Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services	)	GN Docket No. 14-177
	)	
Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands	)	IB Docket No. 15-256
	)	
Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations	)	IB Docket No. 97-95
	)	
Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42.0-43.5 GHz Band	)	RM-11664

REPLY OF AVANTI

Avanti Communications Group plc ("Avanti") is a UK headquartered Ka-band satellite operator based in London. Avanti has already committed over US $1.2 billion in the deployment of existing and already procured Ka-band satellite systems; circa US$ 500 million of that investment committed by Avanti has been directed to US-based suppliers of goods and services. Avanti hereby submits its reply in response to the Comments to the

Federal Communications Commission's ("FCC" or "Commission") Notice of Proposed Rulemaking ("NPRM") in the above referenced proceeding.

I. Executive Summary

Avanti welcomes the FCC's approach to consider all stakeholders views in this proceeding. Allocating and / or identifying new frequency bands for the terrestrial component of future 5G systems is a challenging task. The FCC decisions will have far-reaching effects on the development of new technologies and services for both new and existing FCC licensees and careful consideration is therefore required. This will only happen if key factors are taken into account:

1. International harmonization;
2. Protection of incumbent services;
3. Identification of suitable bands for 5G.

After reviewing the filings from all the stakeholders that commented on the Commission's NPRM, we base our reply to this contribution based on the above three main principles: (1) international harmonization as a key for the success of future 5G systems roll out, (2) the need to ensure incumbent services are not displaced and allowed to continue their sustainable growth (3) the suitability of mmWave frequency bands (i.e. 32 GHz and above 32 GHz) for future mobile services.

As the record demonstrates, 5G technologies are still largely in the conceptual phase and, accordingly, are years away from potential deployment despite some early testing by some manufacturers[1]. Before the FCC can examine the use of the spectrum above 24 GHz in

[1] *See, e.g.,* GN Dkt No. 14-177, RM-11664, Comments of Verizon at 2 ("While a substantial amount of work is being done that may eventually lead to commercial uses of one or more above-24 GHz spectrum bands, it is currently unclear what technologies and business models may eventually emerge for those frequencies."); GN Dkt No. 14-177, RM-11664, Comments of 4G Americas at 3 (. . "much more research and development by industry is needed before 5G is deployed . . ").

a rulemaking proceeding, 5G technology needs to be further defined[2]. Only once the 5G technology and associated radio standards for 5G are developed can the exercise to examine spectrum, even begin. Outside the United States, regulators and terrestrial carriers alike have recognized that heterogeneous networks leveraging satellite technology will play a critical role in the delivery of 5G. Under the Commission's current proposal for the 28 GHz, 37 GHz, and 39 GHz bands, however, that role remains unlikely to develop to the detriment of consumers and the 5G ecosystem.

This is further evidenced by the fact that no party from the terrestrial industry that advocates for sharing of terrestrial 5G services with satellite services in the 28 GHz band has provided any technical analysis in their filings on which the FCC could even make the most basic of decisions required as part of a rulemaking. Accordingly, the FCC should only move forward with a rulemaking proceeding based on the above key principles to determine the use of the frequency bands above 24 GHz. In doing so, we believe that the FCC can provide the appropriate balance between enabling new 5G / IMT mobile services and allowing for continued investment and innovation in existing and planned satellite services particularly the 28 GHz band.

II. Harmonisation

In its NPRM, the Commission identified international harmonization as one of the four main criteria to be used in evaluating the suitability of mmWave bands for mobile use. In addition, they stated they would: "*work with other countries through the International Telecommunications Union (ITU), in particular the World Radio Conference (WRC), and*

[2] *Cf.* Amendment of Part 11 of the Commission's Rules (Emergency Alert System), Order, 18 FCC Rcd. 16406, 16406 ¶ 1 (EB 2003) (dismissing a petition for rulemaking that was premature because an advisory committee was still working through issues); *cf.* 47 C.F.R. § 1.401(e) (petitions for rulemaking may be denied or dismissed if premature).

other processes to promote harmonized spectrum assignments for mmW mobile use"[3]. Avanti commended the Commission for these statements in its Comments to the NPRM and recognized the importance of the future requirements for globally harmonized spectrum for IMT services in relevant frequency bands above 24 GHz.

