Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of Review of the Commission's Rules Governing the 896-901/935-940 MHz Band	))))	WT Docket No. 17-200

To: The Commission

COMMENTS
OF
ENTERPRISE WIRELESS ALLIANCE
AND
PDVWIRELESS, INC.

Respectfully submitted,

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EXECUTIVE SUMMARY

The 900 MHz Band (896-901/935-940 MHz) has provided a valuable spectrum option for meeting the narrowband requirements of Private Enterprise ("PE") entities, including Critical Infrastructure Industry ("CII"), in certain parts of the country for three decades. But as evidenced in this NOI, the spectrum allocated for use by those entities has remained largely unutilized in many parts of the nation. It is time to modernize the 900 MHz Band regulatory structure so that this prime spectrum below 1 GHz can continue to support narrowband requirements while also addressing escalating PE/CII broadband needs. This can be accomplished by establishing a new category of licensee, the private enterprise broadband ("PEBB") carrier. The PEBB will offer a private carrier option, working with PE/CII entities to build broadband systems that meet their demanding specifications for coverage, reliability, redundancy, and security when those needs are not met on commercial wireless networks.

Providing for the deployment of new private carrier broadband networks across the country, while preserving and protecting important incumbent operations, will address a significant number of the key issues and goals presented by the FCC Chairman and Commissioners, including:

- Ensuring the evolution of less than fully utilized spectrum, while protecting incumbents;
- Stimulating private investment in infrastructure;
- Accelerating deployment of innovative broadband technologies;
- Acting in a timely manner on items with benefit to the public good;
- Promoting rural broadband deployment;
- Generating new and significant job growth;
- Injecting new competition in the delivery of broadband; and
- Removing regulatory impediments.

It will "increase access to spectrum, improve spectrum efficiency, and expand flexibility" in the 900 MHz Band, and thereby ensure that this spectrum is put to its "best and highest use for the American public."

Consistent with their Petition for Rulemaking in this proceeding, the Enterprise Wireless Alliance ("EWA") and pdvWireless, Inc. ("PDV") recommend a bifurcation and realignment of the band to create a 3/3 megahertz broadband allocation at 898-901/937-940 MHz – the PEBB allocation – while retaining a 2/2 megahertz allocation at 896-898/935-937 MHz for narrowband systems. The PEBB allocation would be a combination of the spectrum held by PDV, primarily auctioned MTA authorizations, plus site-based licenses purchased from PE/CII entities, and the 900 MHz Band channels that are unused and being held in the FCC's inventory. The PEBB licensee would be responsible for identifying replacement spectrum for any incumbent with channels above 898/937 MHz and for all costs associated with providing comparable facilities for their continued narrowband operations.

EWA/PDV reaffirm their belief that the rules they proposed initially remain valid, with some modest modifications intended to harmonize them with rule changes adopted by the Commission for broadband systems generally. The technical viability of those rules and their ability to protect adjacent operations from harmful interference have been validated by independent analyses conducted on EWA/PDV's behalf, as attached hereto or filed separately in this proceeding by Pericle Communications Company. EWA/PDV did examine the possibility of adopting a dynamic sharing arrangement in the 900 MHz Band, and they endorse that approach as allowing efficient use of spectrum in many instances, but they have determined that it would not be viable in an allocation of this size.

The Commission has ample authority to grant PEBB authorizations through license modifications, and EWA/PDV submit that it is in the public interest to do so as promptly as possible, given both the market need and the public benefit. Initiating a competitive bidding process for spectrum that, for the most part, was acquired at auction initially, and that otherwise was purchased in the secondary market, would unnecessarily extend the period until PE/CII entities can take advantage of the PEBB option. These users, in particular utilities, have repeatedly advised the FCC and other agencies of their urgent need for access to other than consumer-focused broadband systems. Delaying the availability of PEBB authorizations will further postpone the time at which these critical communications requirements can be met.

EWA/PDV do propose overlay auctions without mandatory relocation rights for most of the 2/2 megahertz narrowband allocation, albeit with a time-limited, 10-channel reservation for site-based licensing, should that continue to appeal to certain PE/CII entities. They recommend that such auctions be for wideband authorizations of varying bandwidths that could attract interest from incumbent or new entrants with other than narrowband needs, and thereby put into productive use spectrum that has lain fallow in too many areas for too many decades.

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The Enterprise Wireless Alliance ("EWA") and pdvWireless, Inc. (previously Pacific DataVision, Inc.) ("PDV") (collectively "EWA/PDV") are pleased to file these Comments in response to the Federal Communications Commission ("FCC" or "Commission") Notice of Inquiry ("NOI") in which the FCC seeks to determine whether rule changes in the 896-901/935-940 MHz band ("900 MHz Band") would "increase access to spectrum, improve spectrum efficiency, and expand flexibility…for next generation technologies and services."[1] As discussed in greater detail below, modernizing the rules for this underutilized band and allowing for the deployment of new private carrier broadband networks across the country, while preserving and protecting important incumbent operations, will address a significant number of the key issues and goals presented by the FCC Chairman and Commissioners, including:

- Ensuring the evolution of less than fully utilized spectrum, while protecting incumbents;
- Stimulating private investment in infrastructure;
- Accelerating deployment of innovative broadband technologies;

[1] Review of the Commission's Rules Governing the 896-901/935-940 MHz Band, WT Docket No. 17-200, *Notice of Inquiry*, 32 FCC Rcd 6421 at ¶ 1 (rel. Aug. 4, 2017) ("NOI").

- Acting in a timely manner on items with benefit to the public good;
- Promoting rural broadband deployment;
- Generating new and significant job growth;
- Injecting new competition in the delivery of broadband; and
- Removing regulatory impediments.

This Commission is committed to a regulatory environment that promotes innovation and investment, in particular in delivering broadband service. As stated recently by Chairman Pai:

> I believe that the FCC's most powerful tool for expanding digital opportunity is setting rules that maximize private investment in high-speed networks. For the plain reality is that the more difficult government makes the business case for deployment, the less likely it is that broadband providers, big and small, will invest the billions of dollars needed to connect consumers.[2]

And also:

> We believe that removing barriers to investment promotes more competition, which fuels innovation and investment and benefits consumers.[3]

EWA/PDV agree. Accordingly, the Commission should embrace the opportunity to realign the 900 MHz Band in support of its public interest responsibilities.

I. INTRODUCTION

A. <u>The 900 MHz Band Challenge</u>

Today's 900 MHz Band represents a challenge. In certain major markets, it supports a variety of narrowband private land mobile radio ("LMR") and data systems, some of which are used for essential, public service functions. The value of these private systems to the companies that operate them and to the public that relies on the services and goods they deliver is uncontroverted. EWA/PDV agree that any rule changes must provide for their continued operation.

[2]Remarks of FCC Chairman Ajit Pai at the Mobile World Conference Americas, San Francisco, California, September 12, 2017.
[3] Remarks of FCC Chairman Ajit Pai at the Kansas Broadband Conference, Wichita, Kansas, September 11, 2017.

However, in too many areas the channels reserved for site-based private systems have never been applied for by eligible users and remain unassigned – 30 years after the allocation was made. The Private Enterprise ("PE"), including Critical Infrastructure Industry ("CII"),[4] entities that qualify for these channels frequently are able to acquire narrowband spectrum outside major markets in other spectrum bands, including lower VHF, UHF or 800 MHz, where equipment choices are plentiful and often less costly. In those areas, site-based channels in the 900 MHz band have remained largely vacant for more than 30 years.[5]

This under-utilization, at least in part, is reflective of the fact that the 900 MHz Band rules have not been updated in more than two decades; the basic technical regulations are unchanged since adopted in 1986, although there has been a revolution in wireless technology since then. This regulatory structure prevents PE/CII users, as well as commercial providers such as PDV, with other than narrowband requirements from migrating to the advanced technologies that have become the norm in other bands and in the 900 MHz Band itself in other countries. It does not allow "continued evolutions in technology"[6] even for PE/CII entities that are prepared to invest in broadband facilities.

B. <u>The 900 MHz Band Opportunity</u>

> Today's Report and Order illustrates the need for the Commission to review its rules regularly and assess whether they continue to be necessary in light of changing technological and/or market conditions. In this item, we remove certain channel spacing and bandwidth limitations in the 800 MHz band that may have made sense almost twenty years ago but currently stand in the way of mobile broadband deployment.[7]

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[4] The FCC's CII definition can be found in 47 C.F.R. § 90.7.
[5] The same is true for narrowband 700 MHz Public Safety spectrum in more rural areas, where users sometimes favor VHF spectrum with its superior propagation and less costly equipment. The 700 MHz broadband network being deployed by the First Responder Network Authority ("FirstNet") will serve different purposes and is expected to be embraced throughout the nation.
[6] NOI at ¶ 1.
[7] Improving Spectrum Efficiency Through Flexible Channel Spacing and Bandwidth Utilization for Economic Area-based 800 MHz Specialized Mobile Radio Licensees, WT Docket No. 12-64, *Report and Order*, 27 FCC Rcd 6489; Statement of Commissioner Ajit V. Pai.

The instant NOI presents a similar opportunity to modernize an allocation below 1 GHz, spectrum that is optimally suited for cost-effective mobile operations, to accommodate both traditional LMR and advanced broadband technologies. Doing so would address the PE/CII need for more modern data communications capability, while also providing greater and more efficient spectrum utilization. Some PE entities are very large enterprises, including utilities, transportation companies, and manufacturing facilities. Others are relatively small. But all deserve access to broadband that is designed to address business, rather than consumer, service level requirements, whether they are located in urban areas or in more rural communities.

Almost three years ago, EWA/PDV submitted a Petition for Rulemaking recommending that the Commission bifurcate the 900 MHz Band to create a 3/3 megahertz broadband allocation at 898-901/937-940 MHz, while retaining a 2/2 megahertz allocation at 896-898/935-937 MHz for narrowband systems.[8] They proposed that this modernization be accomplished by combining the spectrum assets held by PDV that were acquired at auction or in the secondary market – representing approximately 52% of the nationwide megahertz/pops in the 900 MHz Band – with the 22% held in FCC inventory to create a wireless private carrier, the Private Enterprise Broadband ("PEBB") option, for PE/CII entities. This option will unlock the value of this spectrum by delivering the capabilities and functionalities that broadband technology, including LTE, offers, built to the demanding specifications of critical users with 24/7 responsibilities for delivering essential goods and services to the American public, while also addressing the national goals identified above.

In proposing a PEBB option for this band, EWA/PDV consider it a fundamental principle of good spectrum management to continuously investigate means for increasing spectrum

[8] Petition for Rulemaking of the Enterprise Wireless Alliance and Pacific DataVision, Inc., RM-11738 (filed Nov. 17, 2014) ("EWA/PDV Petition").

efficiency, while also ensuring that any changes do no harm to incumbent operations. This is particularly true at 900 MHz, as certain incumbents operate systems that provide and protect services vital to the public. Many of these licensees are also highly interested in moving to advanced broadband technology on networks that provide coverage, reliability, resiliency, and security that is not available on commercial systems. EWA/PDV are confident that the Commission will balance the interests of all 900 MHz Band incumbents, as well as the public interest, in its decision in this proceeding. [9]

The proposed 3/3 megahertz PEBB allocation represents only a small fraction, (3%), of the spectrum below 1 GHz that has been allocated for commercial mobile service:

600 MHz band – 70 megahertz
700 MHz band – 70 megahertz
800 MHz band – 64 megahertz

But this 3% of spectrum, if optimally realigned, can offer an outsized opportunity for the deployment of purpose-built systems designed to address the specialized broadband requirements of PE/CII entities without degrading their narrowband operations, a conclusion that is supported by the technical analyses described below and attached hereto.[10] In appropriate circumstances, the allocations listed above, and others, including unlicensed spectrum, could work synergistically with 900 MHz Band broadband through "carrier aggregation," a key feature of LTE-Advanced that enables operators to create larger "virtual" carrier bandwidths for LTE services by combining separate spectrum allocations.[11]

[9] Band repurposing and other changes in the rules inevitably draw opposition from some percentage of affected incumbents. Differences of opinion on such matters are the norm, whether based on technical or other considerations. The Commission does not require unanimity in such instances, but instead evaluates positions on their merits and considers them in light of what the FCC determines to be the public interest.

[10] *See* Attachments 1 and 2; *see also* Pericle Communications Company Comments being filed separately.

[11] LTE Carrier Aggregation, Technology Development and Deployment Worldwide, 4G Americas, http://www.5gamericas.org/files/8414/1471/2230/4G_Americas_Carrier_Aggregation_FINALv1_0_3.pdf.

Without in any way minimizing the inconvenience and disruption that incumbents experience when a band is realigned to promote its more efficient and intensive use, there simply is no other way to improve spectrum utilization, since the cupboard of vacant spectrum is bare. The public interest demands that all spectrum, but especially a rare allocation below 1 GHz, must be configured to support full, nationwide deployment and, on a non-interfering basis, technology with the advanced capabilities needed by American businesses, including those that provide essential service to the American public. EWA/PDV urge the Commission to adopt a Notice of Proposed Rulemaking that recommends their proposed approach as the best and highest use of the 900 MHz Band.

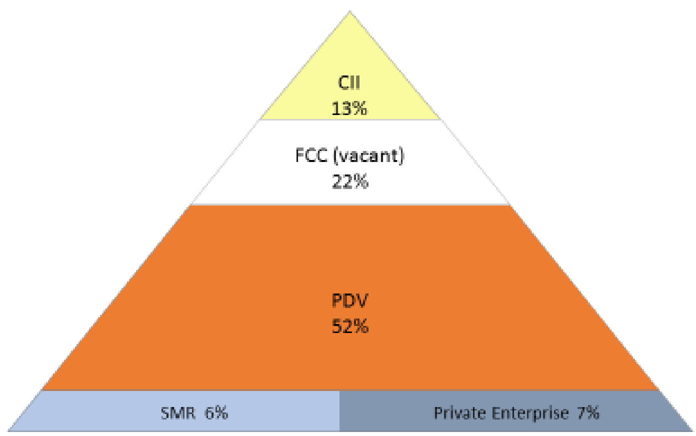
II. 900 MHz BAND – BACKGROUND[12]

The 900 MHz Band was allocated more than 30 years ago with a band plan based on 399 12.5 kHz bandwidth channels.[13] The rules governing 900 MHz channels allocated for commercial Specialized Mobile Radio ("SMR") systems were modified in 1995, more than 20 years ago, to provide for overlay geographic licenses purchased at auction. However, the auctioned SMR spectrum still is assigned in 10-channel blocks of contiguous frequencies separated by 10-channel contiguous blocks assigned for Business/Industrial/Land Transportation ("B/ILT") use.[14] The B/ILT channels available to PE/CII entities are licensed on a first-come, first-served, site- and frequency-specific basis through the frequency coordination process and pursuant to technical and operational rules that have remained unchanged since 1986.

[12] *See* NOI at ¶¶ 2-6.
[13] 900 MHz Reserve Band Allocation, GN Docket No. 84-1233, *Report and Order*, 2 FCC Rcd 1825 (1986).
[14] Users that qualify as B/ILT under the FCC rules are defined herein collectively as PE, or Private Enterprise entities that deploy private, internal communications systems. This category includes the subset of PE entities that are included in the CII definition.

The nationwide distribution of channels in the 900 MHz Band as determined by megahertz/pops covered is depicted in the diagram below. PDV is the largest spectrum holder, but the FCC itself holds in inventory the next greatest amount of spectrum, primarily B/ILT spectrum with some SMR spectrum that had been designated for geographic licensing by auction on a Major Trading Area ("MTA") basis.[15] The rest of the channels are divided among a small number of SMR licensees on both MTA and converted B/ILT channels, as well as utilities, other CII entities, and PE users, all operating on B/ILT spectrum.

Nationwide 900MHz Licensing Landscape*



* Based on calculated MHz-Pops from currently available FCC ULS license data, 2010 US Census data, and PDV analysis.

B/ILT spectrum is used in and around certain major urban areas by a variety of entities whose operating requirements can be met on 12.5 kHz narrowband channels, but is largely vacant outside those areas. This underutilization is confirmed by the incumbent information - approximately 500 B/ILT licensees nationwide – and map included in the NOI.[16] (The

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[15] As explained in previous filings, PDV holds an average of 240 900 MHz Band channels in each of the top 20 markets, as well as substantial 900 MHz Band spectrum outside those markets. *See, e.g.*, EWA/PDV Petition at 5.
[16] *See* NOI at ¶ 7.

Commission recently described the use of certain Part 90 173 MHz channels, ones with substantially more facilities per channel than on 900 MHz B/ILT spectrum, as "underutilized."[17])

The great majority of incumbents on B/ILT spectrum are licensed for very small systems, typically only a single site and the number of channels necessary to accommodate communications among their own personnel. There are only 61 B/ILT licensees with systems that are licensed collectively for more than 25 base stations. Some of these 61 licensees have facilities at multiple locations around the country, each of which may only have one or two transmitters. All these systems, large and small, provide essential communications services, and only a limited subset will be more challenging to migrate to different 900 MHz frequencies.

The relatively limited number of incumbents, only some of which would need to be relocated under the EWA/PDV proposal, makes this below-1 GHz band a prime candidate for modernization by the FCC, an action that would be consistent with the intent of many in Congress as expressed in the pending Mobile Act Now legislation.[18] It would allow the FCC to set an example for all Federal agencies by demonstrating its commitment to ensuring that valuable 900 MHz Band spectrum, channels that are in the FCC's inventory and not being used for any purpose, will be put to productive use for the benefit of the American people. As stated by Chairman Pai during Congressional testimony in 2012 with regard to spectrum allocated for Federal use:

[17] *See* Attachment 3.
[18] Making Opportunities for Broadband Investment and Limiting Excessive and Needless Obstacles to Wireless Act or the MOBILE NOW Act, S.19 - 115th Congress (2017-2018).

> I can't put it any better than the House Energy and Commerce Committee's bipartisan Federal Spectrum Working Group: "Finding more efficient ways for the government to use this valuable public asset without compromising critical objectives would not only produce dividends for government agencies, but also inject additional resources into the private sector to spur our economy."[19]

III. PE/CII AND THE BROADBAND REVOLUTION

The NOI is correct. It is time to consider "how to ensure that the 900 MHz band is put to its best and highest use for the American public."[20] In the world of wireless technology, the 30 years since the rules in this band have been updated is multi-generational. The remarkable technological progress that has occurred over those three decades makes possible extraordinary advances in the functionality, flexibility, capability and efficiency of spectrum resources, provided those advances can be implemented consistent with FCC rules. Unfortunately, that is not possible in the 900 MHz Band, whose rules limit the aggregation of more than a very modest 125 kHz of contiguous spectrum and therefore lock users into a limited number of technology choices.[21]

Without questioning the continued preference of some licensees for narrowband systems, the attached presentations confirm that a growing number of major utilities are building their future business and operational models around broadband capabilities. For example, Duke, in a project intended to develop a 15-year enterprise communications strategy, has concluded that "Broadband IP is needed from the core to the edge of the grid" and that it must "Improve performance of the business network to support video, mobility, data transfer, etc."[22] Southern Company, through its Southern Linc subsidiary, is a trailblazer in recognizing the critical need

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[19] Statement of Commissioner Ajit Pai at Hearing Before the Subcommittee on Communications and Technology of the US House of Representative Committee on Energy and Commerce, "Keeping the New Broadband Spectrum Law on Track," December 12, 2012.
[20] NOI at ¶ 18.
[21] 47 C.F.R. § 90.645(h).
[22] *See* Communications Case Study: Strategy for Duke Energy's "3rd Grid;" Brian Hartzog, UTC Journal 2nd Quarter 2017, https://www.bluetoad.com/publication/?i=416281#"{".

for CII broadband. It already has begun to deploy LTE on its contiguous 800 MHz Enhanced Specialized Mobile Radio ("ESMR") spectrum and has identified the following LTE data use cases and applications:[23]

- AMI backhaul
- C&I metering
- Distribution line devices
- Transmission line devices
- T&D substations
- Reservoir management
- Street lighting
- Gas metering
- Substation card readers
- Transmission tower lighting
- Transformer gas monitoring
- Transformer bushing monitor

While narrowband systems may continue to address voice and certain data communications needs for some time, vendors also have confirmed that new use cases such as infrastructure security, smart cities, grid automation, and SCADA communications require low latency broadband.[24]

The vital importance of broadband to the future of utilities was emphasized recently in a presentation at the 2017 UTC Conference entitled: Communications for the Modern Age: Is Your Network Ready for the Next Big Thing?[25], which identified the "ideal attributes" of a Tier 3 primary RF solution as:

[23]This information was presented jointly by Southern Company and Ericsson at the 2017 Utilities Technology Council ("UTC") Telecom & Technology Conference, May 8-12, Charlotte Convention Center, Charlotte, NC ("2017 UTC Conference").

[24]Power Forward, Utility Communications Requirements, Ericsson (July 2017); https://www.puco.ohio.gov/index.cfm?LinkServID=C51AED5C-5056-B562-E15158CFA4714216.

[25] *See* Attachment 4: Communications for the Modern Age: Is Your Network Ready for the Next Big Thing?; presented by Black & Veatch at 2017 UTC Conference.

