. Hoptroff
2. NAL Research Corp.
3. Locata
4. Parsons
5. Carahsoft
6. SAFRAN
7. NextNav
8. Microchip
9. TERN AI

These vendors use four different types of technology:

1. Low Earth Orbit: NAL Research and Parsons
2. Time over Fiber: Hoptroff, Microchip, and Safran
3. Terrestrial Radiofrequency: Locata and NextNav
4. Map Matching: Carahsoft and Tern AI

[121] U.S. Dep't of Transp., "Department of Transportation Awards $7 Million for Complementary Positioning, Navigation and Timing Technologies," July 3, 2024, available at https://www.transportation.gov/briefing-room/department-transportation-awards-7-million-complementary-positioning-navigation-and.

In November 2024, DOT solicited additional firms for testing of PNT capabilities.[122]

In December 2024, DOT made a presentation at the National Space-Based PNT Advisory Board Meeting.[123] The presentation includes a slide with a list of nine different vendors that the DOT is testing for complementary PNT services.[124] The first three of these vendors—Hoptroff, NAL Research Corp., and Locata—were assigned a technology readiness level of 9, higher than the remaining six vendors, although all nine vendors were rated at a technology readiness level of 8 or higher. Thus, in December 2024 the DOT did not rate NextNav as having the highest technology readiness. Other applicants with lower technology readiness presumably compete in the market for complementary PNT services. Of these, all except Hoptroff, SAFRAN, and Microchip provide both position and navigation. These nine vendors are not the only ones offering complementary PNT services.

In describing the NextNav technology in 2021 and 2024, DOT does not state that NextNav—or any other vendor—can offer PNT services only if FCC rules in the Lower 900 MHz band were altered. In the many documents available at its website, DOT makes no mention of a need to change any FCC rules to accommodate PNT services, much less specifically in the Lower 900 MHz band. DOT has not filed comments in the FCC Docket 24-240.

If NextNav is not the only option for a GPS backup system, and other options do not require the FCC rule changes proposed by NextNav, it is improper for NextNav to argue that the value of a GPS backup system should be assigned to its petition.

4. The NextNav Proposed Rule Changes Do Not Require a New High-Power Terrestrial Licensee to Build Out a Backup GPS Network.

Finally, the NextNav proposed rule changes do not require a new high-power terrestrial licensee to offer PNT services. Such a licensee may offer such services but is not required to do so.

B. The Only Economic Benefit of the NextNav Petition Is the Creation of a New Frequency Range for Commercial Wireless Activities That Would Assign Licenses Worth at Most $1.2-2.1 Billion, and Likely Substantially Less.

The commercial value of the proposed 15 megahertz of spectrum for mobile broadband spectrum for NextNav (10- and 5-megahertz blocks) would be between $1.2 and $2.1 billion without

[122] U.S. Dep't of Transp., "Complementary Positioning, Navigation, and Timing (CPNT) Services Rapid Phase II," Nov. 27, 2024, available at https://sam.gov/opp/396f1f1e901a4155ace2263e3c70a588/view.
[123] U.S. Dep't of Transp., Off. of the Assistant Sec'y for Rsch. and Tech., "National Space-Based PNT Advisory Board Meeting," Dec. 4, 2024, available at https://www.gps.gov/governance/advisory/meetings/2024-12/van-dyke.pdf.
[124] Ibid., slide 18.

discounting for the primary allocation of government stations and ISM devices.[125] Discounting for government stations and ISM devices would reduce the value further.

Several factors might reduce the market value of the high-power terrestrial license from NextNav proposal including the following:

(1) The future date on which service would begin is uncertain, and the net present value of the public interest should discount the value of those future services. In the calculation above, I assume that it would take five years to clear the new TPNT bands. A longer (shorter) time to clear the spectrum would decrease (increase) the value of the license.
(2) Whether a high-power terrestrial licensee could negotiate a favorable contract with a major wireless carrier to use the Lower 900 MHz band to offer mobile broadband services is uncertain. Anterix has not yet been successful in negotiating such a contract for the Upper 900 MHz band.
(3) Operating around government stations and ISM devices as primary in the band.
(4) The proposed block is not internationally harmonized and does not line up with a 3GPP 5G NR band, which could decrease the value further.