The ITU World Radiocommunication Conference 2015 ("WRC-15") agreed to conduct and complete, in time for ITU WRC-19, sharing and compatibility studies for possible new allocations and identifications for the terrestrial component of IMT in a limited set of frequency bands. The ITU Member States attending the WRC-15 did not include the band 27.5 - 28.35 GHz ("the 28 GHz band") as a candidate band for future terrestrial mobile IMT services ("MS"). This was a key outcome of the Conference to exclude this band from the scope of the studies as a result of overwhelming worldwide opposition to considering Ka-band for future terrestrial mobile 5G services, given its current and planned used for satellite communications and the incompatibility between satellite earth stations and terrestrial mobile broadband applications. Therefore we think it will be very challenging, if not impossible, for the Commission to reach consensus globally within the 28 GHz band as there was already clear opposition to this band during the WRC-15. The levels of investment in Ka-band satellite systems around the world will continue to increase and there will be an increasing number of countries using Ka-band for the delivery of high value Ka-band satellite broadband and other satellite services to governments, enterprises and consumers in those countries including in the Americas.

Avanti urges the Commission to note that current frequency bands for mobile communications are already highly fragmented because of a lack of common band plans

[3] http://apps.fcc.gov/ecfs/comment/view?id=60001386426 *(see page 4)*

among regulatory administrations, creating significant challenges for equipment manufacturing with a complex set of regulations and requirements for mobile devices already for 3G and 4G technologies. Continuing to consider the 28 GHz band would create further band fragmentation and affect the interoperability across geographic regions, while also decreasing the economies of scale for equipment manufacturers planning to develop 5G terrestrial mobile equipments.

The FCC should carefully take note of the Comments received by AT&T and 4G Americas in their Comments advocating for bands with global harmonisation. We also see this from the studies and development conducted by 5G vendors who categorically emphasize the need for global harmonisation for the success of 5G. This harmonization of technical and regulatory issues also promotes (1) global interconnection (the economies and scale); (2) limited number of models of equipment needed; (3) lower roaming cost; (4) minimum fragmentation of spectrum; (5) greater interoperability.

International harmonisation is well known to reduce development and hardware costs by promoting a unified world market and enabling greater economies of scale. Not only has this been acknowledged by the Commission and most regulators worldwide – who have frequently highlighted international harmonization of spectrum as a key policy goal and have endorsed the benefits of global harmonization – but it is also considered to be a key component of 5G's success by the mobile industry. To name a few, AT&T[4], 4G Americas[5], Samsung[6] and Huawei[7] all highlight the benefits of globally harmonized spectrum bands for future terrestrial 5G services in their Comments to the NPRM. Cisco, in particular, states that:

[4] See http://apps.fcc.gov/ecfs/comment/view?id=60001386420 *(see page 3)*
[5] See http://apps.fcc.gov/ecfs/comment/view?id=60001384650 *(See page 14)*
[6] See http://apps.fcc.gov/ecfs/comment/view?id=60001384896 *(see page 12)*
[7] See http://apps.fcc.gov/ecfs/comment/view?id=60001386694 *(see page 6)*

"*for technology companies to make the substantial investments necessary for developing 5G equipment, the Commission must (1) provide reasonable assurance that the market for mmWavebased mobile services will be large enough to justify those investments*"[8] which, would certainly be more likely when considering a globally harmonized band.

In this context, Avanti believes that the FCC should give immediate consideration to the 31.8 – 33.4 GHz ("32 GHz"), 71-76 GHz and 81-86 GHz bands for which the FCC has not developed proposed rules notwithstanding identification of these bands for study and inclusion on the agenda for WRC-19 as reflected in the final act of WRC-15. In particular, given the importance of international harmonization expressed by the mobile industry in its Comments to the NPRM and the outcome of the WRC-15, Avanti urges the Commission to consider the suitability of the 32 GHz band for the future development of 5G services. Avanti is of the opinion that continuing to only consider the 28 GHz band would risk delaying the rollout of 5G services in the United States and worldwide, as the band does not have broad international support for future IMT/5G use and will therefore not achieve consensus during the development stage of IMT, let alone international harmonization. In return, the United States would lose the opportunity to be world leaders in promoting the 5G technology worldwide.