- Private
- Licensed
- Broadband
- Low-Cost
  - Scalable
  - Standardized
  - IP

This PE/CII focus on wireless broadband will come as no surprise to the Commission. The FCC recognized that utilities would require broadband capability at least as early as 2010 when it adopted Connecting America: The National Broadband Plan.[26] The Broadband Plan specifically identified the lack of a mission-critical, wide-area broadband network that was capable of meeting Smart Grid requirements.[27]

That FCC conclusion was consistent with repeated requests from representatives of the CII community for licensed broadband spectrum on which they could deploy systems built to their specifications, rather than relying on commercial networks that fail to meet often government-mandated, resiliency, redundancy, security and other criteria.[28] However, without a Southern Linc-equivalent authorization, the challenge for utilities and other PE users with equally demanding communication needs is accessing broadband spectrum with all the attributes identified above and blending their various communications functions into what Florida Power & Light Company ("FPL") has described as a "layered communications stack," an "architecture

[26] Federal Communications Commission, Connecting America: The National Broadband Plan, March 17, 2010.
[27] *Id.* at p. 251.
[28] The repeated efforts by UTC and the American Petroleum Institute ("API") to secure additional CII spectrum, based on detailed studies of future requirements, to date have been unavailing. *See, e.g.*, The Utility Spectrum Crisis: A Critical need to Enable Smart Grids, Utilities Telecom Council, January 2009; *see also* API, EWA, and UTC Letter to Roger C. Sherman, Acting Chief, Wireless Telecommunications Bureau, dated Feb. 27, 2014, stating "Introducing broadband capability to the 900 MHz band will be complicated but is absolutely necessary if Private Enterprise – in particular critical infrastructure industries – broadband interests are to be met;" *see also* Comments of UTC – NBP Public Notice #6, GN Docket No. 09-47, filed Oct. 23, 2009 at 9-11; Reply Comments of The American Petroleum Institute – NBP Public Notice #6, GN Docket No. 09-47, filed Nov. 13, 2009.

that empowers utilities and commercial carriers to leverage future communication technologies that offer improved coverage, capabilities and cost."[29]

The Commission's spectrum management policies in recent decades have not been well aligned with PE/CII broadband capacity and coverage needs. Those policies promote flexible, primarily large-scale broadband allocations that can take advantage of advanced technologies to serve a seemingly insatiable consumer demand, with licenses awarded through competitive bidding. With the exception of Public Safety,[30] the FCC relies largely on the marketplace to determine how spectrum is distributed rather than adopting special purpose allocations for operators of private systems.

While this approach works well for consumer-oriented commercial networks, auctions are not well-suited for most PE/CII operations that have specific capacity requirements and defined service areas. Purchasing auctioned spectrum to address those needs can leave these users with a Goldilocks-type conundrum: The defined channel blocks and market areas can be too large, too small, or just not a match for their needs. This puts them at a distinct competitive disadvantage when bidding against commercial providers and makes acquiring spectrum in the secondary market challenging as well.

It is now seven years since the FCC determined that utilities had a compelling need for broadband to protect their critical operations, five years since broadband spectrum was awarded to Public Safety,[31] and almost three years since EWA/PDV submitted the 900 MHz PEBB

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[29] Florida Power and Light Comments of July 12, 2010 at p. 17 in response to DOE Request for Information – Implementing the National Broadband Plan by Studying the Communications Requirements of Electric Utilities to Inform Federal Smart Grid Policy.

[30] The 700 MHz broadband Public Safety license awarded to FirstNet was made available in an allocation enacted in Federal legislation. Middle Class Tax Relief and Job Recovery Act of 2012, Pub.L. 112–96, H.R. 3630, 126 Stat. 156 (February 22, 2012).

[31] The near-term availability of FirstNet has prompted at least one additional nationwide carrier to offer priority access and even preemption for Public Safety users. These initiatives are to be commended, but commitments to award priority access and preemption for emergency responders confirms that PE/CII users cannot expect their

proposal, yet PE/CII entities continue to search for viable solutions to their communications requirements and sometimes must accept ones that still do not address their broadband needs.[32] The price of not having access to a PE/CII wireless broadband communications option in a band that would deliver meaningful cost advantages can be measured in lost efficiency, lost job opportunities, and lost access to the broadband functionalities that this user community repeatedly has said it needs.[33]

The 900 MHz private carrier broadband network proposed in the EWA/PDV Petition is superior to any alternative available to PE/CII entities today in terms of checking the "ideal attributes" boxes above. As discussed below, it also is superior to the alternatives posed in the NOI: increasing operational flexibility while retaining the current band configuration or leaving the 900 MHz Band with its status quo, including B/ILT channels that remain unassigned three decades after allocation. EWA/PDV are pleased to support this Commission effort "to ensure that the 900 MHz band is put to its best and highest use for the American public,"[34] the standard against which utilization of all the nation's valuable, limited spectrum must be measured.

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communications to be assigned the highest service priority levels on commercial broadband networks when emergencies arise.

[32] *See, e.g.*, Wireless Telecommunications Bureau Seeks Comment on FELHC, Inc. et al. Request for Extension or Waiver of 700 MHz Guard Band Performance Requirement, WT Docket No. 17-201, *Public Notice*, DA 17-743 (rel. Aug. 7, 2017).

[33] *See* n. 28 *supra*.

[34] NOI at ¶ 8.

IV. THE 900 MHz BAND RULES SHOULD BE MODERNIZED TO ALLOW BOTH BROADBAND AND NARROWBAND USE

A. Realignment To Create a Broadband Service

The EWA/PDV filings in RM-11738, including the EWA/PDV Petition, the Proposed PEBB Rules, and other comments and *ex parte* filings, define the EWA/PDV vision for the best and highest use of the 900 MHz Band. The parties request that those filings be incorporated herein by reference. However, they also have spent considerable time since the filing of the EWA/PDV Petition, and creation of the record in RM-11738 listening to interested parties and talking with 900 MHz Band incumbents, as well as prospective users of a 900 MHz Band private carrier broadband option.

EWA/PDV have heard the concerns of certain licensees operating narrowband 900 MHz systems and herein reconfirm their position that innovation cannot come at the expense of degrading narrowband systems for incumbents that choose to continue operating them. The rules governing a band realignment must ensure that incumbents are provided with comparable facilities at no cost to them.[35]

However, protecting incumbent rights need not mean the preservation in perpetuity of a more than 30-year old licensing structure based on then-emerging trunked system technologies, a structure adopted decades before wireless broadband became available. The rules governing the 900 MHz band were appropriate over 30 years ago, but also have resulted in much of this below-1 GHz spectrum allocation remaining significantly underutilized in many parts of this nation,

[35] EWA/PDV submitted proposed rules for a realigned 900 MHz Band and suggested refinements to those rules in a subsequent filing. However, they remain open to recommendations for modifications consistent with those adopted in other band repurposings if needed to ensure protection of incumbent rights. *See Ex Parte* Comments of EWA/PDV; Proposed 900 MHz PEBB Allocation Rules, RM-11738 (filed May 3, 2015); *see also* EWA/PDV Reply Comments, RM-11738, (filed July 14, 2015), (collectively, "Proposed PEBB Rules").

while other countries have enjoyed its economic potential by adopting rules that encourage broadband deployment.[36]

With those caveats and in response to ongoing discussions with band incumbents, EWA/PDV have modified certain aspects of their 900 MHz proposal. Those modified positions and the specific responses to matters on which the NOI seeks input in considering a PEBB allocation in the 900 MHz Band are below.

1) <u>Band Plan/Band Repurposing Experiences/Cost</u>

The record in RM-11738, filings in other proceedings at the FCC and with other agencies, and voluminous studies and reports answer the fundamental question in this NOI.[37] There can be no credible disagreement that the operating requirements of CII and other PE entities currently do and in the future increasingly will require broadband functionality. It is not a question of whether but through what communications medium those needs will be addressed.

The 3/3 megahertz broadband allocation proposed in the EWA/PDV Petition will be sufficient to build commercially viable private carrier broadband systems from the ground up for PE/CII users. This is a standard LTE carrier size and there is Band Class 8 LTE equipment, both infrastructure and subscriber, available today from multiple vendors that, with relatively minor modifications, could be certified for use in the 900 MHz Band. Should additional capacity be needed, the carrier aggregation option discussed *supra* could be employed.

Moreover, the purpose-built private carrier broadband systems that a PEBB would offer are the right solution for these users from a cost perspective. The infrastructure capital and ongoing operating expenses such as site rent and backhaul at 900 MHz are an order of magnitude less than would be needed to build a private broadband network above 1 GHz. Superior

[36] See Attachment 5.
[37] *See, e.g.,* http://utc.org/wp-content/uploads/2016/11/UTC_Issue_Brief_Why_Utilities_Need_SpectrumNOV-2016.pdf.

propagation at 900 MHz will limit the number of fixed sites required, and both subscriber and infrastructure equipment will enjoy economies of scale, since the 3GPP Band Class 8 spectrum includes the 900 MHz Band. Equipment is globally standardized for LTE use and, as evidenced in the attached report, its international deployment is growing steadily.[38]

This will be particularly important as the EWA/PDV Petition does not propose a nationwide broadband network funded entirely by PEBB licensees. Rather, the PEBB would deploy private carrier networks pursuant to negotiated arrangements with PE/CII entities in which users would define the technical, financial, and operational structure best-suited to their individual situations.

Participating entities would maintain control over the design, deployment, and ongoing operation of their broadband operations to whatever extent they wish. Some might elect to lease spectrum from the PEBB licensee and provide all the capital to construct a system built to their specification, one that would be completely under their control as permitted in the Commission's long-term *de facto* control spectrum lease arrangements.[39] Business and even government entities operate under this model today in a variety of bands and, as contemplated in the FCC rules, exercise autonomy over all decision-making related to their systems. Others may elect a managed service contract on a built-to-suit network operated by the PEBB licensee, such as a managed asset-type arrangement with implementation, spectrum, and operational costs bundled into an Op-Ex payment.[40] This type of arrangement is likely to be particularly attractive to smaller enterprises that are satisfied to operate on a broadband system designed by a larger entity in the area. Based on PDV's extensive outreach efforts with PE/CII entities in assessing their

[38] Relatively minor modifications of standardized subscriber equipment will be required.
[39] 47 C.F.R. §1.9001 *et seq.*
[40] Utilities already are considering broadband options that involve leasing spectrum from a licensee. The propagation, and therefore the infrastructure cost, in the 900 MHz Band compares favorably with those options.

growing demand for broadband, there likely are hybrid variations on these models that would be desired as well.

The PEBB proposal also has significant implications for the expansion of broadband coverage to rural communities, a primary FCC concern:

> A core Commission goal is to facilitate access to scarce spectrum resources and ensure that wireless communications networks are widely deployed so that every American, regardless of locations, can benefit from a variety of communications offerings made available by Commission licensees.[41]

Because PE/CII operations often are outside major urban markets, and frequently in truly rural areas where local utilities, pipelines, and railroads require service, a private carrier broadband network built to their requirements, by definition, will extend broadband coverage into under- or unserved communities with sufficient capacity to address the needs of multiple PE entities, both large and small businesses. As UTC has stated, "…utilities are uniquely positioned to offer broadband because they have extensive communications networks and other infrastructure that can be leveraged to provide broadband to areas that are currently unserved or underserved by other commercial service providers."[42] Once this infrastructure has been constructed, it could be used to support colocation of systems in other bands. The lower the cost of deployment, the greater opportunity for expanded coverage.

The EWA/PDV Petition proposed that the PEBB allocation be assigned at 898-901/937-940 MHz, the upper end of the 900 MHz Band. The parties still believe that would be

[41] Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95 and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services, WT Docket No. 10-112, *Second Report and Order and Further Notice of Proposed Rulemaking*, FCC 17-105 at ¶ 98 (rel. Aug. 3, 2017).

[42] Utilities Broadband Council; https://utc.org/utilitiesbroadbandcouncil.

appropriate, but are open to a different location in the band, depending on the future plans of incumbents as they are clarified during the course of this proceeding.[43]

Whatever band segment is selected, of course, there will be costs associated with realigning the band to separate broadband from narrowband operations – in this case to be borne entirely by the PEBB licensee. It is the blessing and curse of wireless communications that the unprecedented speed with which it has been adopted and the seemingly limitless applications that run on it have exhausted the supply of vacant "no-cost" spectrum on which wireless broadband services can be deployed. The Commission rightly has repurposed and modernized a substantial number of bands when, as here, there is a compelling public interest in doing so. The ground rules for these undertakings are well-established. While there are various flavors of relocation, in all cases incumbents must be provided with fully comparable facilities and must not bear any of the reasonable costs of relocating their systems.

Similar band realignments in the 800 MHz band are instructive. Between 1995 and 1997, the FCC adopted rules to provide for geographic licensing in both the "upper 200 800 MHz band,"[44] and the "lower 800 MHz band."[45] Both relocation processes were completed within approximately three years and with almost no need for FCC dispute resolution about replacement spectrum comparability or rebanding costs.

The more recent 800 MHz rebanding project demonstrates that the facilities of the most complex Public Safety systems supporting mission critical operations that cannot tolerate any

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[43]One important use of 900 MHz B/ILT spectrum is the facilities operated by our nation's railroads pursuant to the nationwide license held by the Association of American Railroads ("AAR"), call sign WPSF894. Recognizing the important nature of these systems, PDV has initiated discussions with AAR and its members to better understand their current and future communications needs and to ensure that the proposed band realignment will accommodate those needs.

[44] *See* Future Development of SMR Systems in the 800 MHz Frequency Band: Regulatory Treatment of Mobile Service of Competitive Bidding, PR Docket No. 93-144, *First Report and Order*, *Eighth Report and Order, and Second Further Notice of Proposed Rule Making*, 11 FCC Rcd. 1463 (1995).

[45] *See* Future Development of SMR Systems in the 800 MHz Frequency Band: Regulatory Treatment of Mobile Service of Competitive Bidding, PR Docket No. 93-144, *Second Report and Order*, 12 FCC Rcd. 19079 (1997).

downtime can be modified safely to comparable frequencies. Approximately 1,300 Public Safety systems, some with hundreds of frequencies and sites over entire states or very large regions, as well as other incumbent systems,[46] including those operated by utilities, transportation providers, transit agencies, large manufacturing facilities, and virtually every other type of business in this country, have been rebanded successfully. This exemplary record was due to careful planning, rigorous implementation, and accommodation of the requirements of specific licensees. For example, certain 800 MHz incumbents in Florida and along the Gulf Coast were understandably unwilling to touch their systems during hurricane season, and schedules were developed to accommodate that concern. More than two thousand systems throughout the country have been rebanded and, to the best knowledge of EWA/PDV, this has been accomplished without a single reported incident of unscheduled loss of service during the process.

The 900 MHz landscape is significantly less complicated. As noted, the NOI states that there are only 500 licensees nationwide on B/ILT channels and only systems with channels above 898/937 MHz would need to be relocated to the lower portion of the band.[47] Many of the larger incumbents, like 800 MHz Public Safety licensees, cannot tolerate disruption of their operations. Meticulous planning and execution will be required to realign them safely and effectively, but experience proves this can be done. In fact, PDV already has entered into frequency exchanges with some incumbents to move their systems to narrowband frequencies

[46] The ad hoc interoperability arrangements among 800 MHz Public Safety licensees contributed significantly to the complexity, cost, and duration of this rebanding effort. Many Public Safety systems required a carefully constructed sequence of rebanding steps involving all parties that were sharing frequencies to ensure that no interoperability capabilities were lost during the process, even temporarily. B/ILT systems typically do not have these extensive interoperability arrangements with third parties, but to the extent they exist they will be accommodated appropriately.

[47] NOI at ¶ 7.

below 937 MHz, the proposed location of the 2/2 megahertz allocation.[48] Additionally, as mentioned previously, some incumbents may prefer to relocate to other bands, a choice already made by one entity that is voluntarily relocating out of the band with PDV's financial assistance. Others have sold their systems to PDV and presumably are making their own arrangements to address any remaining communications requirements.

It is not possible to quantify a total 900 MHz incumbent realignment cost without additional information about the specifics of each system and without knowing which licensees will elect to move to broadband or choose an option other than a realigned 900 MHz system. Moreover, the number of licensed transmitters typically is greater than the number of transmitters that are in permanent operation; therefore, the number of licensed transmitters would be greater than the number that would need to be realigned.

At 800 MHz, when all hard, soft, and transactional expenses for fixed and mobile equipment in non-Public Safety systems, including those operated by multi-site, multi-frequency utilities, transit agencies, pipelines, large manufacturers, and commercial SMRs, were captured in a single figure, the amount was $10,200 per transmitter, with transmitter defined as each frequency at each site.[49] There is no obvious reason why the costs would vary significantly for 900 MHz systems operated by these same types of licensees.

The NOI also queries whether the 900 MHz Band should be fully reconfigured to create a 5/5 megahertz broadband channel. The FCC does not appear to be suggesting a wholesale reallocation from narrowband to broadband, but is seeking information as to whether there could be dynamic sharing between the two types of systems throughout the 5/5 megahertz allocation.

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[48] These entities include Southern California Edison Company ("SCE"), Phillips 66 Communications, Inc., and PSEG Services Corporation.
[49] *See* Attachment 6.

EWA/PDV are strong proponents of spectrum sharing when it is technically feasible. Sharing under appropriate conditions maximizes the use of limited spectrum resources and can provide opportunities for the development of innovative services and consumer-oriented applications. Although not yet tested, it is anticipated that the tiered sharing arrangements in the 3.5 GHz CBRS will allow a variety of system types to co-exist compatibly. One major factor, however, is the amount of spectrum over which those systems will be permitted to operate. That allocation has 15 times the amount of spectrum than is available in the 900 MHz Band, which makes dynamic sharing, even sharing in only portions of the 3.5 GHz band, viable. Further, the LMR systems that would need to be avoided have channels distributed throughout the 5/5 megahertz allocation and operate narrowband facilities in many of the same areas where these same users need broadband facilities. For the reasons described in Attachment 7, dynamic sharing it is not feasible in either a 3/3 or a 5/5 megahertz 900 MHz allocation.

EWA/PDV do not support reallocation of the entire 900 MHz Band for broadband use in all geographic areas at this time, if such an option is under consideration. There would be benefits from assigning this spectrum for broadband use exclusively, but EWA/PDV believe that the costs currently outweigh those advantages. The narrowband LMR systems operating in the 900 MHz Band serve important communications functions and will continue to do so into the future. There is no need to co-opt them, as they can co-exist compatibly with broadband in this band.

A primary challenge, should this approach be pursued, would be identifying replacement spectrum for incumbents that wish to continue operating narrowband systems, particularly those located in or close to major urbanized areas. There is no obvious source of comparable, exclusive B/ILT spectrum to which they could be moved, even if they were compensated to relocate.[50] As noted above, some incumbents have accepted payment to vacate the band, but financial compensation is not necessarily adequate consideration for an entity that must have a reliable communications network to run its business safely and efficiently. However, as discussed in Section 2(b) below, EWA/PDV believe an alternative approach would create an opportunity to create a 5/5 megahertz broadband allocation in markets where B/ILT spectrum historically has been underutilized through a competitive bidding and voluntary negotiation process that is fully responsive to B/ILT incumbent concerns.

2) <u>License Assignment Process/Auctions</u>

The EWA/PDV Petition proposed an approach for awarding PEBB licenses that was described in further detail in the Proposed PEBB Rules. The PEBB license in each MTA would be awarded to the holder of at least 15 geographic SMR authorizations in that MTA, which authorizations had been purchased at auction, with the remaining MTA licensees electing either to relocate to spectrum below 898/937 MHz or to participate in the PEBB operation in that MTA. In the small number of markets where no licensee holds 15 MTA licenses, all MTA licensees would need to agree to a PEBB entity or forego the opportunity for a broadband network in that market. The proposal also contemplated participation in the PEBB by incumbents operating on B/ILT channels that wished to deploy broadband facilities.

The NOI questions whether awarding a PEBB license as proposed by EWA/PDV would create a windfall for that entity and, if so, whether the cost to the public would be outweighed by the public benefit of realignment and creation of a private carrier broadband allocation. In this case, the public already received an economic benefit from the issuance of MTA authorizations that were purchased at auction in 1996 and 2004, with bid amounts exceeding $209,000,000.

[50] *See* EWA Reply Comments, PS Docket No. 13-42 (filed June 11, 2013); Attachment A, "Industrial and Business T-Band Relocation Costs" study prepared by Televate LLC.

The question is whether the public interest lies in awarding PEBB licenses through competitive bidding, despite the time required to adopt the applicable rules and then conduct the auction, or whether an alternative approach would better serve the Commission's objectives and the public interest.

a) Auctions are not Statutorily Mandated in All Situations

In response to the specific query in the NOI, the fact that a PEBB licensee may receive an "unexpectedly large" benefit[51] from being able to provide broadband service over the realigned spectrum does not mean either that the public interest requires that the licensee "pay" the government for the benefit, or that there will be any "cost" to the public. Certainly, the Commission is not required to auction licenses.[52] It has maintained its "freedom to consider all available spectrum management tools and the discretion to evaluate which licensing mechanism is most appropriate for the services being offered."[53] The Commission has chosen the licensing mechanism on a service-by-service basis "focus[ing] on the application of the public interest factors enumerated in [§] 309(j)(3) and [its §] 309(j)(6)(E) obligation in the public interest to avoid mutual exclusivity in application and licensing proceedings."[54] The FCC has exercised this freedom in a number of situations as detailed in Attachment 8. EWA/PDV submit that the repurposing of the 900 MHz Band outside the auction context will further the § 309(j)(3) public interest objectives.