V. Even If the FCC Were to Create a New Nationwide High-Power Terrestrial License in the Lower 900 MHz Band, the FCC Would Have No Basis to Assign the License to NextNav.

The NextNav proposal not only requests that the FCC create a new nationwide high-power terrestrial license in the Lower 900 MHz band but also seeks to have the FCC assign that new license exclusively to NextNav in exchange for its M-LMS licenses. Such an assignment is not sound public policy, would result in a significant windfall to NextNav, and potentially undermines the FCC's statutory requirement to hold an auction for mutually exclusive initial licenses, once reinstated.

[125] Spectrum in the sub-1 GHz spectrum bands is usually thought to be worth between $0.50 and $1.50 per MHz-POP, but much of that value comes from the three major carriers. Dish recently failed to exercise an option with T-Mobile to purchase 13.5 megahertz of cleared spectrum in the 800 MHz band at $3.6 billion, and T-Mobile, prohibited from selling the license to a major carrier, could not find another buyer at that price. Consequently, the value of 13.5 megahertz of cleared spectrum for a non-major wireless carrier in that band is less than $3.6 billion. The value of uncleared spectrum that would take years to clear must be substantially less still, and I estimate the value at between $1 billion and $2.5 billion. A similar valuation can be measured from Anterix which has an enterprise value of less than $730 million. Stock Analysis, "Anterix Inc.," as of Feb. 20, 2025, https://stockanalysis.com/stocks/atex/statistics/. Anterix, has licenses with approximately 10 megahertz of spectrum in the upper 900 MHz band, but Anterix does not have nationwide license, and many of its licenses are at least partly encumbered. I assume the market clearing price for the 15 megahertz of spectrum, if available for service today, would be between $2 and $3.5 billion, and I assume that the spectrum is not available for commercial use for five years as a result of necessary clearing. With a 10% discount rate, the result is $1.2-$2.1 billion.

A. Several LMS Licenses in the Lower 900 MHz Band Are Tenuously Assigned to NextNav.

NextNav's regulatory situation requires that any consideration of its potential to create new economic value by building a nationwide GPS backup should be discounted. NextNav holds FCC LMS licenses through its subsidiary Progeny. Progeny is associated with 228 LMS licenses.[126] Of these, 226 are listed as "active" and two are listed as "terminated."[127] Although the status of some Progeny LMS licenses is without dispute, other Progeny LMS licenses have a tenuous status and troubled history. Of the 226 Active LMS licenses associated with Progeny, 148 licenses—far more than 50% of the Progeny LMS licenses—have an expiration date of July 19, 2020, or nearly four and half years ago.[128] Progeny filed for a license renewal for each of these licenses on July 7, 2020,[129] and each of these Progeny LMS licenses with an expiration date of July 19, 2020 has a "Pending Application" status at the FCC, meaning that a renewal application has been filed but not acted upon.

To understand the precarious nature of many of the Progeny LMS licenses, consider the following information. Commission rules require M-LMS EA licensees either: (1) to construct and place in operation a sufficient number of base stations that utilize multilateration location service to one third of the EA's population within five years of the initial license grant, and two thirds of the population within ten years or, (2) in the alternative, to provide substantial service to their licensed area within the appropriate five and ten year benchmarks.[130]

In 2008, the Wireless Bureau extended these construction requirements for Progeny to meet the five-year construction requirement on or before July 19, 2012, and the ten-year requirement on or before July 19, 2014.[131] In 2012 and 2014, Progeny sought additional extensions for the construction deadlines for 228 LMS licenses covering 115 EAs.[132] In 2015, Progeny again sought a waiver and an extension,[133] which the FCC granted in part in early 2017.[134] Progeny then sought