III. Aggregate Interference From 5G at 28 GHz To Ka Band Satellites

Considering the high density envisaged for 5G base stations – a typical cell radius of around 100 - 200 meters – many thousands of simultaneous interferers could be expected in the satellite footprint. A critical parameter to control interference is the maximum EIRP spectral density from Flexible Use Service (FUS) base stations and terminals. The

[8] See http://apps.fcc.gov/ecfs/comment/view?id=60001386426 *(see page 4)*

Commission has suggested EIRP spectral density limits higher than those suggested by terrestrial 5G proponents such as NYU and Samsung[9], and higher limits still for FUS systems in rural areas. But there is no technical analysis presented by the Commission to demonstrate that Ka-band FSS operations in the 28 GHz band would not be harmed by interference from FUS systems.

Ka-band satellite spot beams cover relatively large geographic areas and receive signals from both earth stations and other transmitters operating in the same frequency band situated within the beam footprint. Given the expected cell size of terrestrial 5G services – approx. 100 - 200 m – and the envisaged ubiquitous deployment of base stations and mobile terminals, a Ka-band satellite spot beam is likely to cover hundreds of thousands of 5G devices within its coverage area, generating aggregate interference at the satellite receiver. Interference to the satellite receiver is particularly disruptive, as it could negativelyaffect all the services provided via Ka-band spot beams serving the US or indeed other countries in the Americas.

We invite the Commission to note that similar concerns are shared by two of the main worldwide players in Ka-band satellite communications, Inmarsat[10] and O3b[11], in their Comments to the NPRM. Also, as far as we are aware, no proponent has presented in its Comments an interference analysis alleviating the concern presented above. In particular, the satellite operators supporting the feasibility of coexistence – under certain conditions – of satellite and 5G services in the 28 GHz band do so based on their assessment of interference of satellite Earth Station transmissions to receive 5G station operations, but fail to identify – or address – the aggregate interference from 5G signals to satellite receivers here presented.

[9] Id. at 11,878 ¶ 275.
[10] http://apps.fcc.gov/ecfs/document/view?id=60001416165 *(see page 7)*
[11] http://apps.fcc.gov/ecfs/document/view?id=60001416258 (*see section 4)*

As stated in our Comments to the Commission's NPRM and based on our technical assessment of the above interference scenario, Avanti does not consider it feasible to establish limits on the EIRP of 5G base and mobile stations that would adequately protect Ka-band satellite uplinks in a sustainable manner that could also allow for the operation of 5G / IMT mobile service systems in both indoor and outdoor environments. Avanti believes there is no valid technical basis for the Commission to proceed with its technical parameters for the FUS in the 28 GHz band.

IV. The 32 GHz Band

Avanti commends the Commission for opening consideration to the 31.8 – 33.4 GHz band (the "32 GHz band")[12] as a suitable candidate for IMT services. This was the band that gathered greater international support during WRC-15 and will therefore be considered within the ITU framework for sharing and compatibility studies in support of a possible new allocation and identification for future terrestrial 5G / IMT services at WRC-19.

Detailed compatibility studies in the 33.0 – 33.4 GHz band between 5G / IMT mobile services and Federal satellite systems should be undertaken. Even if it is assumed that for non-technical reasons one excluded the 33.0 – 33.4 GHz band currently used for Federal satellite systems under US FN G117, the band 31.8 – 33.0 GHz still provides 1.2 GHz of spectrum for 5G / IMT mobile services. This is circa 50% more than the 850 MHz considered

[12] See PROPOSALS FOR WORK OF THE CONFERENCE, Member States of the Inter-American Telecommunications Commission (CITEL), Proposed Agenda Item for WRC-2019 for consideration of identification of frequency bands for the terrestrial component of IMT in the frequency range 27.5-71 GHz, including appropriate mobile allocations if needed, to facilitate the development of mobile broadband applications, Doc. XXXX-E, July 31, 2015 (identifying spectrum bands at 24.25-27.5 GHz; 31.8-33.4 GHz; 37-43.5 GHz 45.5-50.2 GHz; 50.4-52.6 GHz; 66-76; and 81-86 GHz).

for 5G / IMT mobile services at 28 GHz, with similar propagation characteristics but with high prospects of international harmonisation.