The Commission's spectrum management responsibility under § 309(j)(3)(A) is to promote "the development and rapid deployment of new technologies, products, and services for

[51] The word "windfall" means an "unexpected gain, piece of good fortune," or "accruing in unexpectedly large amounts." *Random House Webster's Unabridged Dictionary* 2177(2d ed. 2001).

[52] *See* Improving Public Safety Communication in the 800 MHz Band, WT Docket No. 02-55, *Memorandum Opinion and Order*, 20 FCC Rcd 16015 at ¶ 70 (2005) ("Although the Commission had the authority to auction licenses, it was not required to do so").

[53] Implementation of §§ 309(j) and 337 of the Communications Act, WT Docket No. 99-87, *Report and Order and Further Notice of Proposed Rulemaking*, 15 FCC Rcd 22709 at ¶ 25 (2000).

[54] *Id*. at ¶ 18.

the benefit of the public, including those residing in rural areas, without administrative or judicial delays."[55] The CII community is on record detailing a compelling need for the rapid deployment of broadband facilities to serve their needs. The Commission would minimize the delay in issuing PEBB licenses to meet that need by avoiding mutual exclusivity. When the Commission has elected to repurpose spectrum by auction, it took an average of nearly two years from the Commission's decision to employ competitive bidding just to complete the auction process, after which the FCC licensing and other regulatory processes will need to be completed and facilities constructed before service can be initiated.[56] By comparison, the Commission could authorize the deployment of private carrier broadband networks by license modification immediately upon its decision to repurpose the 900 MHz Band spectrum.

The choice of the licensing mechanism employed to repurpose 900 MHz Band spectrum is an easy one, if the Commission wishes to accelerate the deployment of private carrier broadband networks across the country. The Commission has the authority to avoid mutual exclusivity and competitive bidding by adopting the EWA/PDV proposal and assigning the PEBB licenses by rulemaking and license modifications if it determines doing so would serve the public interest.

b) <u>An Auction Proposal</u>

The 900 MHz Band presents two distinct spectrum landscapes. There are major metropolitan areas where all the channels, both the geographic MTA and the site-based B/ILT, are fully licensed. In other regions, only the MTA SMR spectrum, which was acquired through the competitive bidding process, has been licensed. In these MTAs, the great majority of B/LT channels are not licensed; in most instances, no B/ILT applicant has ever sought their use.

[55] 47 U.S.C. § 309(j)(3)(A).
[56] In 10 auctions that involved repurposed spectrum, a total of 7,053 days elapsed between the decisions to employ competitive bidding and the completion of the auctions. *See* Attachment 9.

Although the analysis above makes clear that the FCC's legal authority to award PEBB licenses in all MTAs without competitive bidding is beyond question, the Commission could choose to adopt different license processes for the 2/2 megahertz allocation in fully licensed versus lightly licensed markets. A properly constructed overlay auction mechanism would open up the opportunity for these channels to be licensed for more technologically advanced uses needed by a variety of entities.

EWA/PDV have reviewed the current licensing situation in each MTA carefully and propose that lightly licensed markets be defined as those where 80 or more channels are unassigned and being held in inventory by the FCC. The map included in Attachment 10 identifies the MTAs in which authorizations in the lower 2/2 megahertz should be awarded by auction. This Attachment also provides a visual depiction of B/ILT licensing in several MTAs that graphically demonstrates the difference between fully licensed and lightly licensed markets.

In fully licensed areas, there would be little motivation for a new entrant or even an incumbent with modest spectrum holdings to participate in an overlay auction. Such a license would come with virtually no "white space" in the populated areas. Conducting an auction in such markets would be a wasteful exercise that would cause unnecessary delay, increase the cost of delivering the benefits of band modernization, and, most important, serve no public interest. The Commission has ample legal authority to proceed by license modification for the reasons discussed above and should do so.

However, EWA/PDV submit that there may be a public interest benefit in conducting overlay auctions, as described below, for non-PEBB authorizations in lightly licensed markets where 80 or more channels are held in inventory by the FCC. If the FCC holds 80 channels in a market, it typically holds substantially more, in some instances including recovered MTA auctioned spectrum.

Thus, EWA/PDV recommend the following:

- 2/2 megahertz band realignment to provide for a variety of bandwidths:[57]
  - (1) 1.5 megahertz: 935.5000-937.0000 MHz
  - (2) 2 channel blocks: 935.0000-935.1250 MHz (125 kHz) and 935.2500-935.5000 MHz (250 kHz)
  - (3) 10 12.5 kHz channels: 935.1375-935.2500 MHz[58]

- In categories (1) and (2), the FCC would conduct overlay auctions for MTA licenses in lightly licensed areas <u>without</u> mandatory relocation rights and <u>with</u> the obligation to protect all incumbent operations under current co-channel protection standards. Channel clearing would be conducted through voluntary negotiations between the auction winner and incumbents. Incumbents would have no obligation to relocate and could maintain their current operations.

- B/ILT or SMR applicants would be auction-eligible.

- Winning bidders could choose from among authorized technologies and bandwidths, depending on their operational requirements.

- In category (3), the 10 channels would remain coordinated, site-based B/ILT channels until December 31, 2025. They would act as a safety valve in the event that a B/ILT entity wishes to expand an existing system or deploy a new one using the traditional site-based licensing process. At the end of that period, almost 40 years after the channels had been made available for narrowband B/ILT use, the FCC would conduct overlay auctions for this 10-channel block under the same rules as used for categories (1) and (2).

- The FCC's spectrum inventory that determines whether a market qualifies for auction is calculated based on channel usage within a 55-mile radius of the center coordinates of the first designated city for which the MTA is named.

- Licensees of contiguous spectrum in the same MTA would be permitted to consolidate their spectrum, provided they comply with all technical requirements for the protection of adjacent channel licensees in the same or adjacent MTAs and of co-channel licensees in adjacent MTAs and all licensees would be allowed to deploy mobile and/or fixed systems.

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[57] *See* Attachment 11 for the proposed band plan. The corresponding mobile frequencies would be 39 MHz below the base frequencies.

[58] These channels 11-20 currently are the lowest channels assigned for B/ILT use.

The proposed approach creates opportunities for multiple auction participants pursuing a variety of technology choices. It would allow an entity to consolidate spectrum in markets where the 900 MHz Band has been relatively lightly licensed and, after December 31, 2025, create a 5/5 megahertz broadband block, provided it was able to negotiate successfully with all incumbents. It also would permit those interested in wideband systems of various bandwidths to select the optimal allocation for applications such as fixed data, including IoT.

The NOI is correct in noting that the B/ILT community, including EWA, opposed the assignment of vacant B/ILT channels on a geographic basis through competitive bidding when proposed by the FCC in 2005.[59] But times have changed; technology has changed; demands on spectrum usage have changed. With no new allocations assigned or anticipated for these users, entities with a need for private, internal communications systems, including utilities[60] and even governmental entities,[61] have had to participate as bidders in FCC auctions or have purchased geographic spectrum in secondary market transactions. The key is tailoring an auction to make the spectrum operationally usable and financially viable for even non-commercial providers.[62] Cost-free spectrum is always preferable, especially for licensees that use spectrum to meet internal requirements, rather than to generate revenue from the provision of wireless service. Yet, experience has taught that properly configured auction blocks can satisfy the needs of B/ILT licensees. It is time to try another approach for spectrum that has lain largely fallow for more than three decades.

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[59] Amendment of Part 90 of the Commission's Rules to Provide for Flexible Use of 896-901 and 935-940 MHz Band Allotted to the Business and Industrial Land Transportation Pool, WT Docket No. 05-62, *Notice of Proposed Rulemaking and Memorandum Opinion and Order*, 20 FCC Rcd 3814 (2005).
[60] *See, e.g.*, SCE, call sign KNNX834.
[61] *See, e.g.*, Snohomish County Public Utility District No. 1, call signs WPXN959/66 and WPZN383/5.
[62] *See* FCC Auctions #40, #48, #87 and #95 of Lower & Upper Paging Bands

EWA has reached this conclusion, although it represents the communications interests of a broad range of B/ILT and SMR entities. It does not subscribe to the theory that, once allocated, spectrum should remain forever assigned to a particular category of licensee even if it remains underutilized. While it recommends a safety value of 10 12.5 kHz B/ILT site-based channels for a limited period, it is not sound spectrum policy to reserve an allocation in perpetuity on the theory that an eligible applicant might one day appear. It is particularly bad policy when it prevents that spectrum from being converted to a more advanced, more efficient use that is needed by the very same entities that were originally eligible to access the band.

3) <u>Relocation Process</u>

As discussed above, there is sufficient experience with the process of rebanding equipment to different, comparable frequencies, including the equipment of mission-critical public safety systems, to validate that this could be accomplished with minimal disruption and without any loss of service for incumbent 900 MHz Band systems.[63] The process could be managed through use of normal 900 MHz frequency coordination procedures, with each incumbent selecting its preferred coordinator. That approach worked when rebanding the 800 MHz "upper 200" and "lower 80" MHz spectrum cited above and for the relocation of 2.1 GHz microwave systems to other bands to make way for Advanced Wireless Systems. The EWA/PDV Petition recommended that replacement channel assignments be centralized for administrative control and reporting purposes, but there is no reason that the regular frequency coordination process would not work in assigning replacement channels in the 900 MHz Band.[64]

[63] If there is equipment operating in the 900 MHz Band that cannot be modified to frequencies below 937 MHz, and EWA/PDV are not aware that there is such equipment, then it would need to be replaced.
[64] The FCC decided that a Transition Administrator would manage the more recent 800 MHz rebanding because there was a need to account for the costs incurred in that process. Under the EWA/PDV Petition, rebanding costs would be negotiated by the parties without third-party oversight, as they have been in every band repurposing other than the recent 800 MHz rebanding.

Additionally, in response to concerns expressed by certain incumbents, PDV commissioned Altairis Technology Partners to evaluate sample realignment channel plans for three representative markets. Altairis was charged with examining the potential impact of the proposed replacement channels on incumbent systems' combiner spacing and with assessing the likelihood that the proposed 900 MHz Band realignment would require the replacement of equipment. The results of that analysis are provided in the Altairis report, which reached the following conclusions:

> We have reviewed sample channel plans prepared by pdvWireless for three markets and found that, in those markets, channels existing above 937MHz can be retuned into the 935-937MHz portion of the band without a significant impact on channel spacing in transmit combiners.
>
> Altairis has also reviewed a range of equipment deployed in 900MHz land mobile radio systems and concluded that almost all of it is technically capable of being retuned to operate in the 935-937MHz portion of the band.[65]

The NOI also questions whether the relocation of incumbent systems could be voluntary rather than mandatory or whether flexible use rights would allow entities desiring to deploy broadband technology to aggregate sufficient contiguous spectrum to do so. The problem with those approaches, as noted in the NOI, is the possibility, indeed the certainty, of a hold-out or hold-outs. Whether the motivation is entirely financial or the desire of one incumbent to experience zero system disruption, even a single non-participant could prevent the PEBB licensee from clearing the spectrum needed to support broadband deployment. There is a clear public interest in creating contiguous channel blocks of sufficient capacity to support advanced technologies. That is why the Commission has provided for mandatory relocation, often following a period of voluntary relocation, when bands are repurposed.[66] That process has

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[65] *See* Attachment 1.
[66] 47 C.F.R. §§ 90.677, 90.699.

worked effectively in multiple instances and, in the opinion of EWA/PDV, is the only realistic approach for the 900 MHz Band.

4) Technical Rules

The Proposed PEBB Rules laid out in detail the technical criteria that EWA/PDV believe will permit the co-existence of narrowband and broadband operations within the 900 MHz Band even without a guard band.[67] If implemented, they do not guarantee that a licensee will never experience any instance of interference, a standard that is neither applicable today among 900 MHz Band narrowband systems, nor applicable to any band regulated by the FCC. They do propose an appropriate emission mask as well as power limitations, the same factors that are used in other bands to define the technical parameters under which licensees on adjacent channels must operate. The FCC approved the same emission mask for use by 800 MHz broadband ESMR licensees, even in geographic areas such as the Canadian Border Region and the Southern Linc territory centered on Atlanta, where there is no guard band between the ESMR allocation and adjacent narrowband systems.

In the opinion of EWA/PDV, as verified by third-party technical analyses included as Attachments 1 and 2, and based on the positive experience at 800 MHz, these rules will be sufficient to prevent interference to both in-band and adjacent band operations, including those described as "low-latency, high-reliability" utility operations.[68] The Proposed PEBB Rules also

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[67] The Commission has rejected the need for a guard band in other instances. "We do not establish a guard band between the adjacent operations in the 600 MHz uplink band and the Lower 700 MHz A Block…because these two bands are both used for terrestrial uplink services, they are harmonized and do not require guard bands to prevent harmful interference." Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket No. 12-268, *Report and Order*, 29 FCC Rcd 6133 n. 307 at ¶ 45 (2014). While it is likely that broadband technology will be deployed in both allocations, the FCC's rules are sufficiently flexible that a variety of technologies could be implemented, including narrowband applications, provided they comply with applicable technical requirements. There is no certainty that both allocations will be put to similar uses in every part of the country.

[68] NOI at ¶ 40.

recommend that co-channel MTA licensees be subject to the provisions of current Rule Section 90.671 vis-à-vis adjacent market MTA systems.

The Proposed PEBB Rules set out recommended provisions for governing incumbent interference protection rights. These rules mirror those adopted by the FCC for resolving post-rebanding interference complaints related to the more recent 800 MHz rebanding process, where the affected incumbents were Public Safety licensees. Those rules do not establish an absolute right of incumbents to interference mitigation under all circumstances. Instead, they require a defined level of incumbent system performance before the mitigation obligation is triggered, the same approach proposed by EWA/PDV. There is no technical basis for establishing an even greater protection standard for non-Public Safety systems.

The NOI also asks "are the receivers in the adjacent services designed to appropriately filter unwanted emissions?"[69] Responsible licensees purchase equipment and design their systems to operate reliably, based on the technical rules that define permissible co-channel and adjacent channel operations; that is, to function in the wireless environment permitted by those rules, rather than in reliance on an under-utilization of spectrum or a non-existent "right" to no increase in the noise floor over time.

Nonetheless, based on the analyses in Attachment 2 and in the report filed in this proceeding by Pericle Communications Company, EWA/PDV believe that there is an extremely low risk of harmful interference to adjacent LMR or Narrowband PCS systems operating at 901-902/940-941 MHz ("NPCS") irrespective of their receiver specifications. The Proposed PEBB Rules are designed to allow non-interfering broadband-narrowband operations. For the NPCS systems that are self-described as susceptible to interference,[70] PDV has already developed

[69] *Id*.
[70] *See* Comments of Sensus USA Inc. filed in RM-11738 on June 29, 2015.

protocols that it believes will be useful in addressing those situations and is prepared to discuss them with interested incumbents and with the Commission.

Since the Proposed PEBB Rules were submitted, the Commission has modified certain technical rules governing broadband systems generally.[71] For purposes of maintaining uniformity in treatment of like systems, EWA/PDV recommend that these same changes be incorporated in the technical rules governing the 900 MHz PEBB allocation, as detailed in Attachment 12.

Finally, in reaching its decision regarding the optimal rules for this band, EWA/PDV urge the Commission to adopt a flexible regulatory structure that can accommodate future improvements in spectrum utilization. The requirements of the Administrative Procedures Act[72] dictate that even relatively simple rule modifications typically require a multi-year cycle to implement. More fundamental changes take longer. By contrast, advances in wireless technology occur at speeds which make it challenging for regulations to keep pace. The FCC is aware of this spectrum management dilemma, and is adopting regulations in bands other than 900 MHz that are sufficiently malleable to accommodate advancing technologies and licensees who wish to take advantage of the technology improvements. They should do the same in the 900 MHz Band.

B. Relaxed 900 MHz Eligibility/Operational Rules

The NOI questions whether the 900 MHz Band eligibility and operational rules should be relaxed to (i) allow commercial SMR entities to apply for vacant B/ILT channels and (ii) permit (1) aggregation of spectrum beyond 10 contiguous channels; (2) a greater number of channels to

[71] *See* Amendment of Parts 1 and 22 of the Commission's Rules with Regard to the Cellular Service, Including Changes in Licensing of Unserved Area, WT Docket No. 12-40, *Second Report and Order, Report and Order, and Second Further Notice of Proposed Rulemaking*, 32 FCC Rcd 2518 (2017).

[72] The Administrative Procedure Act (APA), Pub.L. 79–404, 60 Stat. 237, 5 USC §551 *et seq*.

be granted in a single application; and/or (3) unlimited deployment of operational fixed stations. These options are in response to the Petition for Rulemaking filed by M2M Spectrum Networks, LLC ("M2M") in which it asked to allow SMR licensing on B/ILT channels for the purpose of offering Internet-of-Things ("IoT") applications to B/ILT-eligible entities.[73]

There can be little dispute that the current eligibility provisions should be reviewed. Eligibility for B/ILT spectrum is limited to applicants that claim a need for channels to serve the private, internal requirements of their businesses, but, once licensed and constructed, the channels can be converted immediately to commercial SMR status or assigned to an SMR operator. This conversion opportunity was implemented to provide "green space" to accommodate customers of Nextel Communications, Inc. (now Sprint Corporation) while it completed the 800 MHz rebanding process.[74] That additional capacity is no longer needed, but the option remains available to all B/ILT licensees.

The challenge is creating reasonable spectrum opportunities for both B/ILT entities (assuming some might in the future need capacity that has been available for more than 30 years) and commercial SMR interests while promoting the more intensive use of this spectrum. EWA/PDV believe that rather than merely relaxing legacy eligibility rules, the License Assignment Process described above, including the Alternative Auction proposal, is superior to other options considered in the NOI, as it offers optimal flexibility in both eligibility and operational terms for the users of this spectrum.

C. No 900 MHz Rule Changes

For all the reasons detailed above, EWA/PDV cannot recommend approval of the third alternative on which the NOI requests comment: that the legacy 900 MHz Band licensing and

[73] Petition for Rulemaking of M2M Spectrum Networks, LLC, RM-11755 (filed June 29, 2015).
[74] Improving Public Safety Communications in the 800 MHz Band, et al., WT Docket No. 02-55, *Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order,* 19 FCC Rcd 14969 (2004).

eligibility rules remain intact. While appropriate when adopted over 30 years ago based on then state-of-the-art LMR technologies, these rules cannot be expected to support advanced broadband technology or promote appropriately intensive use of below-1 GHz spectrum in much of the country. Their modernization is overdue in light of the many public interest benefits described herein that would be achieved by adopting the broadband proposal submitted by EWA/PDV, as modified in these comments.

V. CONCLUSION

The Commission for some time has expressed a clear preference for exercising regulatory restraint in its administration of wireless services. The dramatic success of this approach is demonstrated by the near universality of wireless penetration, while dramatic improvements in video and data performance have been accompanied by ever lower costs to the consumer. Because they have been allowed to flourish in a flexible regulatory environment, innovation and competition have combined to make the U.S. consumer wireless marketplace the envy of the world.

Any proposals for new rules carry a heavy burden of justification, and appropriately so. But old regulations sometimes demand to be revisited. That is the case with the 900 MHz Band, whose regulatory structure was adopted at a time when the typical approach was command-and-control, not the flexibility of current allocations. What made sense more than 30 years ago based on technologies and marketplace assumptions specific to the times do not serve the public interest today. The regulatory restraint which performs so admirably under most circumstances has exactly the reverse effect if it serves to preserve the status quo, and by so doing, frustrates the introduction of new technology and innovation.

Throughout these comments, EWA/PDV have repeated the beliefs that existing users of narrowband spectrum must be free to continue such use as long as practical, and that incumbency is entitled to protection from harmful interference. Equally important, however, is the right of other incumbents to innovate, to modernize, and to adopt new technologies that bring enhanced services into the marketplace. The balancing act between these two principles of incumbency is the appropriate task of the Commission. This NOI, and the comments it has invited, will provide a foundation for effecting a balance that best serves the public interest. EWA/PDV respectfully request that the FCC adopt a Notice of Proposed Rulemaking consistent with the recommendations herein as promptly as possible.

ATTACHMENT 1

September 27, 2017

900 MHz Realignment Channel Plan Analysis

Altairis Technology Partners ("Altairis") was requested by pdvWireless to review a sample channel plan for their proposed realignment of the 900MHz band, covering the San Francisco, Seattle and Baltimore-Washington markets, and to comment on the technical feasibility of retuning land-mobile radio system types commonly deployed at 900MHz. This report contains the findings of that review.[1]

Altairis is an independent technology strategy, sourcing, and implementation firm, specializing in the most technically and operationally complex engagements. Altairis was established in 2008 to offer a unique blend of technical and business talent, with broad experience in land-mobile and commercial wireless technologies. Altairis offers a broad range of communications technology and business consulting services to local government, commercial wireless and utility industry clients. Our experience and services span the technology lifecycle from technology assessment, through procurement, and implementation to operations.