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[126] FCC, Universal License System, as of Jan. 1, 2025 (Progeny ULS Search) (search for licenses held by "Progeny" using radio service code "LS.").
[127] Ibid., WPQQ203 in Minneapolis/St. Paul, Minnesota and WPQQ254 in Sacramento-Yolo, California.
[128] Progeny ULS Search.
[129] Progeny LMS, LLC, Application for License Renewal, FCC Form 601, Narrative Exhibit, available at https://wireless2.fcc.gov/UlsEntry/attachments/attachmentViewRD.jsp;ATTACHMENTS=WhQkz6zNz_bMQBFPvUA7_RUBEEPg7vDg_x_KvyHX-KUAqWkA1dpD!422559864!1143267655?applType=search&fileKey=1751158298&attachmentKey=20941043&attachmentInd=applAttach.
[130] 47 CFR 90.155(d).
[131] FCC, DA 08-2614, released Nov. 26, 2008 (LMS Extension Order).
[132] Progeny LMS, LLC, Request for Waiver and Extension of Time, Attachment, ULS File No. 0005273654 (filed June 21, 2012) (Progeny Waiver Request); Progeny LMS, LLC Request for Extension of Time, Attachment, ULS File No. 0006383686 (filed July 17, 2014) (Progeny 2014 Waiver Request).
[133] Progeny LMS, LLC, Amendment and Restatement to Requests for Waiver and Extension of Time (filed Mar. 27, 2015) (Progeny Amendment); Progeny LMS, LLC, Limited Amendment to Amendment and Restatement to Requests for Waiver and Extension of Time (filed June 26, 2015).
[134] FCC, DA 17-20, released Jan. 17, 2017.

in March 2020 an extension and waiver.[135] The Wireless Telecommunications Bureau of the FCC conditionally granted the extension and waiver in July 2020.[136] Progeny then sought additional waivers and extensions in 2019, 2020, and 2021.[137] These requests were largely granted by the Wireless Telecommunications Bureau in 2023, but also required biannual progress reports from Progeny in Docket 12-202.[138]

On January 10, 2025, Progeny requested yet another extension of buildout requirements.[139]

Related to the NextNav Petition to reconfigure the Lower 900 MHz band, NextNav also sought to transfer largely terminated LMS licenses from Telesaurus to NextNav and to reinstate those licenses.[140] The FCC describes the other M-LMS licensee as follows: "Telesaurus Holdings GB LLC (Telesaurus), is an entity formerly controlled by the late Warren Havens and currently licensed under a court-ordered receivership."[141] Having little or no build-out and constantly missing deadlines, the Telesaurus licenses are even more precarious than the NextNav licenses.

B. NextNav's Calls for the FCC to Gift It Spectrum in Areas of the Country Where No M-LMS Licenses Exist Today to Provide for Nationwide Coverage—an Extraordinary, Unwarranted Giveaway.

NextNav seeks a nationwide high-power terrestrial license and acknowledges that to obtain it, the FCC must "includ[e] spectrum sitting fallow in FCC inventory"[142]—in effect, a gift of high-power licensed rights in geographic areas of the country *where no M-LMS licenses exist.* Put another way, NextNav not only wants the FCC to exchange its M-LMS licenses with far lesser rights for a nationwide license that would be substantially economically superior to the M-LMS license, it wants a license with nationwide coverage including in areas where it has no rights. This giveaway is inexplicable and NextNav does not even attempt to defend it as a legal matter.