In our Comments to the NPRM, we suggested the Commission considered the 32 GHz band as part of this proceeding. We now invite the Commission to note that several mobile proponents have also identified this band as a good candidate for terrestrial 5G services in their Comments. In particular, Samsung[13] – a pioneer in the development of 5G trials in the United States – expressed its support for future spectrum identification at 31 GHz for mobile services. In addition, and considering the outcome of the WRC15, Nokia[14], Huawei[15] and T-Mobile[16] also asked the Commission to consider the 32 GHz band in the proceeding.

Furthermore, for the ambitious bandwidth needs set out for 5G, the higher frequencies such as the 32 GHz can offer more opportunities than challenges. The very high user data rates require very substantial system capacity (consider the amount of overall system capacity required to support millions of users with peak data rates of 1 Gbps or even more). A spectrum efficient deployment of such networks requires maximizing the frequency reuse factor, which increases with the carrier frequency as the user range decreases due to physics of signal propagation. Going to higher carrier frequencies is thus an advantage rather than a drawback. It is also expected that use of the 32 GHz will rely primarily on line-of-sight paths at ranges in the order of 100 –200m or less. Research has indicated that massive MIMO can provide additional benefits, which can be exploited more effectively as the carrier frequency increases.

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[13] See http://apps.fcc.gov/ecfs/comment/view?id=60001384896 (*see page 3)*
[14] See http://apps.fcc.gov/ecfs/comment/view?id=60001385502 *(see page 3)*
[15] See http://apps.fcc.gov/ecfs/comment/view?id=60001386694 *(see page 10)*
[16] See http://apps.fcc.gov/ecfs/comment/view?id=60001386166 *(see page 4)*

V. The 64-71 GHz Band

The fourth spectrum band proposed in the NPRM for a 5G mobile services allocation is the 64-71 GHz Band. Provided that the bands considered in the NPRM aim to fulfil future terrestrial 5G services' requirements for capacity, Avanti believes that the 64-71 GHz band should also be prioritized and consistent with global allocations in the 66-76 GHz band. The Commission should grant exclusive use within this band 64-71 GHz to ensure the spectrum can be put to its most efficient use supporting 5G systems and promote economies of scale and globally accessible services. The importance of this band is clear in the Comments to the NPRM filed by mobile industry – manufacturers such as Ericsson[17], Nokia[18], Intel[19], Qualcomm[20] and operators such as T-Mobile[21] or AT&T[22] all support allowing mobile services in the band.

Furthermore, as evidently commented by stakeholders, this band holds a promising potential for indoor home licensed 5G services. Microwave links can co-exist with unlicensed short range broadband mobile broadband access technologies like WiGig which are today available in the market, but more importantly it is the specific propagation conditions in this band (characterized by a maximum oxygen absorption in the 60 GHz band) which can facilitate coexistence which is expected to be feasible without implementation of any mitigation technique.

[17] See http://apps.fcc.gov/ecfs/comment/view?id=60001385298
[18] See http://apps.fcc.gov/ecfs/comment/view?id=60001385502
[19] See http://apps.fcc.gov/ecfs/comment/view?id=60001385051
[20] See http://apps.fcc.gov/ecfs/comment/view?id=60001385572
[21] See http://apps.fcc.gov/ecfs/comment/view?id=60001386166
[22] See http://apps.fcc.gov/ecfs/comment/view?id=60001386420

VI. Some Comments Re LMDS Status In The 28 GHz Band

An initial analysis of the current status of US 28 GHz LMDS licencees (see Annex 1) suggests that in most major urban areas of the CONUS, there are existing LMDS licencees in place. It appears that the rules proposed in the NPRM would enable all (or virtually all) of these existing 28 GHz LMDS licences the freedom to convert their LMDS licences to 5G / IMT mobile service uses without participating in any competitive spectrum award process. If this is the intent of the proposed NPRM rules, it is not at all obvious that this regulatory policy approach will for example encourage new entrant mobile service operators to use the 28 GHz bands; it would instead seem to represent a mechanism to provide a remarkable windfall opportunity for the existing 28 GHz LMDS licencees. This may raise some broader spectrum policy questions for consideration by regulators and lawmakers.