Altairis provided a wide range of consulting services to Sprint Nextel during the 800MHz reconfiguration process, with particular focus on equipment issues, negotiation support for technologically complex reconfigurations and budgetary forecasting.

Market Summary

The sample channel plan was prepared by pdvWireless and provided to Altairis for review. In each market, a replacement frequency (in the range 935MHz to 936.9875) had been proposed for each site-based frequency at or above 937MHz. We were informed that the replacement channels were taken from spectrum currently licensed to pdvWireless or spectrum that is not assigned to a licensee in that area.

[1] Our review was limited to examining the proposed channel plan to assess the feasibility of retuning 900MHz land mobile radio equipment, including subscriber radios, transmit combiners, and other system equipment.

The 900MHz site-based licensing (excluding pdvWireless channels) in the three markets can be summarized as follows:[2]

Metric (total – 935-940MHz)	San Francisco	Seattle	Baltimore-Washington
Licensees	37	25	35
Frequencies Used	124	108	101
Sites	131	66	71
Gross Channels	393	474	312

In the table above, and throughout this report, the term "Frequencies Used" refers to the number of licensed 12.5kHz channel pairs (out of the possible total of 199 defined in the 900MHz band, which would be reduced to 159 in the proposed reconfiguration). This gives a measure of spectrum utilization in the market. "Gross Channels" refers to a raw count of the number of licensed site-frequencies in the market. This gives a basic measure of the scale of the deployed systems, and could roughly be translated to the number of repeaters in the market. As an example, a licensee with two sites, each with the same three frequency pairs would have six Gross Channels.

The table below shows the impact of the proposed realignment within each market:[3]

Metric (impacted – 937-940MHz)	San Francisco	Seattle	Baltimore-Washington
Licensees	31 (84%)	19 (76%)	26 (74%)
Frequencies Used	74	60	51
Sites	88 (67%)	49 (74%)	57 (80%)
Gross Channels	192 (49%)	335 (71%)	191 (61%)

Impact on RF Combining Systems

A common concern with the proposed realignment of the 900MHz band is the reduced channel spacing after the narrowband channels have been moved into 2MHz of the band while they were

[2] This table includes all site based licenses in the range 935-940MHz (other than those licensed to pdvWireless) irrespective of whether they are affected by the proposed channel plan.

[3] This table shows the subset of the license data that is currently in the 937-940MHz range and that would be retuned under the proposed channel plan. No channels in the 935-937MHz range in the three sample markets are required to be retuned.

previously distributed over 5MHz. In particular, it is well known that some transmit combiner technologies suffer from greater insertion losses when combining channels with insufficient separation, which could lead to a reduction in system coverage. While each combiner model has a specified minimum separation (typically 150kHz to 250kHz) to achieve a specified loss, the loss then gradually increases at lower separations.

Without a detailed inventory of the antenna systems deployed on each of the licensed systems, it is impossible to fully evaluate the impact of the sample channel plans on combiner spacing. However, by examining the spacing amongst current and proposed channels it is possible to identify whether the proposed plan is likely to cause combiner spacing to become a significant issue.

In each of the target markets, Altairis examined the minimum channel spacing for each licensee on each site with both the current and proposed channels. This analysis showed that a significant number of sites already had closely spaced channels, and in many cases, adjacent channels. In our analysis, we identified sites where the minimum spacing would be reduced after migrating to the proposed new channels, and where the new minimum spacing would be less than a threshold.[4] The results are shown below for a number of different thresholds:

Count of Sites with Min Spacing Reduced to	San Francisco	Seattle	Baltimore-Washington
Less than 350kHz	10	6	1
Less than 300kHz	9	5	0
Less than 250kHz	6	0	0
Less than 200kHz	0	0	0

It should be noted that these results are based upon the sample channel assignments, and could vary depending on final channel assignments. It is important to note that if a particular channel assignment is incompatible with the RF combining system actually deployed in a system, it may be feasible to use a different replacement channel.

While this analysis did not find any significant increases in combiner channel spacing, it should be understood that increased combiner loss does not always lead to a loss of system coverage, and can

[4] These results exclude sites where the spacing is already below the threshold and is not reduced.

often be mitigated in practice. The true impact can only be assessed after considering the design of an individual system. For example, if the system coverage is limited by the talk-in pathloss (i.e. from portable radios), a small increase in talk-out pathloss (as a result of increased combiner loss) will be unlikely to reduce the useful coverage of the system. Similarly, if the transmit power could be increased, or other components in the RF distribution system could be replaced with lower loss or higher gain components, an increase in combiner loss can potentially be compensated. Alternatively, depending on the currently deployed equipment and the particular assigned channels, it may be possible to replace the combiner with a model that has a lower loss at the desired channel spacing.

Furthermore, many 900MHz systems were deployed with hybrid combiners. Unlike cavity combiners, hybrid combiners are designed to operate without minimum spacing requirements, and were commonly deployed in the 900MHz band specifically because of the close spacing commonly encountered between licensed channels. As a result, such a system would not suffer from coverage degradation if it were allocated replacement channels with little separation from its existing channels.

Equipment Review

Based upon a review of publically available information, there are numerous system types deployed in the 900MHz band, including (but not limited to):

- Conventional systems
- Motorola Startsite, Smart Works, Privacy Plus, SMARTNET & SmartZone
- EFJohnson LTR
- DMR, including Motorola MOTOTRBO
- Project 25
- Harris EDACS
- Harris OpenSky

Most of these system types (including all of the older system types which tend to be more difficult to reconfigure) were successfully retuned during the 800MHz reconfiguration process. As a result, to the extent that the proposed 900MHz realignment is similar to that at 800MHz, it should be expected that retuning at 900MHz would also be technically feasible.

One critical question to understanding the feasibility of retuning land-mobile radio systems is whether the existing equipment will operate properly on the replacement channels. If it will not, then new software or replacement equipment would be required to assure incumbent licensees of comparable facilities.

In the 800MHz reconfiguration process, there were two distinct phases. Firstly, the 851-854MHz channels were cleared by retuning to channels in the 854-859MHz portion of the band. Then the systems using the NPSPAC (866-869MHz) channels were moved down into the spectrum cleared at 851-854MHz. While there were exceptions, these two phases were very different in their complexity, with the Phase 1 retuning being simpler and taking less time. In part, this was because in Phase 1, most of the equipment was capable of being retuned to the new channels, while in Phase 2 (NPSPAC) considerable numbers of subscriber radios had to be replaced, as they were not capable of meeting the rules for the NPSPAC channels in their new position in the band. In particular, the channel spacing was halved, and the required emission mask and frequency deviation was changed for channels between 851-854MHz. As a result, many subscriber radios required replacement or updated firmware, and some trunked system software had to be updated.

In the case of the proposed realignment of the 900MHz band, which is similar to Phase 1 of the 800MHz reconfiguration, the replacement channels already exist within the current band, and would be operated under the same set of technical rules as they do today; indeed, there is no technical reason that the systems could not have been deployed on the replacement channels. As a result, equipment that is compatible with the 900MHz rules prior to the reconfiguration would continue to be compatible with the 900MHz rules after, and the retuning process would be more similar to the Phase 1 (lower 120) reconfiguration at 800MHz (where there was minimal equipment replacement required) than it would to the Phase 2 (NPSPAC) reconfiguration.

Altairis has reviewed specifications of a variety of equipment deployed in the 900MHz band and confirmed that it is specified to operate over (at least) the entire 935-940MHz band as it exists today. As the proposed new narrowband allocation of 935-937MHz would be a subset of that, the currently deployed equipment would continue to operate within its design specifications.

Another critical requirement for retuning without replacing equipment is that it must be possible to change the frequencies being used after the initial deployment. Our experience with very similar equipment in the 800MHz band was that the overwhelming majority of deployed equipment is technically capable of being reprogrammed to operate on new frequencies. The rare exceptions would be radios or repeaters requiring replacement crystals or EEPROMs if they were no longer readily available.

It is impossible to draw absolute conclusions that would apply to every deployed 900MHz system without investigating each one individually; however, based upon our research and our experience throughout the 800MHz reconfiguration, we conclude that from an equipment perspective it should be technically feasible to retune almost all of the currently deployed 900MHz land mobile radio equipment from 937-940MHz to 935-937MHz.

There will, however, likely be a small number of systems for which retuning in this manner will be complex and challenging. As was the case in the 800MHz reconfiguration, larger systems where a high proportion of the channels are impacted have the potential to be more demanding. Such challenges will be highly system-specific, as they will depend on the particular combination of system technology, system design (including, but not limited to, number of sites, number and type of subscriber equipment, redundancy and antenna system configuration) and usage model (for example, system loading).

Summary & Conclusion

We have reviewed sample channel plans prepared by pdvWireless for three markets and found that, in those markets, channels existing above 937MHz can be retuned into the 935-937MHz portion of the band without a significant impact on channel spacing in transmit combiners.

Altairis has also reviewed a range of equipment deployed in 900MHz land mobile radio systems and concluded that almost all of it is technically capable of being retuned to operate in the 935-937MHz portion of the band.

ATTACHMENT 2

Analysis of the Proposed Petition for Realignment of the 900 MHz Band under FCC Part 90

Dominick Arcuri,

pdvWireless engaged DVA Consulting to perform an objective analysis of their proposed petition to realign a portion of the 900 MHz band. This report documents the finding of that analysis.

DVA Consulting, LLC

12833 Pennmardel Lane

Henrico, VA 23233

12/7/2015

Contents

Executive Summary

DVA Consulting performed an objective analysis of the Petition for Rulemaking filed on November 17, 2014, by the Enterprise Wireless Alliance (EWA) and pdvWireless (pdv) requesting that the Commission open a rulemaking proceeding to realign the 896-901/935-940 MHz (900 MHz) band to create a private enterprise broadband allocation.

DVA's analysis focused on the ability to successfully realign incumbent narrow band channels to the proposed 2x2 allocation from the existing 5x5 assigned channels as well as an analysis and recommendations for how the proposed broadband allocation can operate and not interfere with narrowband systems above and below the broadband allocation.

DVA has concluded that the realignment of the incumbent narrowband channels to the new proposed allocation is feasible and expected to be less complex and costly than the realignment of the 800 MHz band affecting public safety licensees. While some markets exist where sufficient channels for relocation are not currently available, suggestions are provided to address these areas.

DVA has also concluded that sources for potential interference between the proposed broadband allocation and narrowband systems in adjacent bands do exist. However, they appear no worse, and are in many cases reduced, from what is possible today with narrowband licenses that comply with the current rules. Still, specific actions and precautions can be taken by the broadband licensee and incorporated into the proposed rules to protect against the risk of interference and mitigate any occurrences that may arise.

Introduction and Background

On November 17, 2014, the Enterprise Wireless Alliance (EWA) and pdvWireless (pdv) (collectively Petitioners) jointly filed a Petition[1] for Rulemaking requesting that the Federal Communications Commission (FCC) open a rulemaking proceeding to realign the 896-901/935-940 MHz (900 MHz) band to create a private enterprise broadband allocation. Currently, the 900 MHz band consists of 399 narrowband (12.5 kilohertz (kHz)) channels grouped into ten-channel blocks that alternate between Specialized Mobile Radio (SMR) blocks that are geographically licensed by Major Trading Area (MTA) and Business/Industrial/Land Transportation (B/ILT) blocks in which channels are assigned on a site-by-site basis. The current allocation is shown in Figure 1 below.

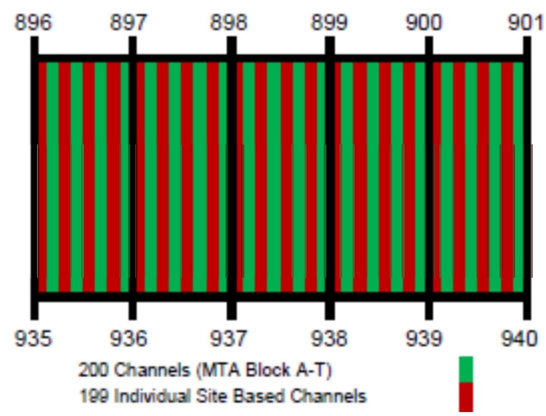
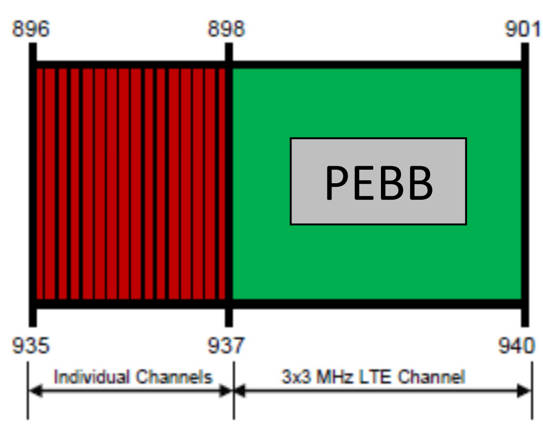


Figure 1: Current 900 MHz Band Configuration

Petitioners propose that the band be divided into a 3/3 MHz broadband segment (898-901/937-40 MHz) and a 2/2 MHz narrowband segment (896-98/935-37 MHz). Under the Petitioners' proposal, the broadband segment would be assigned in each of the 51 MTAs to the licensee that currently holds at least fifteen of the twenty SMR licenses for that MTA. It is anticipated that a broadband technology, such as Long Term Evolution (LTE) would be deployed in the 3/3 MHz broadband segment. The proposed allocation is shown in Figure 2.



[1] Petition for rulemaking – Enterprise Wireless Alliance/Pacific Data Vision: 12/08/14

Figure 2: Proposed 900 MHz Band Configuration

Following the realignment, the narrowband segment would continue to be used for site-based B/ILT and MTA SMR narrowband operations. Additionally, current licensees below 898/937 MHz would be unaffected by the realignment.

Scope of Engagement and Report

pdvWireless (pdv) engaged DVA Consulting (DVA; the Consultant) to perform two tasks related to the Petition for band realignment. DVA's scope included the following tasks:

1. Provide a written, objective, formal evaluation of pdvWireless' analysis and technical assumptions with respect to the ability to successfully realign incumbent narrowband channels to the proposed 2x2 allocation from the existing 5x5 assigned channels with recommendations, as needed, and
2. Review, analyze, and provide recommendations for the proposed Private Enterprise BroadBand (PEBB) allocation to operate and not interfere with narrowband systems above and below the broadband allocation.

Task One: Band Re-alignment Evaluation

A number or concerns immediately come to mind when a band re-alignment is considered. It is DVA's experience, given the Principal's experience with dozens of 800 MHz rebanding projects, that the concerns include the following:

1. Channel Availability;
2. Relocating to a different co-channel and adjacent channel environment;
3. Equipment Compatibility;
4. How to effectively re-tune the equipment and system to the new frequencies;
5. How to minimize operational disruption during the transition;
6. How to gain access to and coordinate re-programming of the user radios;
7. Maintaining interoperability with neighboring agencies during the transition;
8. The cost of the re-alignment.

DVA understands these concerns and has evaluated each of them related to the 900 MHz band realignment proposed by the Petitioners. The evaluation and conclusions are discussed and summarized below:

Channel Availability

Concerns have been raised by several commenters regarding the potential difficulty of relocating the incumbent licensees from the upper 3 MHz portion of the band to the lower 2 MHz of the band as proposed. The current band configuration contains 399 narrowband channels spaced at 12.5 kHz, while the proposed re-alignment would reduce the narrowband channel availability to a total of 159 channels. The Petitioners contend that the band is underutilized in many areas and that the proposed relocation of the current licensees is feasible in most, if not all market areas.

To evaluate the feasibility of this proposal, the Consultant performed an analysis of the top 25 target markets identified by pdv. In each market, the Consultant's analysis included the following:

- A review of the current license information provided by pdv;
- Verification of the license information through specific searches of the Federal Communications Commission's (FCC) Universal License System (ULS) database;
- Identification of the number of licenses in the lower 2 MHz portion of the band that would be available for relocation. This figure consisted of:
  - Licenses held by pdv in this portion of the band; and
  - Unlicensed channels in this portion of the band.
- Identification of the number of licenses in the upper 3 MHz portion of the band that would require relocation under the Petition;
- A calculation of the surplus or deficit of the number of channels required for relocation.

The results of this analysis are summarized in Table 1.

MTA	PDV Chnls Total (MTA/Other)	PDV Chnls in NB Sgmt.	Avail Chnls (Total/ below 937)	Total Avail Chnls	Other licensed Chnls (Total/ above 937)	# CII	Relocation Channel Surplus or Deficit
New York	248 (200/48)	111	4/2	113	147/101	42	+12
Los Angeles	171 (160/11)	73	3/1	74	215/140	82	-66
Chicago	241 (200/41)	91	2/0	91	156/88	32	+3
Dallas	239 (200/39)	90	0/0	90	157/91	55	-1
Houston	233 (200/33)	90	1/1	91	166/96	66	-6
Philadelphia	274 (190/84)	117	27/4	121	98/60	36	+61
Wash DC	303 (200/103)	113	4/1	114	92/47	15	+67
Miami	125 (110/15)	55	2/0	55	272/168	45	-113
Atlanta	242 (190/52)	79	13/9	88	144/73	40	+15
Boston	147 (110/37)	46	2/0	46	250/137	1	-91
San Francisco	290 (200/90)	111	6/4	115	103/59	2	+56
Phoenix	201 (170/31)	100	2/0	100	196/137	27	-37
Riverside	170 (160/10)	72	5/3	75	224/140	46	-65

MTA	PDV Chnls Total (MTA/Other)	PDV Chnls in NB Sgmt.	Avail Chnls (Total/ below 937)	Total Avail Chnls	Other licensed Chnls (Total/ above 937)	# CII	Relocation Channel Surplus or Deficit
Detroit	232 (200/32)	97	22/0	97	145/83	2	+14
Seattle	277 (200/77)	109	11/2	111	111/63	28	+48
Minneapolis	206 (200/6)	82	186/71	153	7/1	0	+152
San Diego	265 (180/85)	110	6/4	114	128/83	39	+31
Tampa	217 (190/27)	80	51/21	101	131/73	36	+28
St. Louis	200 (200/0)	80	97/40	120	102/63	2	+57
Baltimore	291 (200/91)	110	8/3	113	100/54	12	+59
Denver	258 (170/88)	120	1/0	120	120/91	0	+29
Pittsburgh	200 (200/0)	80	193/73	153	6/0	0	No relo
Charlotte	184 (180/4)	73	161/55	128	54/23	4	+105
Portland	200 (200/0)	80	161/59	139	38/18	5	+121
San Antonio	201 (190/11)	81	36/12	93	162/96	80	-3

Table 1: Analysis of Channel Availability in Top 25 Target Markets

As a result of this analysis, the Consultant has determined that a total of 1983 channels will require relocation in these markets and 17 out of the 25 target markets have sufficient channels available to support the proposed re-alignment. The eight remaining markets require as little as one (Dallas) to as many as 113 (Miami) additional channels to make relocation feasible.

The consultant understands that pdv continues to pursue additional channels in these and other markets in order to ensure sufficient channels are available for the relocation throughout the country. In addition to purchasing or acquiring additional channels, the consultant notes that there are other options available to pdv to facilitate relocation in the more congested markets. Some of the options that consultant suggests pdv consider include:

- Pack channels via an engineering analysis, such as short-spacing where possible;
- Offer service credit on the PEBB system;
- Offer service credit on a different commercial network;
- Build an LTE site(s) to support a specific licensee and provide core services.

The Consultant notes that simply identifying sufficient available/unlicensed channels in a given market does not guarantee that relocation of all necessary channels will be possible. The actual identification of suitable channels will require coordination to ensure that a specific channel can be used at a given site or in a given location. While this activity is beyond the scope of this analysis, the Consultant is confident that given a significant pool of available channels, the flexibility of assigning different channels will help facilitate the relocation.

Combiner Spacing Concerns

Another concern related to channel availability raised by some of the commenters is the potential for performance degradation due to reduced combiner spacing. Given the reduced number of available narrowband channels that will result from the proposed realignment, it is likely that some current licensees that operate multiple channels at a single site will receive replacement channels with reduced frequency separation. The basis for this concern is radio frequency combiners generally exhibit higher insertion loss with reduced separation. Due to this factor, it is common for radio system managers to license frequencies that are 500 kHz or more apart from other frequencies at the same site, in order to minimize this impact. With the current band configuration, a total of ten channels can be combined into a single antenna at a single site, while still maintaining a frequency separation of 500 kHz. With the proposed band alignment, which limits the frequencies available for narrowband operation to 160, a licensee would need to accommodate reduced separation in order to utilize this same number of channels in a single combiner/antenna configuration. Specifically, in order to maintain ten channels, the maximum frequency separation would be reduced to 200 kHz, while a more common 250 kHz channel separation would allow up to eight channels in a single combiner and antenna.

In order to examine the potential performance degradation caused by rebanding due to the proposed band realignment the Consultant reviewed the performance of several 900 MHz combiners. An example of a high performance/low loss combiner is a unit by Bird Technologies shown in Appendix A. This unit displays a table (shown below in Figure 3) that indicates the insertion loss values for a different number of channels with different frequency separation. It is important to note that the insertion figures for this unit were better than many others researched by the Consultant, and also that it was difficult to identify units that supported more than eight or ten channels.