In addition, this giveaway potentially violates the FCC's currently lapsed statutory obligation under Section 309 of the Communications Act to auction mutually exclusive initial licenses.[143] In

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[135] Progeny LMS, LLC, Request for Waiver and Extension of Time, WT Docket No. 12-202, filed Mar. 31, 2020, amended by Erratum to Request of Progeny LMS, LLC for Waiver and Extension of Time, WT Docket No. 12-202, FCC File Nos. 0009029687 through 0009029728, dated Apr. 18, 2020 (Request).
[136] FCC, DA 20-755, released July 17, 2020.
[137] Progeny LMS, LLC's Request for Waiver and Extension of Time, WT Docket No. 12-202, Apr. 2, 2019 (Handset Waiver Request); Progeny LMS, LLC's Further Request for Waiver and Extension of Time, WT Docket No. 12-202, Sept. 17, 2020 (Second Construction Deadline Request); Progeny LMS, LLC's Further Waiver Request, WT Docket No. 12-202, Feb. 2, 2021 (Coverage Waiver Request); Progeny LMS, LLC's Request for Waiver and Extension of Time, WT Docket No. 12-202, Mar. 31, 2021 (Third Construction Deadline Request).
[138] FCC, DA 23-265, released Mar. 29, 2023.
[139] Request of Progeny LMS, LLC For Waiver and Extension of Time, WT Docket No. 12-202, Jan. 10, 2025, available at https://www.fcc.gov/ecfs/document/1011043364282/1.
[140] NextNav Inc., Current Report (Form 8-K), Mar. 7, 2024, p. 1, available at https://www.sec.gov/ix?doc=/Archives/edgar/data/0001865631/000121390024021237/ea0201463-8k_nextnav.htm.
[141] FCC, DA-24-776, fn. 10.
[142] NextNav Petition, p. 29.
[143] 47 CFR 309(j).

addition, foregoing an auction deprives the U.S. Treasury of significant auction revenue, while providing a windfall to incumbents.

C. NextNav Is Financially Weak.

In addition, NextNav's financial status is relevant to assessing the risk that the rule changes will not actually lead to a new nationwide 900 MHz 5G system. In 2022 and 2023, NextNav's revenues for all services, including PNT services, was less than $4 million annually.[144] Consistent with facing substantial competition and having little revenue, NextNav is not, and has not been, profitable.[145] In reviewing its risk factors, NextNav includes a long list of challenges related to its lack of profitability, but none of these refer to a need for a change in FCC rules or spectrum allocation:[146]

- We have incurred significant losses since inception. We expect to incur losses in the future and may not be able to achieve or maintain profitability and may need to raise additional capital to maintain our operations in the future.
- Our limited operating history makes it difficult to evaluate our future prospects and the risks and challenges we may encounter.
- Our business plan and, in turn, our ability to generate revenue, depends in large part on end users accessing our services through our customers' platforms.
- We may not be successful in the evolution of our TerraPoiNT technology to utilize 5G NR signals, which would increase our costs and may increase the challenges of adopting our service.
- Our hybrid architecture, which depends on the use of our transmitters and our ability to calibrate signals transmitted by third parties, is unproven, may not perform well and may cost significantly more than our initial estimates.
- Our services may not continue to be adopted or retained by wireless carriers and device vendors for E911.
- Our services are available within defined network footprints, and if we are not able to deploy new infrastructure, we will not be able to expand our service area. There is no guarantee that TerraPoiNT service will be sold to commercial or additional government users or achieve broad commercial support in the United States or internationally.
- There is no guarantee that Federal and state government resilient positioning, navigation and timing ("PNT") programs will result in procurements that result in the adoptions of our services and revenue to use, and the process that may result in such adoption or revenue may be delayed.

[144] Ibid., p. F-4.
[145] Ibid.
[146] Ibid., pp. 12-29.

VI. Conclusion

Upon weighing the estimated costs associated with NextNav's petition against the estimated benefits, this analysis concludes that NextNav's proposed re-banding of the Lower 900 MHz band provides *no net economic benefit* to the American people. Instead, the costs to the nation due to disruptions to current incumbent operations in the Lower 900 MHz band far outweigh the estimated benefit of a new commercial wireless frequency range. Therefore, this study concludes that the NextNav proposal is not in the public interest.