VII. Conclusion

Avanti urges the Commission to ensure that U.S. consumers and organizations continue to have access to cost-effective, innovative and spectrally efficient satellite services in Ka-band. Avanti supports the expansion of broadband terrestrial services and the development of 5G / IMT technologies in appropriate frequency bands which do not cause disruption to satellite services. Avanti encourages the Commission to adopt a vision of 5G in this proceeding that encompasses the important investment of satellite services as a critical component of the future 5G ecosystem. Pioneering spectrum regulation should therefore allow both satellite services and terrestrial services to flourish. Spectrum regulations which envisage use of the 28 GHz band (viz 27.50 – 28.35 GHz) for 5G/IMT mobile services will on the other hand create serious conflicts and market disruption to current and planned

satellite services through harmful interference effects to those Ka-band satellite services provided in the US and North America.

Avanti supports the submissions made by ESOA and other parties proposing that the status of FSS be elevated from secondary to co-primary status to LMDS systems in the 28 GHz band (viz 27.50 – 28.35 GHz).

Avanti does not support the NPRM proposal to enable use of the 28 GHz LMDS band (viz 27.50 – 28.35 GHz) for future 5G/ IMT mobile uses since this will inevitably cause serious interference conflicts with and disruption to existing and planned Ka-band satellite services and associated operations in the US and in North America in this frequency band.

Avanti believes the Commission should continue with active consideration of the 32 GHz band and 64 – 71 GHz band as strong candidate bands that are both inherently suitable for 5G / IMT mobile service development and potential for global harmonisation. These bands are preferable alternatives to the 28 GHz band for new 5G / IMT / mobile services and provide more than sufficient bandwidth to accommodate future 5G/ IMT services in the US.

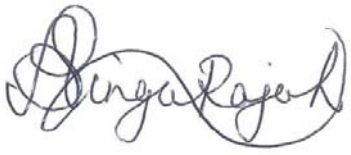
Avanti also notes in this context that there is already significant spectrum identified for mobile services in the US by prior FCC actions in various frequency bands below 3.7 GHz. There is also very significant spectrum in various bands above 31 GHz to accommodate mobile services. It is more than likely for economic and coverage reasons that future *cost efficient* high capacity 5G / IMT mobile service networks will be deployed in bands below 3.7 GHz in the US and will also probably use multi-band radios to support 5G/IMT networks at 32 GHz and above 64 GHz (or above 64 GHz) which would leverage of the economies of scale associated with the expected mass market deployment of 60 GHz WiGig devices. Given the existence of viable alternative frequency bands to support the future development of 5G / IMT mobile services in relevant bands below 3.7 GHz and above 31.0 GHz, in Avanti's view

there is no real compelling reason why the 28 GHz band should be targeted or identified for accommodation of future 5G/ IMT / mobile services in the US.

Respectfully submitted,

Avanti

/s/ Kumar Singarajah
Director of Regulatory Affairs and Business Development
Avanti



February 26th, 2016

ANNEX – LMDS Licenses Status

The FCC allocated two licenses per Basic Trading Area (BTA) across the United States – a Block A and Block B license in each. According to the Commission[23], of the 986 designated license areas (493 BTAs times two licenses per BTA), 416 areas have active licenses, which cover about 75 percent of the U.S. population. In terms of Block A licenses – which include **27.50-28.35 GHz**; 29.10-29.25 GHz and 31.075-31.225 GHz – there are currently 355 active out of the 493 auctioned.

Most of the areas with higher concentration of population are covered by active Block A LMDS licenses. For instance, the 10 largest cities in the US – which are likely to be the main markets of future IMT / 5G services at microwave frequencies – all have active LMDS licenses.

Figures 1 to 7 show an overview of the BTAs which have active Block A licenses across the US, along with details of the active licenses in highly populated areas.