Tx-Tx Separation	Cavity Loss	Loss (dB) vs. No. of channels				
		2	3	4	5	6
1 MHz	1.25	2.2	2.3	2.4	2.4	2.5
500 kHz	1.80	2.8	3.0	3.2	3.4	3.5
250 kHz	2.80	3.9	4.3	4.5	4.7	4.9

Figure 3: Combiner Example Insertion Loss Chart

It can be seen that for a given number of channels, the insertion loss increases by a maximum of 1 dB when the frequency separation is reduced from 1 MHz to 500 kHz and no more than 1.4 dB when the frequency separation is reduced from 500 to 250 kHz. While an increased loss of 1.4 dB would not be considered negligible, it was the Consultant’s experience during the 800 MHz rebanding process that a 1 or 2 dB change in insertion loss can generally be mitigated by tuning adjustments or power increases at the base station. Additionally, if those adjustments were not feasible in any particular situation, replacement combiners are available which exhibit lower insertion loss, thereby limiting or eliminating any performance degradation. An example of this type of combiner is the CCI Model ATC-936-8. This eight channel combiner has a maximum insertion loss of 3.5 dB when combining frequencies as close as 200 kHz, which is on par with the high performance Bird Technologies combiner referred to above, when used with channels separated by 500 kHz. In fact, this particular combiner can combine channels with a minimum separation of as little as 75 kHz. The specifications sheet for this combiner is included as Appendix B.

Another important consideration in the relocation is the number of channels to be combined at a site. During the 800 MHz rebanding process, the Consultant very rarely experienced systems where more than eight or ten channels were combined into one antenna. Additionally, this experienced was based primarily on public safety systems, which are generally designed for higher capacity (more channels) than business and industrial systems.

As a result of this analysis, the Consultant concludes that while combiner spacing is a legitimate concern when performing a system redesign or relocation, sufficient channel and equipment flexibility exists to minimize or eliminate the concerns of performance degradation.

Relocating to a different co-channel and adjacent channel environment

Another common concern of incumbents about to be rebanded is the fear that their co-channel or adjacent channel environment may be different than prior to rebanding. This concern was also raised by incumbents during the 800 MHz rebanding process. It is the Consultant's experience and opinion, that this concern was alleviated through the requirement of "equivalent facilities". In that previous rebanding project, the FCC required that relocated incumbents receive equivalent facilities following their frequency relocation.

Additionally, the FCC clarified that while not every relocated licensee would receive the same exact co-channel and adjacent channel licensees, they would all receive protection at least to the minimum level required by the FCC rules for frequency coordination. For even further protection, as part of the initial 800 MHz rebanding ruling[2], the FCC established steps to address interference. These steps include:

1. An objective definition of unacceptable interference;
2. Assigning responsibility for mitigating interference; and
3. Prior notification requirements before ESMR or cellular operators activate new or modified cells.

It is the Consultant's opinion that if similar rules and precautions are put in place during this proposed relocation, this concern can be effectively managed and mitigated.

Equipment Compatibility

Another concern that was prevalent during the 800 MHz rebanding process was the capability of the equipment to accommodate the replacement frequencies. It is the Consultant's opinion that this concern will be a much less significant issue in this proposed realignment than it was during the 800 MHz rebanding process. Prior to 800 MHz rebanding, the 800 MHz band was comprised of sub-bands, which included the General Category licenses, as well as separate National Public Safety Planning Committee (NPSPAC) licenses. Many different types of equipment, including both infrastructure (i.e. antennas, tower-top amplifiers, etc.) and subscriber

[2] FCC 04-168: Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order

equipment (mobile and portable radios) had been designed to operate in one sub-band and not the other. As a result, the equipment relocation to replacement frequencies could be quite complicated and an extensive planning process was required to determine what equipment was compatible and what equipment had to be replaced.

An additional item that contributed to the equipment compatibility issue during the 800 MHz process was the fact that different portions of the 800 MHz had different channel spacing and different emission mask requirements. This issue does not exist in the 900 MHz band since all channels are based on 12.5 kHz spacing today and one emissions mask is used for the entire band.

The Consultant has determined that equipment compatibility is of much less concern in the 900 MHz band, due to the reduced complexity of the band. The Consultant's research into the available equipment in the 900 MHz band has only revealed equipment that supports the entire band (896-901/935-940 MHz), and therefore can be effectively and efficiently retuned or reprogrammed to support replacement channels.

How to effectively re-tune the equipment and system to the new frequencies

To evaluate this concern, the Consultant again refers back to the experience gained during the recent 800 MHz rebanding process. A number of effective methods for re-tuning equipment have been developed and proven during this recent rebanding process. For individual equipment, these are the generally accepted methods:

- RF Combiners: Retune in the field at the site;
- Base Stations: Reprogram in the field at the site;
- Subscriber Radios: Reprogram at the user location; at a radio shop; or over the air.

From a system perspective, conventional channels of systems can be retuned by adding the replacement channel to the subscriber units and then retuning the base station(s) and combiner/duplexer at a specific cut-over time. Then, at some later date, the original channels can be removed from the subscriber radios. Alternatively, if the system is small and sufficient coordination occurs, all equipment can be retuned within a given period and it can be done with a single touch/reprogramming of the subscriber equipment.

Trunked systems require a different approach but they can be retuned through a variety of methods. The majority of systems that were retuned during the 800 MHz rebanding process were done through the following general process:

1. Add the replacement channels to all of the subscriber radios;
2. Add the new channels to the trunking controller firmware;
3. Retune the base stations and RF combining equipment at all sites;
4. If desired (not necessary), remove the original channels from the subscriber radios.

Some systems were done simply by disabling a site, rebanding it and then bringing it back on line, while others were done incrementally either a single channel at a time, or using groups or blocks of channels and utilizing one or more interim system configurations.

Given the experience gained from the 800 MHz rebanding process, the Consultant is confident that an effective rebanding procedure can be determined for any system that must be relocated per the proposed band realignment.

The Consultant notes that the systems that will be encountered in this band will generally be smaller than the systems that have been successfully rebanded during the 800 MHz rebanding process. Specifically, for the top 25 target markets analyzed above, a total of only 82 licensees were found to have more than five channels licensed above 937 MHz. The Consultant is confident that this is significantly less than what was addressed at 800 MHz, given the likely hundreds of large city and countywide public safety systems that were rebanded during this process.

Furthermore, the magnitude of the entire reconfiguration in this band is anticipated to be significantly less than the earlier process. Again, referring to data from the top 25 target markets referenced above, which represents half of, and also the most populous MTAs across the country, a total of approximately 290 separate Frequency Reconfiguration Agreements (FRAs) would be required to reconfigure these markets. As a comparison, as of the June 30, 2015 status report, a total of 1988 FRAs have been successfully reconfigured as part of the 800 MHz rebanding process.

How to minimize operational disruption during the transition

As described in the previous section, a number of methods have been developed and proven to reband a system that needs relocation. These methods can be adjusted depending on a particular situation in order to minimize disruption for incumbents. For example, for critical conventional channels or systems, a back-to-back repeater system can be put in place to simultaneously transmit and receive on both the original and replacement frequencies during the transition. For critical trunking systems, interim system configurations can be utilized and the system transition can be done in an incremental fashion as simply as one channel at a time if necessary.

The methods described here were used extensively during the 800 MHz process for public safety and Critical Infrastructure Industry (CII) systems, which cannot tolerate anything more than planned momentary interruption. The Consultant notes that the majority of channels to be relocated for this proposed realignment are non-CII channels. Table 1 above indicates 697 of the total 1983 channels that require relocation are licensed to CII licensees – only 35%. Therefore, in most cases, the retune of the non-CII channels can occur during times of no usage or reduced activity using straight-forward retuning methods.

How to gain access to and coordinate reprogramming of the user radios

While the access to subscriber radios and coordination of reprogramming may initially be raised as a concern, experience learned through the 800 MHz rebanding process indicated that this challenge can generally be overcome through proper up-front planning. Through years of rebanding experience, the Consultant found that generally there is a radio system manager or radio service shop that has accurate records of the radio users and locations and can help develop an efficient plan to access the radios and perform the reprogramming. The Consultant found that only geographically large multi-jurisdictional systems proved to be a significant challenge. However, in spite of these challenges, the Consultant witnessed several statewide public safety systems with hundreds of user agencies and tens of thousands of subscriber radios successfully rebanded.

Based on a review of the current licenses, it is apparent that the 900 MHz band contains fewer large multi-jurisdictional complex systems than what have previously been addressed during the 800 MHz rebanding process. While the Consultant is aware that there are at least several large critical infrastructure and utility systems currently operating in this band, it is the Consultant's opinion that the extent of these types of systems is significantly less than the hundreds of public safety systems that were successfully rebanded in 800 MHz. Therefore, the Consultant has concluded that the issue of gaining access to and coordinating the reprogramming of radios required by this proposed re-alignment is entirely feasible and significantly less involved than the 800 MHz rebanding process.

Maintaining interoperability with neighboring agencies during the transition

It is common practice for public safety agencies to have interoperability and mutual aid agreements with neighboring jurisdictions, and therefore have either their communications systems connected together or have common frequencies or system information programmed into their user radios. For example, in the National Capital Region, the Consultant is aware of up to 17 neighboring agencies that enjoy interoperability through a complex common programming and interconnection network. In spite of these complexities, it was possible to develop a rebanding plan that accomplished the 800 MHz band realignment without negatively impacting the numerous interoperability arrangements.

Due to the types of systems and user base in the 900 MHz band, it is highly unlikely that the installed base of systems has nearly the same level of interoperability complexities that were prevalent with 800 MHz public safety systems. Therefore, in the Consultant's opinion, the realignment of the 900 MHz band will not be significantly complicated by inter-system interoperability and rebanding can occur more smoothly than the 800 MHz process.

The cost of the re-alignment

The cost of the realignment should not be a major concern of the incumbent licensee since all costs are proposed to be paid by the broadband licensee. As recommended in the petition:

> "The PEBB licensee would be required to fund the relocation to comparable facilities (as defined in FCC Rule Section 90.699, including the same quality of service as the facilities enjoyed prior to relocation ("Comparable Facilities")) below 898/937 MHz of all site-based B/ILT licensees in the PEBB allocation, as well as any MTA licensees that wish to continue to operate narrowband systems."

The PEBB licensee will need to negotiate mutually agreeable rebanding agreements for each of the affected licensees based on a review of installed equipment and a reasonable rebanding plan.

Task Two

The second task included in this engagement requested that the Consultant review, analyze and provide recommendations for the proposed PEBB allocation to operate and not interfere with narrowband systems above and below the broadband allocation. This section of the report discusses the potential sources of interference and the Consultant's analysis and conclusions.

Potential Sources of Interference

Whenever a band realignment is done or a new technology is introduced into an existing band an analysis should be done and care must be taken to ensure the new technology and/or band configuration will not lead to interference to the incumbent licensees or other users. pdv is aware of these concerns and has performed an analysis to determine if the broadband allocation will cause interference and what steps, if any, must be taken to protect incumbent licensees and the PEBB licensee from interference and has also commissioned this study.

It is also instructive to note that a band reconfiguration and subsequent deployment of broadband technology has occurred recently in the 800 MHz band following 800 MHz rebanding. Similar interference concerns were considered during that process and the conclusions and recommendations documented in the FCC Report and Order FCC-12-55A1[3]. The Consultant will draw comparisons to this document (the "800 MHz EA SMR Report and Order") in this report where applicable.

The potential sources of interference fall into three primary categories:

1. Out Of Band Emissions (OOBE);
2. Receiver Blocking; and
3. Intermodulation (IM).

Additionally, due to the proposed band realignment, the PEBB allocation will be adjacent to two different classes of service as defined by the FCC:

- FCC Part 90 Private Land Mobile Radio Services Subpart S on the low side of the proposed PEBB allocation (898/937 MHz border); and
- FCC Part 24 Personal Communications Services Subpart D on the high side of the proposed PEBB allocation (901/940 MHz border).

Each of these potential sources of interference concerns will be analyzed for each of the classes of service.

Out Of Band Emissions (OOBE)

Definition

Out Of Band Emissions (OOBE) are defined as emissions on frequencies that are immediately outside of the necessary bandwidth, which result from the modulation process, but exclude spurious emissions. The concern over this mode of interference relates to an increase in the effective noise floor in an area due to excessive OOBE.

[3] FCC Report and Order FCC-12-55A1: In the matter of Improving Spectrum Efficiency Through Flexible Channel Spacing and Bandwidth Utilization for Economic Area-based 800 MHz Specialized Mobile Radio Licensees: May 24, 2012.

Potential Interference Scenarios

Excessive Out Of Band Emissions can create difficulties with systems operating on adjacent channels or in adjacent band allocations. The difficulties generally result from what is referred to in the industry as the classic Near-Far problem. With the Near-Far problem, if a nearby transmitter exhibits excessive OOBE, it might “drown out” the desired signal transmitted by a transmitter far away. One scenario is shown below in Figure 4 where a Part 90 User Equipment (UE) is far away from its home system base station, but is near to a PEBB base station. In this case, excessive OOBE would be a problem in what will be referred to as the Downlink Scenario.

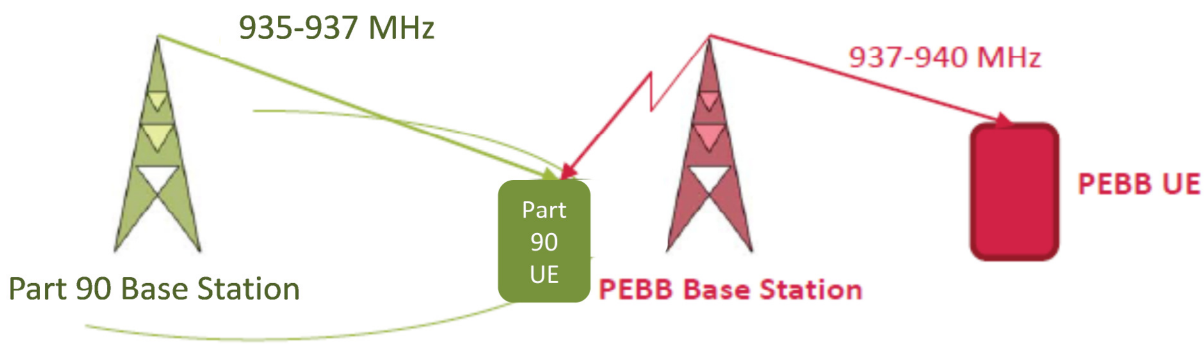


Figure 4: Near/Far Downlink Scenario

In another potential interference scenario (Figure 5 below), the PEBB UE is far away from the PEBB base station but is near to a Part 24 base station. In this case, excessive OOBE would be a problem in what will be referred to as the Uplink Scenario.

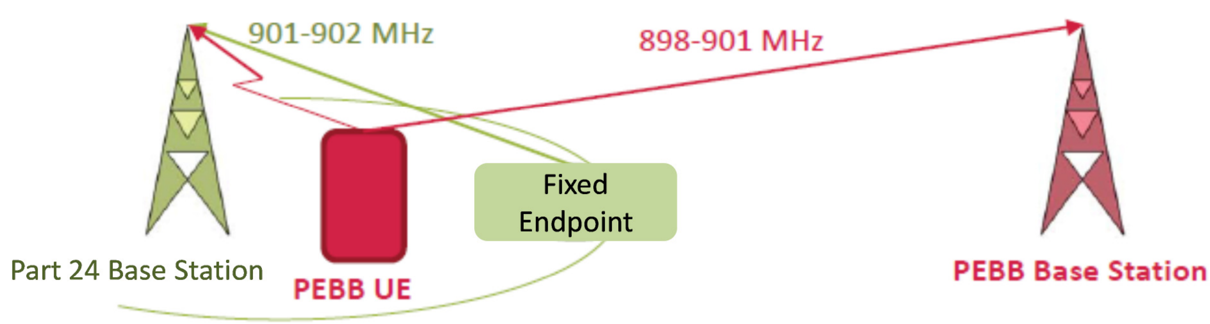


Figure 5: Near/Far Uplink Scenario

Although the Downlink Scenario is shown in a Part 90 situation and the Uplink Scenario is shown in the Part 24 situation for illustrative purposes, both scenarios can occur in either situation.

pdv OOBE Model

In order to evaluate the potential for interference in the above defined scenarios, pdv developed a Radio Frequency (RF) simulation model to predict signal levels and interference thresholds. The model takes into account the proposed emissions mask proposed by pdv as well as anticipated operating parameters for the PEBB system using LTE technology and typical operating parameters for the adjacent system. The Consultant notes that pdv has chosen to propose an emissions mask which attenuates the OOBE by a minimum of 55 + 10 Log (P), where P is the transmit power in watts. This is a more aggressive mask than the mask in the current FCC rules in this band (Part 90.691), which specifies a minimum of 50 + 10 Log (P). Therefore, given that the proposed mask is more aggressive, incumbents in the neighboring adjacent bands will experience less OOBE than if an existing licensee were to deploy a technology that complied with the currently authorized mask. This is significant, given that the FCC cited Sprint's claims of reduced interference as a significant consideration in the 800 MHz EA SMR Report and Order.

Given the proposed emission mask, it is helpful to model the system and the environment to further evaluate the potential for interference. A table of the input parameters for the model developed by pdv is shown in Figure 6 below:

Input		
PDV_BTS	*Tx*	
OOBE Mask Reference	55	+10log(P)
Antenna Gain	16	dBi
Cable Loss	4	dB
Height	30	m
NB_UE	*Rx*	
Antenna Gain/Loss	-0.75	dBi
Height	1.5	m
C/I+N	7	dB
NB Ch BW	7800	Hz

Figure 6: pdv OOBE Model Input Parameters (Downlink)

The model calculates and graphs the Power Spectral Density (PSD) referenced to dBm/Hz at the receiver in question as a function of the receiver's distance from the base station. The output of the model for the Downlink Scenario is shown in Figure 7.

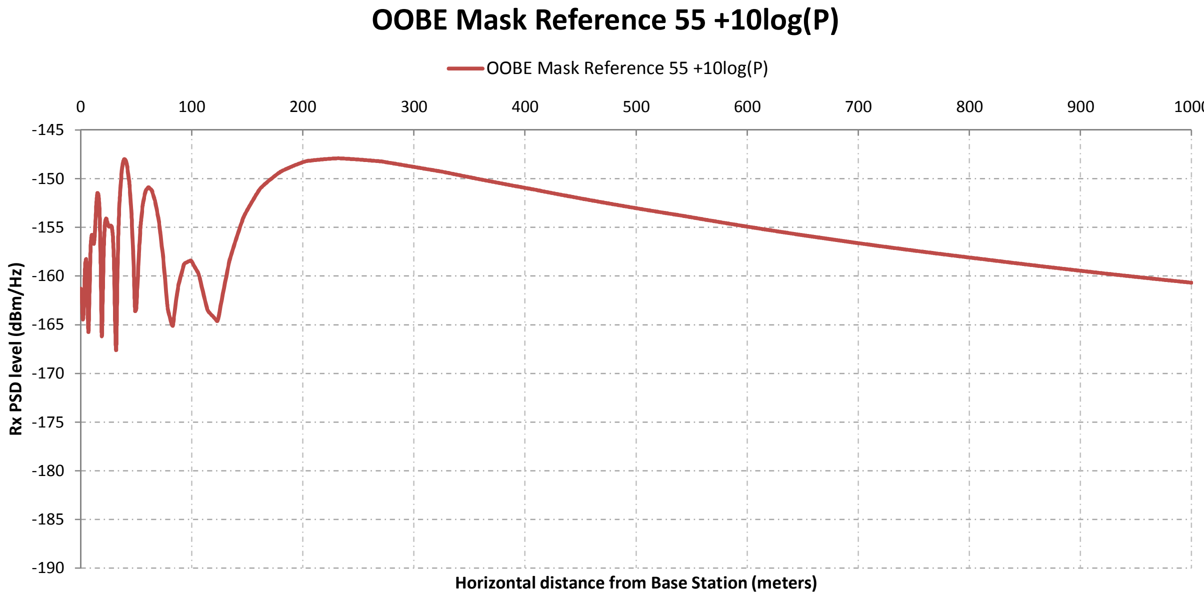


Figure 7: Output of pdv OOBE Simulation Model (Downlink Scenario)

Based on the model parameters and assumptions, it can be seen that the peak of the graph is approximately -148 dBm/Hz. In order to determine if this figure is low enough to prevent interference to an incumbent in an adjacent band, some further analysis is required. To aid in this analysis, it is helpful to refer to the Telecommunications Industry Association's Telecommunications System Bulletin: TSB-88[4]. This document describes design and operating parameters and analysis methods for noise and interference limited systems. The document also provides operating requirements and parameters for specific narrowband technologies that may be operating in adjacent bands to the proposed PEBB allocation. Use of the methods and parameters provided in TSB-88 will facilitate an analysis to determine if the existing systems will be adversely affected by the presence of the PEBB system in the adjacent band.