Exhibit 2.1

Current Rules for Lower 900 MHz Band

		MHz Band		
		902 - 907	907-918	918-928
90.209, 90.210, 90.353, 90.357	Distinction in rules between multi-lateratin and non-multilateration technologies	x	x	x
FN US218, 90.353	LMS Accepts interference from Part 90 Devices	x	x	x
FN US218, 90.353	LMS Accepts interference from Federal users	x	x	x
90.361	LMS Accepts interference from Part 97 devices	x	x	x
90.361	LMS Accepts interference from Part 15 devices	x	x	x
90.353(a)	LMS Does Not cause harmful interference to Part 90 devices	x	x	x
FN US218, 90.353(a)	LMS Does Not cause harmful interference to Federal users	x	x	x
90.353 (d)	LMS Does Not cause unacceptable levels of interference to Part 15 devices	x	x	x
90.155	Time limits for the introduction of LMS services	x	x	x
90.205	LMS authorized a maximum of 30 watts ERP	x	x	x
90.209	Bandwidth limitations on multilateration and non-multilateration LMS operations	x	x	x
"90.210"	Emission masks for LMS systems	x	x	x
90.357	Specific band limits and sharing requirements between multilateration and non-multilateration systems	x	x	x
90.359	Field strength limits for LMS systems	x	x	x
90.365	Partitioning and disaggregation of licenses	x	x	x

Exhibit 2.2

NextNav Proposed Rules for Lower 900 MHz Band

		MHz Band		
		902 - 907	907-918	918-928
~~90.209, 90.210, 90.353, 90.357~~	~~Distinction in rules between multi-lateratin and non-multilateration~~	*	*	*
FN US218, 90.353	LMS Accepts interference from Part 90 Devices	x	x	x
FN US218, 90.353	LMS accepts interference from Federal stations	x	x	x
~~90.361~~	~~LMS Accepts interference from Part 97 devices~~	*	*	*
~~90.361~~	~~LMS Accepts interference from Part 15 devices~~	*	*	*
90.353 (a)	LMS Does Not cause harmful interference to Part 90 devices	x	x	x
FN US218, 90.353 (a)	LMS Does Not cause harmful interference to Federal stations	x	x	x
~~90.353(d)~~	~~LMS Does Not cause unacceptable levels of interference to Part 15 devices~~	*	*	*
~~90.155~~	~~Time limits for the introduction of LMS services~~	*	*	*
90.205	LMS authorized a maximum of 30 watts ERP	x	x	x
~~90.209~~	~~Bandwidth limitations on multilateration and non-multilateration LMS operations~~	*	*	*
~~* 90.210~~	~~Emission masks for LMS systems~~	*	*	*
~~90.357~~	~~Specific band limits and sharing requirements between multilateration and non-multilateration systems~~	*	*	*
~~90.359~~	~~Field strength limits for LMS systems~~	*	*	*
~~90.365~~	~~Partitioning and disaggregation of licenses~~	*	*	*
Proposed 2.106, 90.209, 90.1401, 90.1402, 90.1403,	Terrestrial Positioning, Navigation, and Timing as specified service	x		x
Proposed FN US218	LMS and TPNT accept interference from Part 90 Devices	x	x	x
Proposed FN US218	LMS and TPNT accept interference from Federal users	x	x	x
Proposed 2.106	FIXED and MOBILE Services primary in 902-928 band	x	x	x
Proposed 2.106	Footnote US218 in ITU Table of Allocations amended to include TPNT	x		x
Proposed 2.106	Footnote US275 in ITU Table ofr Allocation amended to include TPNT	x		x
Proposed 90.209	Bandwidth limitations on LMS operations and TPNT operations	x	x	x
Proposed 90.210	Emission limits for LMS at 907 MHz and 918 MHz		x	
	LMS Does Not cause harmful interference to Part 90 devices no mention of TPNT not causing harmful interference, and LMS limited to 907-918MHz)		x	
FN US218	LMS and TPNT Do Not cause harmful interference to Federal users	x	x	x