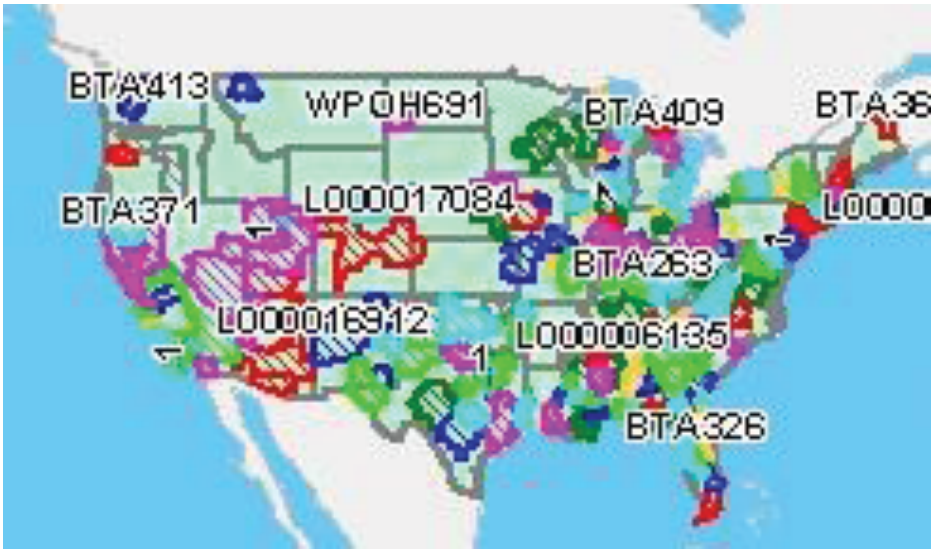


Figure 1 – LMDS Block A Active Licenses US

[23] *See Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, GN Docket No. 14-177, et al., Notice of Proposed Rulemaking, FCC 15-138, 30 FCC Rcd. 11,878 (2015) ("NPRM").