Narrowband systems, such as those occupying the frequencies adjacent to the proposed PEBB allocation are designed to meet a specific Channel Performance Criterion (CPC) in order to meet intended performance. TSB-88's definition of CPC is provided here:

> *The CPC is the specified design performance level in a faded channel. Its value is dependent upon ratios of the desired signal to that of the other noise and interference mechanisms that exist within the service area. It is defined as a ratio of the Rayleigh faded carrier magnitude to the sum of all the appropriate interfering and noise sources, Cf/(ΣI+ΣN) necessary to produce a defined performance level. This Cf/(I+N) determines the Faded Sensitivity value. However the faded sensitivity needs an absolute power reference. The faded sensitivity can be determined from the known Reference Sensitivity, a static desired carrier-to noise ratio, Cs/N, for bench testing, which provides the*

[4] TSB-88.1-D: Wireless Communications System Performance in Noise and Interference-Limited Situations; TIA April 2012

absolute power necessary for the Cs/N criterion. The faded sensitivity for a given CPC is then the static reference sensitivity plus (Cf/N – Cs/N).

TSB-88 also publishes the CPCs and Cs/N values for a variety of narrowband technologies and defines the Inferred Nosie Floor as a calculated figure using Boltzmann‟s constant and an assumed room temperature of 290 K, correcting for the receiver's Equivalent Noise Bandwidth (ENBW) and Noise Figure. TSB-88 also notes that the actual noise floor might need adjustments due to environmental noise or interference. The Consultant concludes that in order to ensure that operation of the PEBB system causes minimal impact[5] to systems operating in adjacent bands the calculated PSD of the PEBB system in the adjacent bands should not exceed the Inferred Noise Floor for these systems, so as not to raise the actual noise floor. Using publicly available figures, the Inferred Noise Floor can be determined from the Reference Sensitivity for a given system component and the Cs/N for a given narrowband technology.

The Reference Sensitivity will vary by system component and manufacturer. However, a typical value, and one referenced in the Part 90 rules, as well as the recommended figure per TIA-102.CAAB and TIA-603, is -116 dBm. Using this value and the values for Cs/N for the expected dominant technologies in the Part 90 portion of the 900 MHz, the Inferred Noise Floor (absolute) can be calculated. The next step is to translate this absolute value to a figure in dBm/Hz in order to compare it to the PEBB PSD per the pdv model. This conversion is produced from information provided in TSB-88 and the Equivalent Noise BandWidth (ENBW) for typical implementation of these technologies. The result of this analysis and conversion is shown in Figure 8.

Inputs	**Part 90**			
Reference Sensitivity (dBm)			-116	
Cs/N for Analog Voice 12.5 kHz (dB)			7	
ENBW for Analog Voice 12.5 KHz (Hz)			7800	
Cs/N for P25 Phase 1 (dB)			7.6	
ENBW for P25 Phase 1 (Hz)			5500	
Inferred Noise Floor (INF) = Reference Sensitivity - Cs/N				
Results				
	Ref Sen	Cs/N	INF (dBm)	INF (dBm/Hz)
Analog FM	-116.0	7.0	-123.0	-161.9
P25	-116.0	7.6	-123.6	-161.0

Figure 8: Calculation of Inferred Noise Floor for Part 90 Technologies

[5] If the PEBB PSD is equal to or less than the calculated Inferred Noise Floor, the effective increase in the Inferred Noise Floor will be no more than 3 dB.

Based on this analysis, it can be seen that the PEBB PSD must remain less than -162 dBm/Hz in order to minimize any potential for interference impact to existing Part 90 licensees. However, as seen earlier in Figure 7 for the Downlink Scenario, the pdv model indicates that the PEBB PSD will reach approximately -148 dBm/Hz at some locations close to the base station. Therefore, this analysis indicates additional signal reduction or protection; a minimum of 14 dB; is required to decrease the PEBB OOBE to the desired level.

To address the Uplink Scenario, it is noted the concern is that the PEBB UE could interfere with the narrowband base station receiving the transmission from its field unit. In this scenario, some different model parameters must be taken into account, specifically in relation to the narrowband base station and the PEBB UE. The input parameters for this version of the model are shown in Figure 9.

Input		
PDV_UE	*Tx*	
OOBE Mask Reference	55	+10log(p)
Antenna Adjustment	-5.2	dB
Power Back Off	5	dB
Height	1.5	m
NB_BTS	*Rx*	
Noise Figure	8	dB
Antenna Gain	12	dBi
Cable Loss	4	dB
Height	45	m

Figure 9: pdv OOBE Model Input Parameters (Uplink)

The results of the model, displaying the PEBB UE PSD received at the narrowband base station as a function of the UE's distance from the base station is shown in Figure 10.

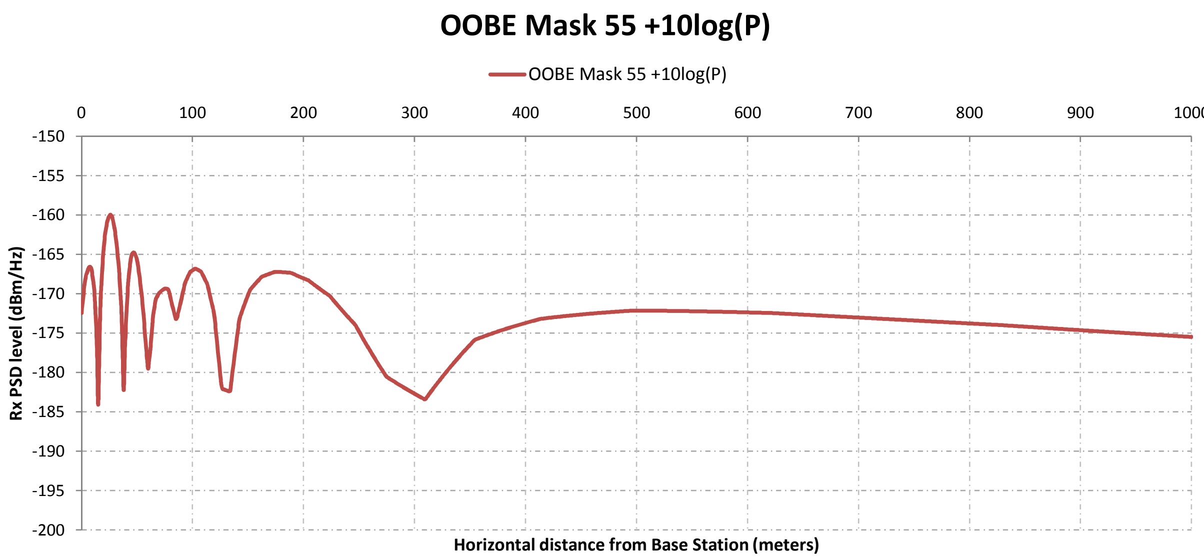


Figure 10: Output of pdv OOBE Simulation Model (Uplink Scenario)

These results indicate the PEBB PSD peaks at around -160 dBm/Hz which is only slightly higher than the calculated desired limit of -162 dBm/Hz. However, this level is only exceeded at a distance of 26 meters from the narrowband base station. The results also indicate the PEBB PSD to be at or below a level of -165 dBm/Hz at all distances beyond 100 meters from the base station.

While these levels appear safe in most situations, there does appear to be a slight possibility of interference. Therefore, the Consultant recommends the PEBB licensee utilize UE equipment that provides more robust OOBE attenuation. In addition, the Consultant also recommends that the rules drafted to govern the operation of the PEBB allocation reflect a similar interference protection process as that established for other band realignments, such as the 800 MHz EA SMR Report and Order referenced earlier, namely:

1. The PEBB licensee provides prior notification to incumbents before initiating service in a specific area;
2. An effective harmful interference threshold and criteria be established to identify the presence of harmful interference; and
3. The PEBB licensee accepts responsibility to take steps necessary to mitigate harmful interference that is identified.

Harmful Interference Threshold

In order to make the interference mitigation process effective, a realistic harmful interference threshold must be defined. The Consultant notes that a harmful threshold process has already been established for Part 90 systems in FCC rules section 90.672. The current harmful interference threshold levels for 900 MHz are:

- A median desired signal strength of -88 dBm as measured at the R.F. input of the receiver of a mobile unit; and

- A median desired signal strength of -85 dBm as measured at the R.F. input of the receiver of a portable or handheld unit.

The Consultant notes that these figures seem high when compared to typical equipment performance when considering today's digital systems. For example, again referencing TIA-102.CAAB, the recommended faded reference sensitivity for Class A equipment is -108 dBm. The Consultant hypothesizes that the current figures may have reflected the period when narrowband analog equipment was dominant and these systems were generally designed to a higher signal level. However, recognizing that now, the majority of new or replacement systems will be of the digital variety, more aggressive thresholds may be more appropriate.

The Consultant feels it is instructive to also review the current 800 MHz harmful threshold levels. These levels are:

- A median desired signal strength of -104 dBm as measured at the R.F. input of the receiver of a mobile unit; and
- A median desired signal strength of -101 dBm as measured at the R.F. input of the receiver of a portable or handheld unit.

These levels are significantly more stringent than the current levels at 900 MHz. However, the current technologies likely to be deployed at 900 MHz are very similar to those operating at 800 MHz and being held to these more stringent levels. Manufacturer specifications suggest that some additional filtering may be necessary for equipment to meet the more stringent 900 MHz emissions mask, but this is likely to be only 1-2 dB. Therefore, taking into account this additional 2 dB, the Consultant recommends pdv suggest the following harmful interference thresholds for the proposed revision to the 900 MHz rules.

- A median desired signal strength of **-102 dBm** as measured at the R.F. input of the receiver of a mobile unit; and
- A median desired signal strength of **-99 dBm** as measured at the R.F. input of the receiver of a portable or handheld unit.

The Consultant feels that these levels will provide incumbent licensees adequate protection against interference, without being overly burdensome to the PEBB licensee.

FCC Part 24 Considerations

The Consultant notes that the analysis above for OOBE refers primarily to the Part 90 side of the PEBB's adjacent band environment. However, as noted earlier, the proposed PEBB allocation is also adjacent to incumbent licensees that are referenced under FCC Part 24 rules. The Consultant has concluded that the analysis performed above for the OOBE levels in the Downlink and Uplink Scenarios as well as the recommended harmful interference thresholds are applicable for Part 24 given that this allocation also authorizes narrowband equipment operating in a similar frequency range in a similar operating environment.

Another consideration relates to significant objections to the Petition that have been raised by representatives of Part 24 licensees. The commenters claim that the proposed broadband allocation will significantly increase the noise floor within the adjacent band and create harmful interference to currently operating systems. This claim is accompanied by an analysis of the pdv

OOBE simulation model described earlier. The Consultant has reviewed the model developed by pdv, the analysis performed by Sensus/Real Wireless and the results are presented here.

A summary of the model parameters and the alternate proposed values from Sensus/Real Wireless is shown in Table 2, followed by a discussion of each parameter.

Model Parameter	PDV Assumption	RW "Challenging Case"	RW "Moderate Case"	Comments
UE Antenna Gain and Body Loss (dBi)	-10	0	-3	TSB-88 -5.2
UE Power Back-Off (dB)	9	0	3	Recommend 5
Effect of UE Power Control on OOBE (dB)	1	0	1	1
LTE eNodeB Cable Loss (dB)	4	0	0	4 is typical
Number of Simultaneously Transmitting UEs	1	15	3	1 reasonable due to scheduling
Protection Level (dBm/Hz)	-160	-170	-168	-162 per analysis
FlexNet Base Station Antenna Gain (dBi)	12.2	12.2	12.2	No comment
FlexNet Base Station Antenna Pattern	BCD-87010-EDIN-1-25	BCD-871010-6-25 (6 elec. downtilt)	BCD-871010-3 (3 elec. Downtilt)	1.25 Downtilt reasoanble
FlexNet Base Station Antenna Height (m)	147.6'	60'	110'	110' is average
Propagation Model	W-I-LOS	Free Space	Free Space	WI-LOS Appropriate
Maximum Antenna Attenuation (dB)	Unlimited	20	Unlimited	Use manufacturer published pattern

Table 2: pdv Model Analysis Summary by Sensus/Real Wireless

UE Antenna Gain and Body Loss: pdv has used 10 dB where Real Wireless argues that this figure will vary and depend on the orientation of the user and the UE. While the figure will vary, there will be some attenuation of the signal due to the antenna characteristics of a handheld/portable unit. The figure provided in TSB-88 for 900 MHz for a unit held at head level is -5.2 dB and this is the figure recommended by the Consultant.

UE Power Back Off: pdv cites a reference that indicates LTE UEs generally operate at a significant power back off level. The Consultant has reviewed the report cited by pdv[6] and agrees that in addition to proper system design that prevents the UE from transmitting at full power prior to transitioning to a neighboring site (assume 20 dBm vs 23 dBm), a power back off of 2 dB includes 95% of the rural subscriber profile and over 99% of the urban/suburban profile.

[6] CSMAC.....

Therefore, the Consultant concludes that a total of 5dB power reduction from the maximum of 23 dBm is appropriate.

Effect of Power Control on OOBE: pdv assumes this is a one for one relationship. While Real Wireless agrees to some extent, they refer to potentially other sources such as spurious emissions that may not scale. Spurious emissions are not a component of OOBE and have not been shown to be a concern. The Consultant has assumed a value of 1 in the revised model.

LTE eNodeB Cable Loss: pdv has assumed a cable loss of 4 dB for this figure. This is a reasonable figure per the Consultant's experience. It appears as if Real Wireless has misinterpreted this parameter.

Number of Simultaneously Transmitting UEs: pdv has modeled a single UE in the Uplink Scenario. This is appropriate given that LTE uses a scheduling algorithm to assign resource blocks to requesting UEs, which reduces the occurrence of simultaneously transmitting UE in proximity of one another.

Protection Level: The protection level used by the Consultant in the modified model was derived from a typical narrowband system reference sensitivity documented in industry accepted publications and a typical static threshold level for a narrowband digital system. The result is -162 dBm as shown above in Figure 8. The Consultant notes that these calculations are based on theoretical levels, and as explained in TSB-88, may need to be adjusted due to environmental noise. However, TSB-88 also points out that, except for certain frequency bands (primarily VHF and some portion of 800 MHz), it is rare for the total environmental noise to exceed the calculated kTB[7]. However, since no evidence has been seen that suggests high environmental noise, no adjustments have been made.

While Sensus claims they have received interference in previous situations from a signal level of approximately -162 dBm, their illustrations do not indicate the specific signal level which caused the interference. The Consultant maintains that this is an appropriate figure for the analysis.

FlexNet Base Station Antenna Gain: pdv and Sensus/Real Wireless agree on this parameter, therefore the Consultant has no additional comment.

FlexNet Base Station Antenna Pattern: pdv has assumed a typical 900 MHz base station antenna and Sensus/Real Wireless has recommended the use of high downtilt antennas. A high level of downtilt such as 6 digress, or even 3 degrees is not consistent with a long range noise-limited system design as promoted by Sensus. The Consultant concludes that the pdv chosen antenna is appropriate.

FlexNet Base Station Antenna Height: Data provided by Real Wireless indicates that the median base station height is between 110 and 120'.

Propagation Model: The Walfisch-Ikegami model is a popular model that was further developed by the Cost 231 project in Europe. It is similar to the free space loss model but does

[7] TSB-88.2-D Section 5.1

take into account scatter loss. At short distances it is nearly identical to free space loss. The Consultant considers this an appropriate selection.

Maximum Antenna Allowance: pdv has calculated the attenuation due to the antenna pattern according to the manufacturer's published data, which exhibits deep nulls at various angles re4lative to the horizon. Real Wireless claims that in a practical environment, small amounts of multipath tend to reduce the depth of the nulls. The Consultant acknowledges that multipath or local reflective scattering can have this effect. However, the Consultant also notes that the areas where the flattening of the nulls may occur are not in the areas of main concern as shown by the model. As a result, this appears to be a moot point and the Consultant agrees with the use of the manufacturer's published data in the simulation.

The results of the simulation model reflected in this report are based on the comments above and the figures shown in the Comments column of the table and therefore constitute the best judgment of the Consultant with the regard to the potential for interference due to the proposed band realignment.

As pointed out earlier, the potential for interference, although slight in the opinion of the Consultant does exist and provisions must be in place to deal with such an occurrence if it arises. Hence, the Consultant has previously recommended incorporating a prior notification requirement in addition to revising the harmful interference levels. In addition, in order to further address the concerns of the Part 24 licensee representatives, the Consultant agrees with pdv's proposed rules which incorporate a provision for a harmful interference threshold for base station equipment, which provides an incumbent licensee an opportunity to claim harmful interference in an Uplink Scenario. This provision does not exist in the current rules and represent another area where the proposed rules will provide incumbent licensees with better protection from interference than the existing rules. Assuming a balanced system (equivalent uplink and downlink path loss), the recommended value for the base station should be the same as the weaker uplink signal, namely that of the portable/handheld unit:

- A median desired signal strength of **-99 dBm** as measured at the R.F. input of the receiver of a base station.

Additionally, the Consultant notes that pdv has proposed to protect incumbent licensees operating a non-voice transceiver receiving an undesired signal which causes the measured Bit Error Rate (BER) to be more than 10^{-2} for systems operating on frequencies in the 901-902/940-941 MHz band[8]. These proposed modified rules will provide further protection specifically to address concerns of the Part 24 licensees.

Conclusions and Recommendations

OOBE is a legitimate concern in band realignments and especially where different technologies are adjacent.

The pdv simulation model was developed to determine the potential for interference. The results of the model indicate that, while the potential for interference appears less likely than under the current rules, it is possible in some situations. In order to mitigate the potential for interference, the Consultant recommends:

[8] EWA/pdv Ex Parte Comments for RM-11738, 05/03/15

1. pdv provide at least an additional 14 dB of OOBE reduction at the PEBB eNodeB (base station);
2. Using User Equipment that performs at least 2 dB better than the proposed emissions mask;
3. Incorporate a prior notification clause into the proposed rules;
4. Incorporate revised harmful interference thresholds into the proposed rules that meet the following levels:
    a. A median desired signal strength of **-102 dBm** as measured at the R.F. input of the receiver of a mobile unit;
    b. A median desired signal strength of **-99 dBm** as measured at the R.F. input of the receiver of a portable or handheld unit; and
    c. A median desired signal strength of **-99 dBm** as measured at the R.F. input of the receiver of a base station.

Receiver Blocking

Definition

Another potential interference concern relates to receive blocking. Receiver blocking occurs when excessive on-channel signal levels overload the receiver, usually the result of Automatic Gain Control (AGC) design limitations. The receiver can also be overloaded by a single high level unwanted signal, not on the desired channel, but within the receiver passband.

For reference, TIA-102.CAAA defines a related measure: blocking rejection, as the ratio of the level of an unwanted input signal to the reference sensitivity. The unwanted signal is of an amplitude that causes the BER produced by a wanted signal 3 dB in excess of the reference sensitivity to be reduced to the standard BER

Potential Interference Scenario

This interference scenario can also occur on either the Part 90 or Part 24 side of the proposed PEBB allocation. The scenario exists because the equipment designed for 900 MHz operation generally covers the 6 MHz band (896-902/935-941 MHz) inclusive of Part 90 and Part 24 frequencies. Therefore, transmissions from the PEBB system in the proposed allocation (898-901/937-940 MHz) will be in the passband of the equipment for narrowband licensees in Part 90 (896-898/935-937 MHz) and in Part 24 (901-902/940-941). The analysis and results described below will apply to both Part 90 and Part 24 situations.

pdv Model and Analysis

In order to evaluate the potential for interference due to receiver blocking, pdv developed a simulation model similar to what was done to evaluate OOBE. As in the previous model, typical operating parameters for the PEBB equipment and potential "victim" receivers are used. Two scenarios are addressed:

1. Scenario 1: PEBB Base Station (eNodeB) transmitting in the vicinity of a narrowband user device; and

2. Scenario 2: PEBB User Equipment (UE) transmitting in the vicinity of a narrowband base station.

Scenario 1: For this scenario, the inputs to the model are shown in Figure 11.

PDV_BTS	*Tx*	
Tx Power	40	Watts
	46	dBm
Antenna Gain	16	dBi
Cable Loss	4	dB
Height	30	m
P90_BTS	*Tx*	
Tx Power	100	Watts
	50	dBm
# Ch Aggregated	5	
Antenna Gain	12	dBi
Cable Loss	4	dB
Height	45	m
NB_UE	*Rx*	
Antenna Gain/Loss	-0.75	dBi
Height	1.5	m

Figure 11: Receiver Blocking Input Parameters and Values (PEBB eNodeB to NB UE)

Please note that the parameters for a Part 90 base station are shown because a comparison is drawn between the effects of the PEBB and the effects of a Part 90 base station operating within the current rules. Also note that the height of the Part 90 base station was increased to 45 meters (the PEBB antenna is modelled at 30 meters) to be, in the opinion of the Consultant, more representative of a narrowband Part 90 implementation.

The output of the model is shown in Figure 12, where three traces are shown. The red trace reflects the effect of the PEBB eNodeB, while the blue and green traces reflect the effect of the Part 90 base station, where blue is for a single channel and green is with five channels operating.

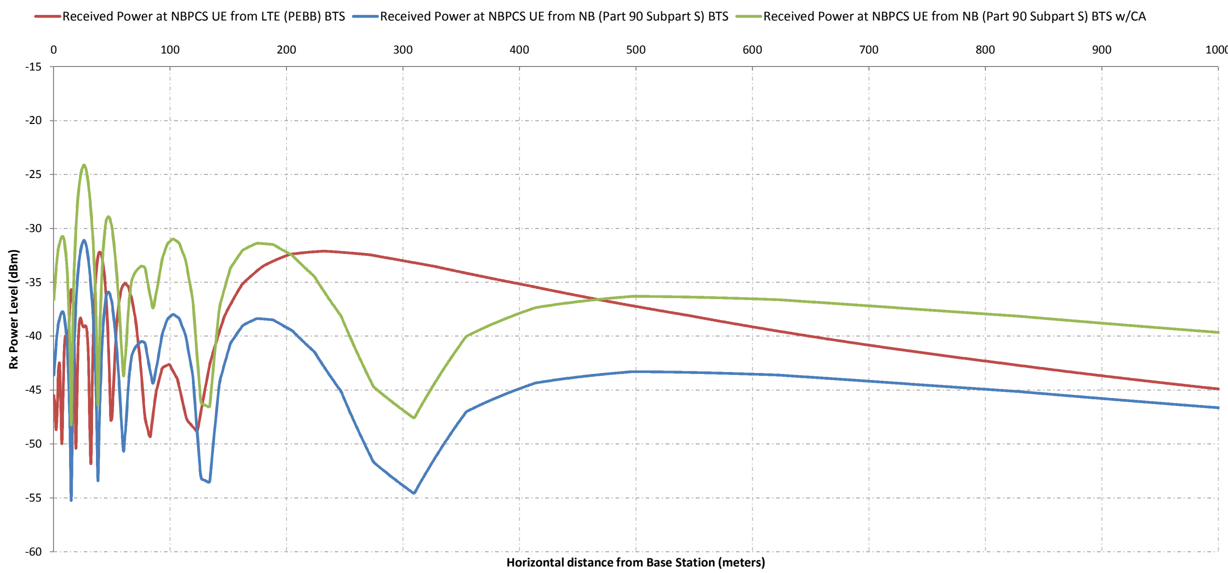


Figure 12: Receiver Blocking Output (PEBB eNodeB to NB UE)

From the results, although the overall shape differs, the peak values of the blue and green traces are approximately the same at about -32 dBm. Therefore, the effect of the PEBB system is no worse that the effect of the Part 90 base station with a single channel operating. Additionally, it can be seen that when the Part 90 base station has five channels operating, the effect exceeds that of the PEBB system. Therefore, the Consultant concludes that the effects of receiver blocking on adjacent incumbents will be less than what is possible today with narrowband licensees.

Scenario 2: For this scenario, the inputs to the model are shown in Figure 13.

Input				
PDV_UE	*Tx*			
Tx Power	0.200	1.25	3	Watts
	23	31	35	dBm
Antenna Adjustment	-5.2	dB		
Body Loss	0	dB		
Height	1.5	m		
NB_BTS	*Rx*			
Antenna Gain	12	dBi		
Cable Loss	4	dB		
Height	35	m		

Figure 13: Receiver Blocking Input Parameters and Values (PEBB UE to NB Base Station)

In the table above, three power levels for the PEBB UE are shown (.2, 1.25, 3 Watts). The standard operating power level for LTE user equipment is .2 watts. The vast majority of equipment fielded today operates at this power level. The "high power UE" figure of 1.25 watts was recently standardized by the Third Generation Partnership Project (3GPP) and is intended to extend the operating range for vehicular-mounted units. The final figure (3 watts) is one that pdv is pursuing to provide additional operating range for specialized user equipment.

The model calculates the receive power at a potential "victim" base station receiver. This model is focused primarily on the concerns of Part 24 licensees who utilize the band extensively for meter reading applications. Therefore, the base station height for this scenario was set to 35 meters to be consistent with a typical base station height of 110-120' as discussed in the OOBE analysis.

The results of the model are shown in Figure 14.

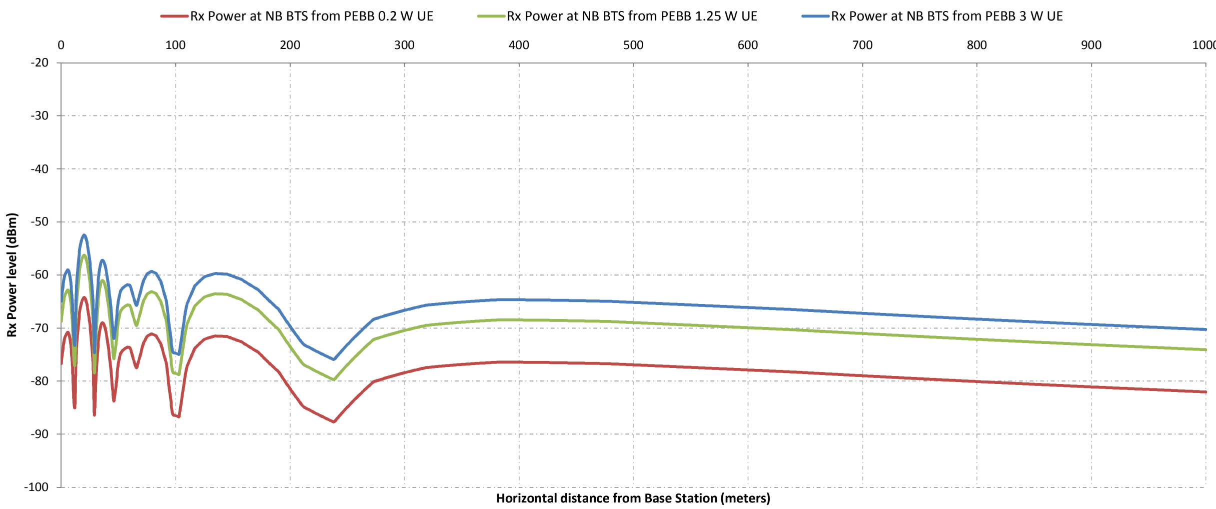


Figure 14: Receiver Blocking Output (PEBB UE to NB Base Station)

The three different traces represent the three different power levels for the UEs: red for .2 watts; green for 1.25 watts; and blue for 3 watts. It can be seen that the peak of highest trace (3 watts) stays below -50 dBm.

Evaluation of Results

The model developed to evaluate receiver blocking has calculated the effect of a PEBB transmitter on a potential victim receiver. The results show that the PEBB transmitter's effect in Scenario 1 is less than -30 dBm and in Scenario 2 is less than -50 dBm.

To evaluate the potential for interference, these figures will be compared to known equipment performance within the industry. An informal survey of equipment manufacturers indicate that their equipment blocking rejection is generally 90 to 100 dB. Additionally, specific radio measurements done by Pericle Communications[9] indicate blocking rejection between 95 and 105 dB. Since this blocking rejection figure is the ratio of an unwanted signal to the reference sensitivity and it was previously noted that typical reference sensitivity for narrowband equipment is -116 dBm, the Consultant concludes that an unwanted signal as strong -26 to -16 dBm can be tolerated before the receiver would enter into an overload situation. These figures are supported by TIA-102.CAAB which specifies a minimum blocking rejection of 90 dB for

[9] Comments of Pericle Communications Company and Shulman, Rodgers, Gandal, Pordy and Ecker P.A., WT Docket No. 12-40, 01/21/15.

mobile and base station equipment. This same reference also specifies a minimum blocking rejection of 80 dB for portable/handheld equipment.

Therefore, the model indicates that receiver blocking should not be an item of concern in Scenario 2 (PEBB User Equipment (UE) transmitting in the vicinity of a narrowband base station), or Scenario 1 (PEBB Base Station (eNodeB) transmitting in the vicinity of a narrowband user device) for mobile user equipment. However, Scenario 1 does raise some concern in the case of a portable/handheld unit, since equipment with a minimum blocking rejection of 80 dB will only protect against signals as strong as -36 dBm (-116 dBm + 80 dB), and the simulation results show peak levels as high as -32 dBm.

Conclusions and Recommendations

While the simulation does show a concern under one scenario, the Consultant notes that this situation appears no worse than the potential that exists today with neighboring narrowband systems. However, in order to protect existing licensees, the Consultant again recommends incorporating the interference mitigation techniques described in the OOBE analysis, including: prior notification; setting realistic harmful interference thresholds; and requiring the PEBB licensee to promptly address legitimate interference complaints.

Intermodulation

Definition

Intermodulation interference is the undesired combining of several signals in a nonlinear device, producing new, unwanted frequencies, which can cause interference in receivers.

Potential Interference Scenarios

Similar to other forms of interference, intermodulation can cause unwanted signals to be received by the system’s receiver which raise the effective noise floor, desensitize the receiver, and make it more difficult to receive the wanted signal, all resulting in degraded system performance.

Intermodulation can be generated in a transmitter, generally in the non-linear power amplifier, or in a receiver as the results of two or more high-level off-channel signals overloading the receiver's RF amplifier causing it to operate in its nonlinear region thus acting as a mixer.

Intermodulation can also be produced in rusty or corroded tower joints, guy wires, turnbuckles and anchor rods or any nearby metallic object, which can act as a nonlinear mixing device. This type of intermodulation, known as passive IM, is independent of the proposed band realignment Petition and will not be addressed in this report. It is generally addressed at the transmitter site through good site maintenance practices.

Intermodulation Analysis

The potential effects of both transmitter and receiver intermodulation will be analyzed. This analysis will apply to both Part 90 and Part 24 adjacent users. With either form of IM, it is noted that intermodulation interference most often concerns odd-order products, because the even-order products will fall outside of the receiver’s passband. The most common interference sources are the 3rd and 5th order products. Higher order products are potential sources of intermodulation as well, however, their practical importance is minimized due to the fact that they are formed at lower power levels than the 3rd and 5th order products and are usually too weak to cause interference problems. It is also noted in several sources that the intermodulation products resulting from wideband systems are generally lower due to spreading of the transmit power across the band.

Transmitter Intermodulation

An LTE system can generate transmitter intermodulation through a combination of the discrete signals of the subcarriers mixing in the power amplifier. These intermodulation products appear as side bands of the transmitted signal. Given that the proposed PEBB transmit band is 937-940 MHz, calculation of the 3rd order intermodulation products that fall outside of the transmit band but into adjacent bands yields products that extend from 934-937 and 940-943 MHz. These intermodulation products will occur just outside of the transmit band and will appear as OOBE and therefore, will be filtered by the transmit filter designed to meet the required emissions mask. Additionally, these products will be attenuated below the OOBE discussed earlier since the intermodulation products are of lower amplitude than the desired signal.

Receiver Intermodulation

Issues related to receiver intermodulation have been documented in an analysis of the public safety portion of the 800 MHz band[10]. These issues result from mixing of frequency carriers from several bands, including A-Band cellular and two separate Sprint carriers in the revised 800 MHz band. This analysis also confirms that the receiver performance against intermodulation generally improves for wideband interferers. The situation relating to the mixing of carriers from multiple bands with products falling within the immediate adjacent band is not applicable in the proposed 900 MHz band realignment strictly due to the introduction of the PEBB allocation. Therefore, the risk of IM interference due to the PEBB allocation is no greater than the current configuration.

However, when multiple systems and therefore multiple frequency carriers are present at a particular site because of colocation, precautions guarding against intermodulation should always be taken to protect all systems operating at or nearby the site. Recommended practice includes performing an intermodulation study prior to collocating systems. When potentially dangerous intermodulation hits (mixes that occur on other operating channels) are detected, a further analysis is recommended to determine what mitigation techniques, is any, need to be implemented. Mitigation actions may include: increasing isolation and antenna separation; additional filtering; frequency changes where possible; and power adjustments.

Conclusions and Recommendations

It is the Consultant’s opinion that interference due to intermodulation effects resulting from the proposed PEBB allocation is not a major concern due to the following conclusions:

- Broadband intermodulation products are generally lower due to lower power density;
- The transmitter intermodulation products possible from the PEBB allocation will be filtered by the proposed emissions mask;
- Narrowband receivers have been shown to perform better against wideband interferers; and

[10] Comments (01/21/15) and Reply Comments (02/20/15) of Pericle Communications Company and Shulman, Rodgers, Gandal, Pordy and Ecker P.A., WT Docket No. 12-40.

- The situation of multiple carriers in separate bands that mix to produce receiver intermodulation products is not present in the proposed PEBB allocation.

Additionally, the Consultant recommends the PEBB licensee follow industry standard best practices with regard to protection against intermodulation effects when designing and installing communications sites.

Conclusions and Recommendations

In this report, the Consultant has investigated and analyzed two critical aspects of the proposed Petition to realign the 900 MHz Band under Part 90 of the FCC's rules.

The Consultant's analysis of the ability to successfully realign incumbent narrow band channels to the proposed 2x2 allocation from the existing 5x5 assigned channels concludes the realignment is feasible and expected to be less complex and costly than the realignment of the 800 MHz band affecting public safety licensees. The Consultant recommends incorporating many of the lessons learned from the 800 MHz rebanding project to aid in the proposed band realignment. In the markets where sufficient channels for relocation are not currently available, the Consultant recommends pdv consider the following options:

- Pursue the acquisition of additional channels;
- Pack channels via an engineering analysis, such as short-spacing where possible;
- Offer service credit on the PEBB system;
- Offer service credit on a different commercial network;
- Build an LTE site(s) to support a specific licensee and provide core services.

With regard to the analysis of how the proposed broadband allocation can operate and not interfere with narrowband systems above and below the broadband allocation, DVA has concluded that while the potential for interference from the proposed broadband licensee is less than that under an environment of extensive narrowband deployment under the current rules, sources for potential interference between the proposed broadband allocation and narrowband systems in adjacent bands do exist. However, specific actions and precautions can be taken to protect against the risk of interference and mitigate any occurrences that may arise.

The Consultant concludes that OOBE is the primary source of concern relating to interference. The results of the model developed by pdv and adjusted by the Consultant indicate that interference is possible in some situations. In order to mitigate the interference, the Consultant recommends the following:

1. pdv provide at least an additional 14 dB of OOBE reduction at the PEBB eNodeB (base station);
2. pdv address the issue to ensure the User Equipment performs at least 2 dB better than the proposed emissions mask;
3. pdv incorporate a prior notification clause into the proposed rules;
4. pdv incorporate revised harmful interference thresholds into the proposed rules that meet the following levels:
    a. A median desired signal strength of **-102 dBm** as measured at the R.F. input of the receiver of a mobile unit;
    b. A median desired signal strength of **-99 dBm** as measured at the R.F. input of the receiver of a portable or handheld unit; and

c. A median desired signal strength of **-99 dBm** as measured at the R.F. input of the receiver of a base station.

The Consultant has concluded the potential for interference due to receiver blocking is not a primary concern and is expected to be less than what would be likely today with a narrowband deployment at current emission limits. Additionally, the protection and mitigation techniques described to address OOBE interference will help address any occurrences of this type of interference as well, if they were to arise.

Similarly, it is the Consultant's opinion that interference due to intermodulation effects resulting from the proposed PEBB allocation is not a major concern. However, the Consultant recommends the PEBB licensee follow industry standard best practices with regard to protection against intermodulation effects when designing and installing communications sites.

References

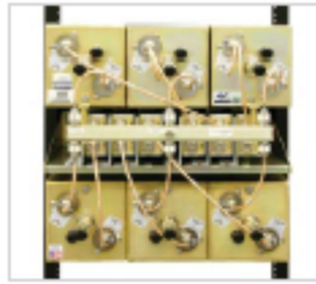
1. Petition: Petition for rulemaking – Enterprise Wireless Alliance/Pacific Data Vision: 12/08/14
2. Comments to the above Petition and Public Notice (Numerous)
3. Reply comments
4. Ex Parte filings
5. FCC Part 90 Rules: CFR-2010-title47-vol5-part90-subpartS
6. 800 MHz Rebanding Order: FCC 04-168: Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order
7. FCC Report and Order FCC-12-55A1: In the matter of Improving Spectrum Efficiency Through Flexible Channel Spacing and Bandwidth Utilization for Economic Area-based 800 MHz Specialized Mobile Radio Licensees: May 24, 2012.
8. TSB-88: TSB-88.1-D & TSB-88.2-D: Wireless Communications System Performance in Noise and Interference-Limited Situations; TIA April 2012, June 2012
9. TIA-102.CAAA-D: Digital C4FM/CQPSK Transceiver Measurement Methods; TIA April 2013
10. TIA-102.CAAB-D: Land Mobile Radio Transceiver Performance Recommendations, Digital Radio Technology C4FM/CQPSK Modulation; TIA Feb 2013
11. TIA-603-D: Land Mobile FM or PM - Communications Equipment - Measurement and Performance Standards; TIA June 2010
12. Comments (01/21/15) of Pericle Communications Company and Shulman, Rodgers, Gandal, Pordy and Ecker P.A., WT Docket No. 12-40.
13. Reply Comments (02/20/15) of Pericle Communications Company and Shulman, Rodgers, Gandal, Pordy and Ecker P.A., WT Docket No. 12-40.

Appendix A: Bird Technologies Combiner

BIRD TECHNOLOGIES GROUP

AIRLINE JUNCTION COMBINER
926-960 MHz
44-96-99104-#

- Anywhere between 2 to 6 channels
- High performance spec with narrow adjacent channel spacing and low insertion loss
- 5.8" Square Cavity with 19" rack mount configuration for space efficiency
- Constant interconnect cable length for the entire frequency range for ease of field retuning and expansion



Frequency Range	926-960 MHz
IL per channel	2.2-4.9 dB typical, depending on freq separation
Min channel separation	250 kHz
Max. power per channel	100 Watts
Isolation, TX-TX	45 dB Min
Isolation, Antenna-TX	35 dB Min
Impedance	50 ohms
Return Loss (VSWR)	20 dB (1.22:1)
Cavity Elec. Length	3/4 wavelength
Temperature Range, °C	-30 to + 60
Cavity Size	5.83" square
Number of Cavities	up to 6
Connectors	N
Dimensions	17.5" H x 19" W x 22" D

Tx-Tx Separation	Cavity Loss	Loss (dB) vs. No. of channels				
		2	3	4	5	6
1 MHz	1.25	2.2	2.3	2.4	2.4	2.5
500 kHz	1.80	2.8	3.0	3.2	3.4	3.5
250 kHz	2.80	3.9	4.3	4.5	4.7	4.9

Appendix B: CCI Combiner Specifications

CCI
EXTENDING WIRELESS PERFORMANCE

Auto-tune Multi-channel Combiner

Tel: 201-342-3338 Fax: 201-342-3339 www.cciproducts.com

General Information

Model ATC-936-8
8 Channel

Contents:

Options

- 01: 7/16 DIN Output Connector

Communication Components, Inc. Auto-Tune Multi-Channel Combiner (ATC) system provides automatic low loss combining of up to eight RF transmit channels in a compact rack mount unit. Each of the eight cavities of the Auto-Tune Combiner monitors the change in operating frequency and power of the corresponding transmitters and automatically tunes each channel to the correct operating frequency. This feature permits dynamic frequency planning of the base-station with virtually unattended operation. Moreover, the Auto-Tune Combiners are factory optimized for operation at the site and require absolutely no tuning or adjustments in the field.

Technical Description

The ATC system consists of eight independent tunable cavities, each equipped with a dedicated microprocessor circuit which controls the frequency tuning mechanism the cavity filter. The cavities are constructed from a solid aluminum extrusion material and contain barium tetratitanate (BaT14O9) dielectric resonators to achieve the optimum Q for low loss operation. A high precision linear actuator is used to position a tuning element within each cavity which adjusts the operating frequency of the cavity. Each transmitter input signal is fed through a double junction isolator providing in excess of 60 dB isolation from port to port. The forward and reflected power of each channel are then sampled and detected for input into an analog-to-digital (A/D) converter. The digitized information is fed to the dedicated microprocessor circuit for each cavity. A unique control algorithm is embedded in each microprocessor circuit which accurately tunes the cavity to the transmit frequency while rejecting all external interference. The operational status of each channel is independently indicated on the front panel LED's and external monitoring and alarm outputs are also provided.

Auto-tune Multi-channel Combiner Electrical Specification

Description	Typical Specifications
Electrical Specifications	
Model ATC-936-8	
Number of Channels	8
Operating Frequency Range:	935-937 MHz
Maximum Input Power	100 Watts/ Channel
Input VSWR	1.25:1 Max.
Output VSWR	2.25:1 Max
Channel to Channel Isolation:	50 dB Min.
Dynamic Range:	10 dB Min.
Tuning Time	
For a 1 MHz step:	250 ms typical
From "PARK" to any frequency	3 sec. typical
Minimum Channel Spacing:	75 kHz
Insertion Loss	
75 kHz Spacing	5.5 dB Max.
100 kHz Spacing	4.75 dB Max.
150 kHz Spacing	3.75 dB Max.
200 kHz Spacing	3.5 dB Max.
Maximum Reflected Power	100 Watts
Operating Temperature	-10 to +60 degrees Celsius
Input Voltage	-48 VDC
Monitoring & Alarms	
Visual Alarm:	Front Panel LED's for alarm indication of each Cavity
Monitoring Signal:	Dry form A contact closure alarm on rear of unit. Open contact indicates failure
Front Panel Indicator:	Front Panel LED's for status indication of each Cavity
Front Panel Switch:	Push-button switch to force re-tune of each Cavity

All specifications are subject to change. The latest specifications are available at www.cciproducts.com

Communication Components Inc.