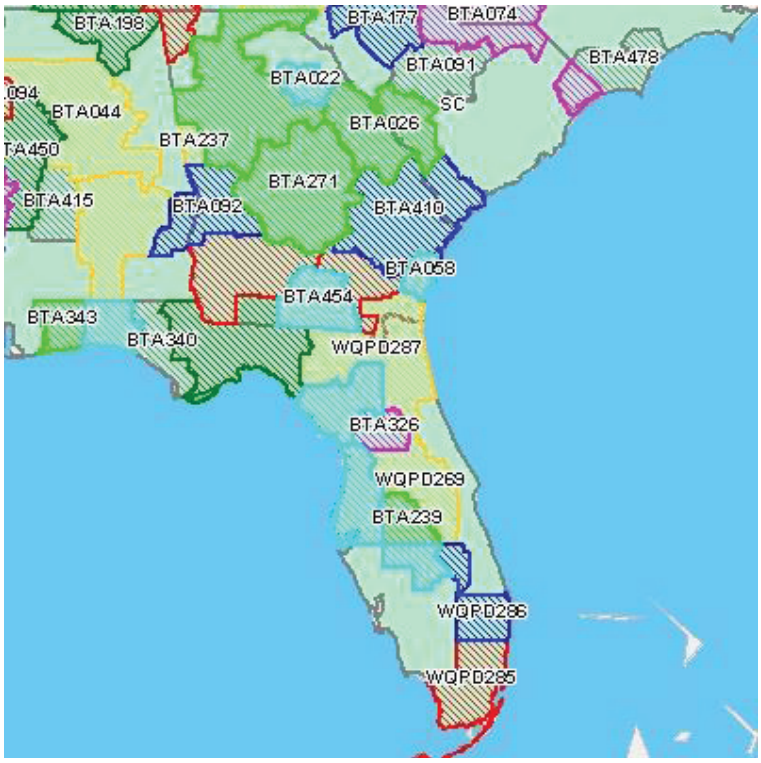


Figure 2 - LMDS Block A Active Licenses – Florida, Georgia

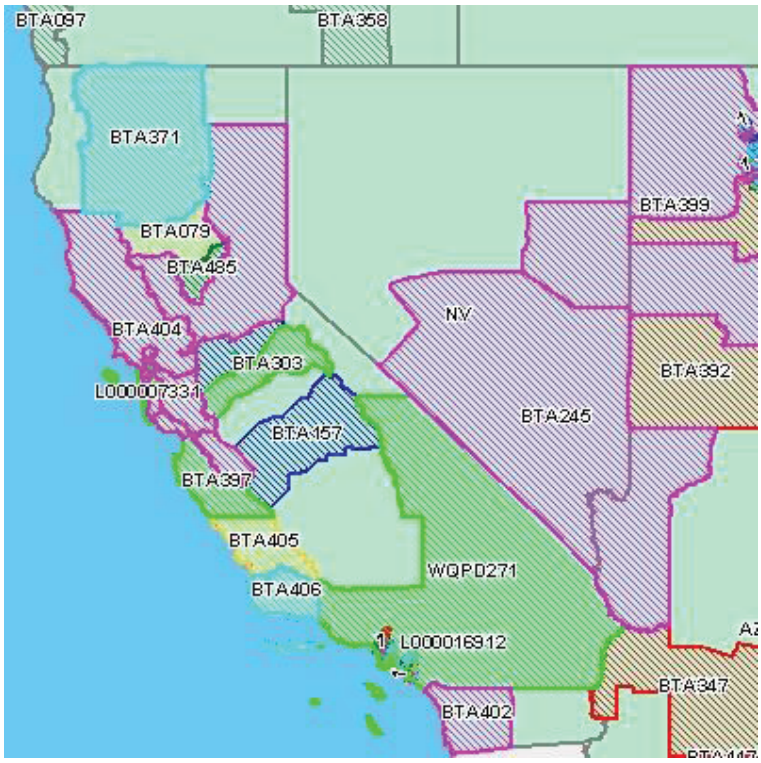


Figure 3 – LMDS Block A Active Licenses - California, Nevada

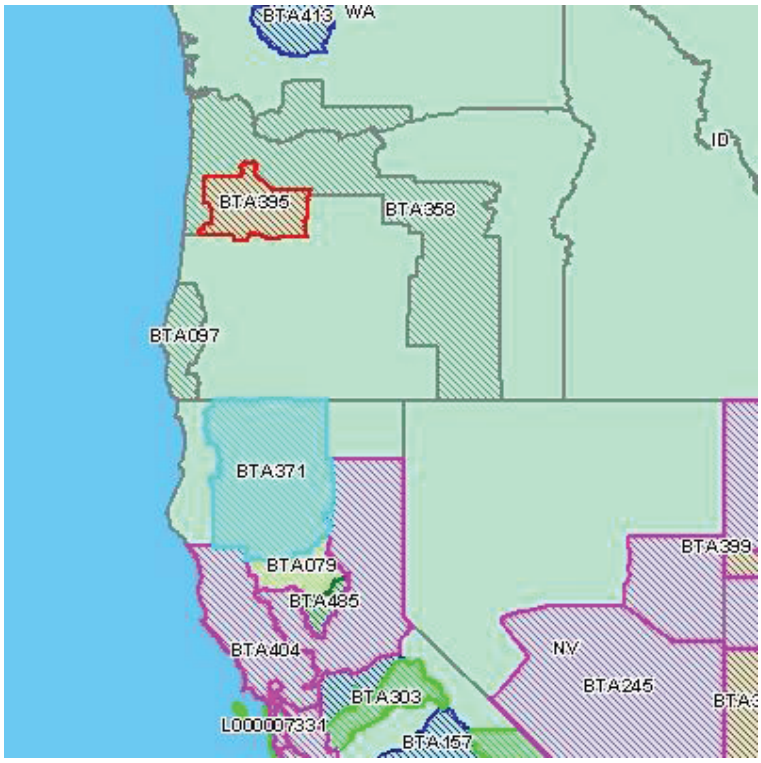


Figure 4 - LMDS Block A Active Licenses – Seattle, Salem

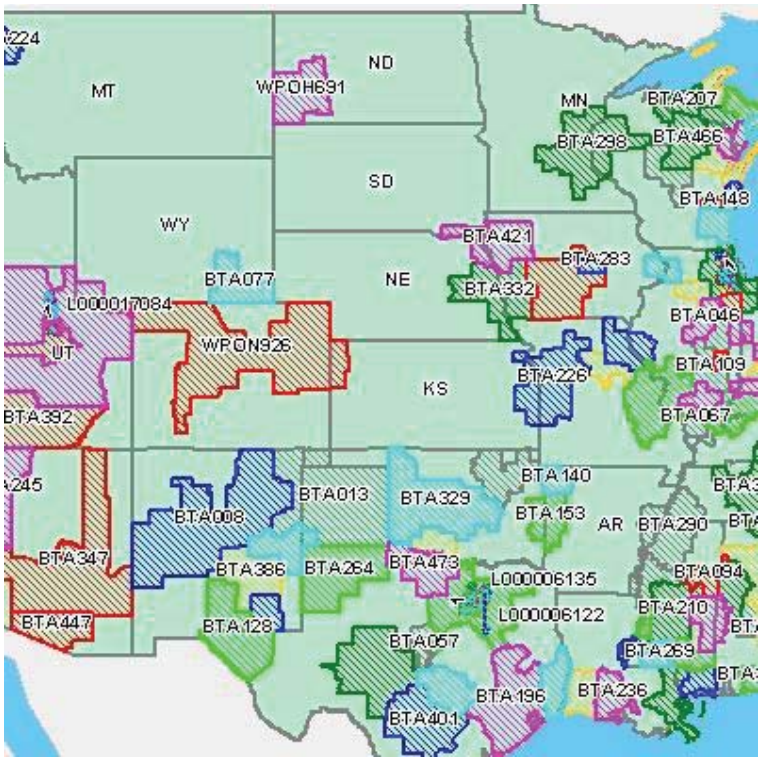


Figure 5 - LMDS Block A Active Licenses – Phoenix, Houston, Dallas, San Antonio

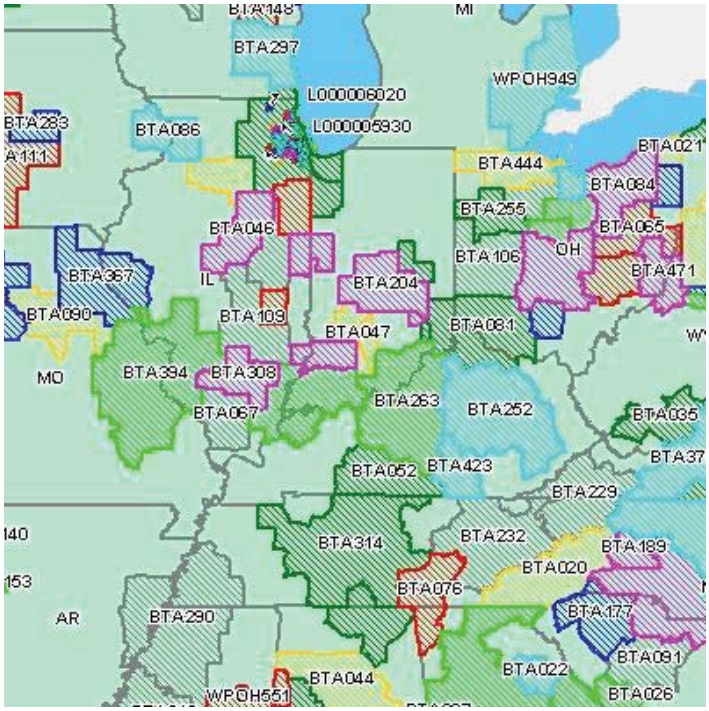


Figure 6 - LMDS Block A Active Licenses – Chicago, Detroit, St Louis

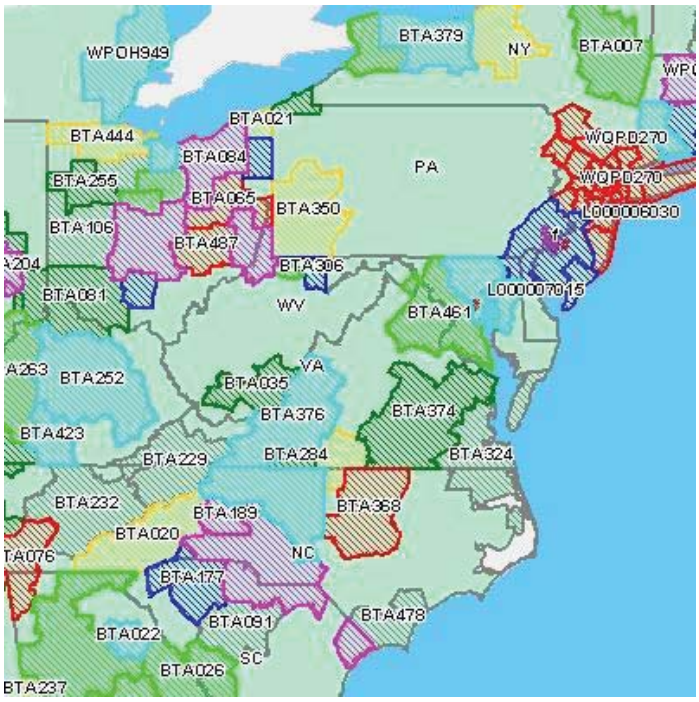


Figure 7 - LMDS Block A Active Licenses – New York, Philadelphia, Washington