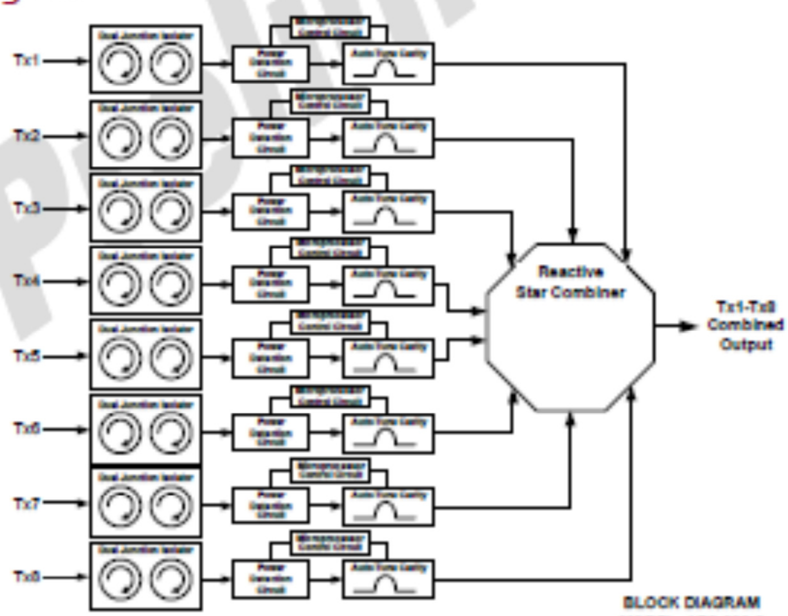
Tel: 201-342-3338 CCI Confidential Fax: 201-342-3339

3/13/2015 Page 2 Revision 0.8

Auto-tune Multi-channel Combiner Mechanical Specification

Description	Typical Specifications
Mechanical Specifications	
Dimensions	
Height	7" (4 U)
Width	Standard 19" Rack Mount
Depth	19"
Connectors	
RF Input and Output	N Type Female (7/16 DIN Optional)
Weight	48 Lbs. Max.
Finish	
Front Panel	Baked Black Epoxy
Chassis	Gold Irridite

Block Diagram



BLOCK DIAGRAM

All specifications are subject to change. The latest specifications are available at www.cciproducts.com

Communication Components Inc.

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3/13/2015 Page 3 Revision 0.8

89 Leuning Street
South Hackensack, NJ 07606
Tel: 201-342-3338
Fax: 201-342-3339
WWW.CCIPRODUCTS.COM

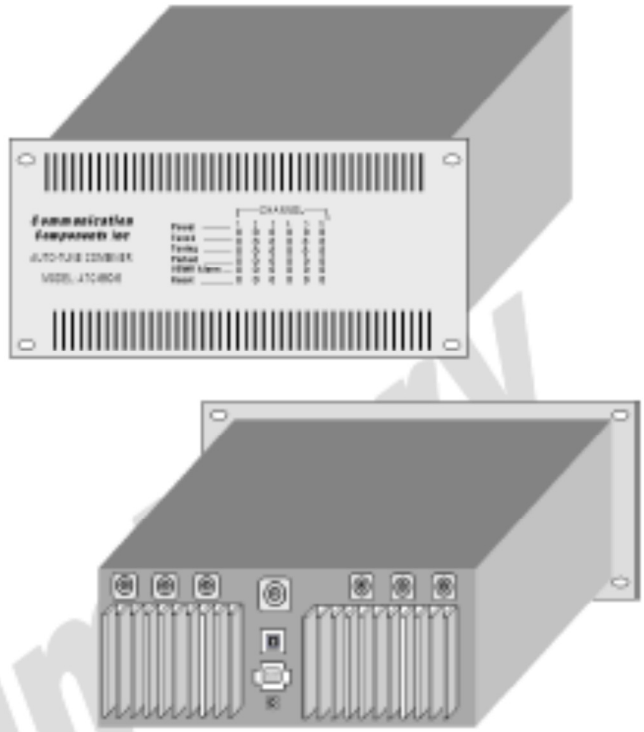
Ordering Information:

Model ATC-936-8
8 Channel

Options:

Accessories:

Auto-tune Multi-Channel Combiner Mechanical Diagram (Front/Back)



Auto-tune Combiner Alarm Pin-out (RJ-48/8)

Pin #	Description
1	Common
2	Normally Open Contact
3	Normally Closed Contact
4	Unused
5	Unused
6	Unused
7	Unused
8	Unused

ATTACHMENT 3

The FCC Evaluates Current Usage When Considering Whether to Provide for Greater Utilization of Allocated Spectrum

Analyzing the number of base stations authorized to operate on a channel is a useful measure of utilization in services licensed on site- and frequency-specific bases. For example, the FCC used this analysis in assessing whether the VHF channels under consideration in PS Docket No. 13-229 could support more intensive use and concluded the following:

> The frequencies are currently designated for fixed remote control and telemetry operations and are shared between the Public Safety and Industrial/Business (I/B) Pools. The Commission first authorized these channels for telemetry use in 1977, and they have been available for telemetry use for over thirty years.

Frequency (MHz)	173.2375	173.2625	173.2875	173.3125	173.3375	173.3625
Number of Call Signs	397	440	401	365	401	371
Number of Base Stations	1278	1620	1455	1350	1332	1242
Number of Users	267	260	236	223	223	244

Geographical Distribution of Base Stations Using 173.2375 MHz

15. Mapping the base stations associated with these frequencies shows their geographical distribution.

Figure 1: Base Stations using 173.2375 MHz

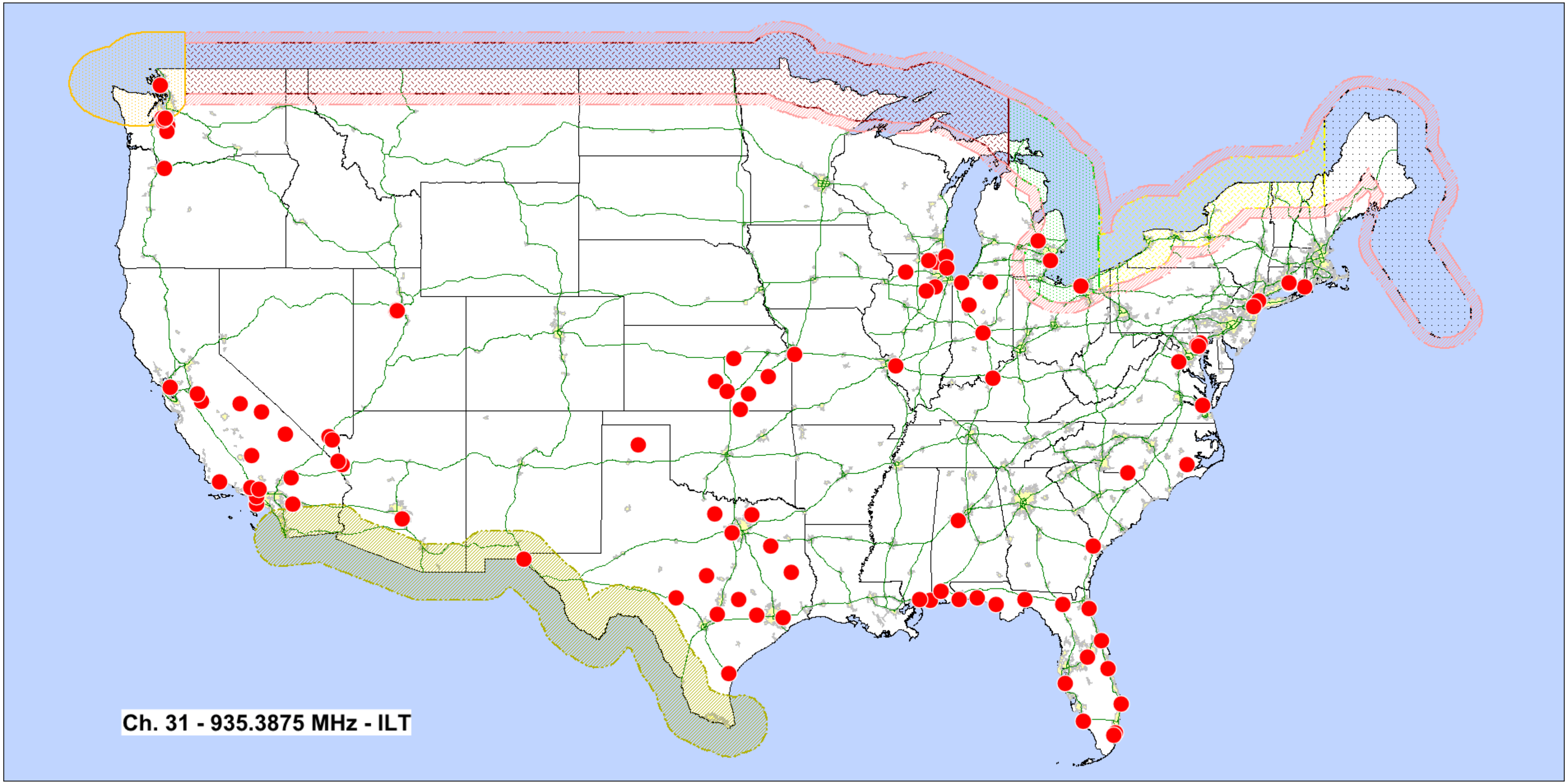
Comparison of 900 MHz Utilization

A sample of 900 MHz site-based Business/Industrial channels, based on ULS database records, shows even less intensive utilization nationwide:

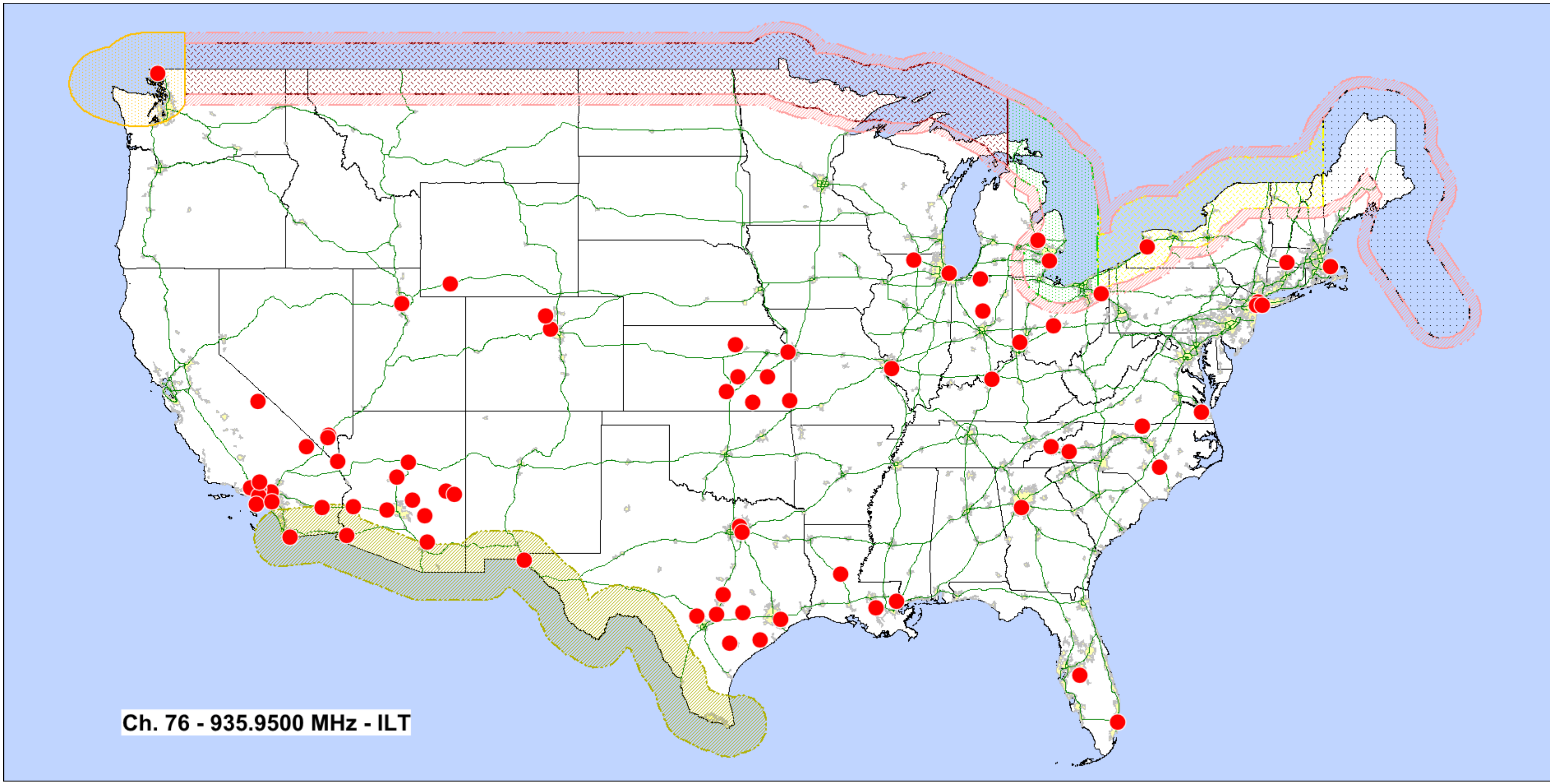
Frequency (MHz)	935.3875	935.9500	936.2125	937.7250	937.8875	938.4125	938.6750	938.8875	939.2375	939.5000
Number of Callsigns	72	58	39	34	60	47	37	62	32	36
Number of Base Stations	105	76	66	41	77	53	55	105	34	45
Number of Licensees*	38	34	26	21	28	26	25	35	18	22

- Numbers do not include duplicative FB4 community repeater licenses or PDV licenses

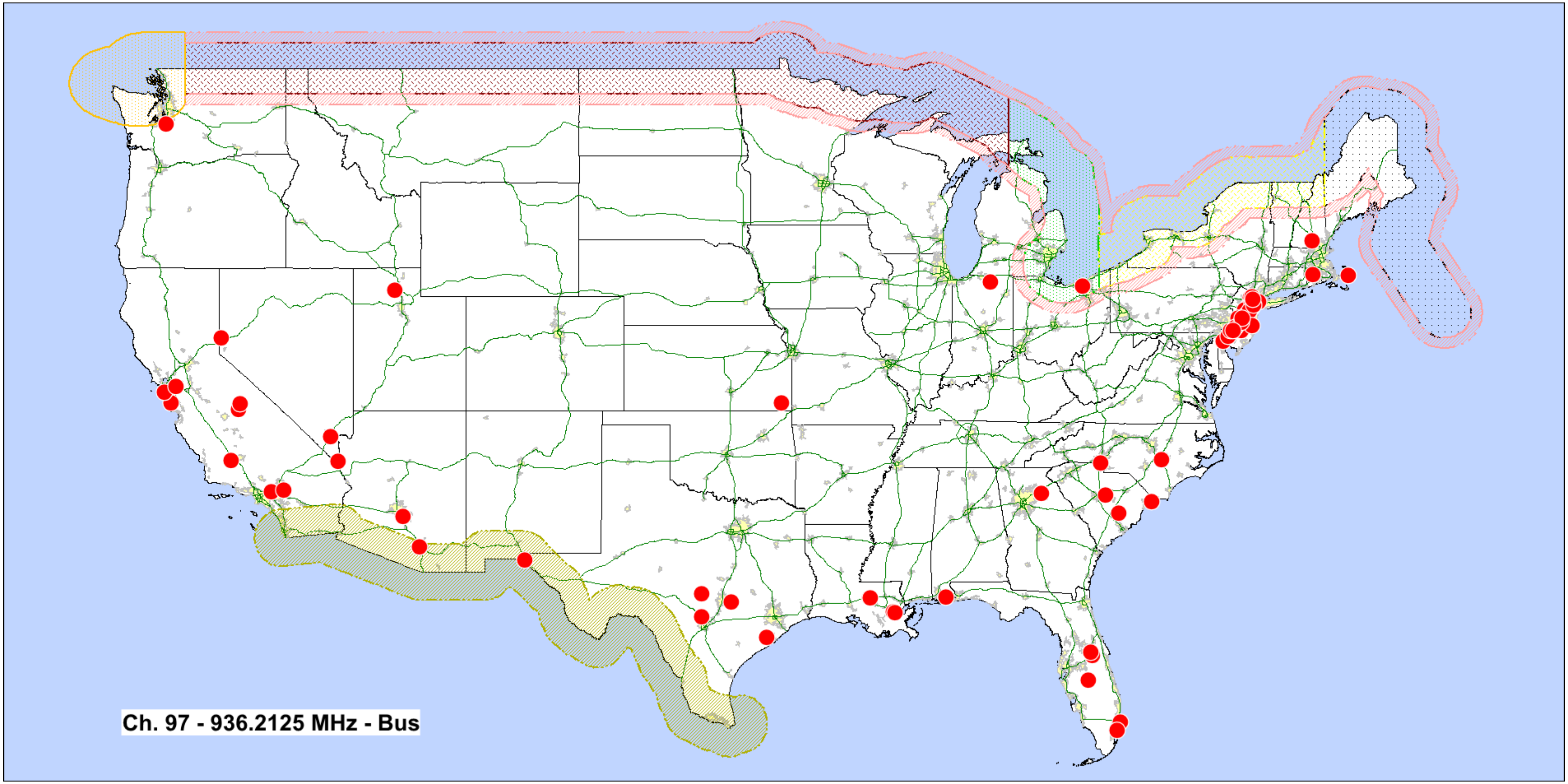
935.3875 MHz



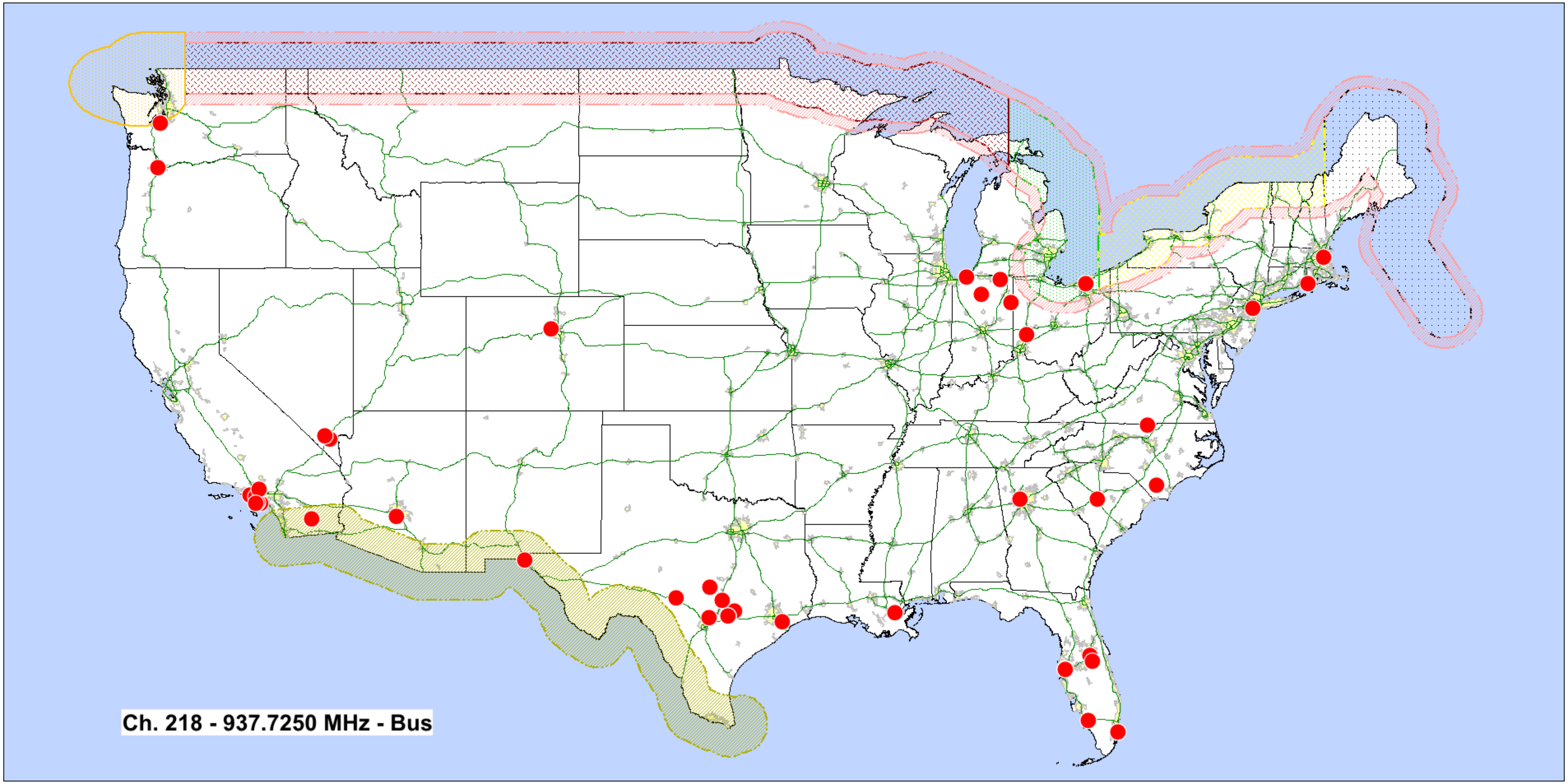
935.9500 MHz



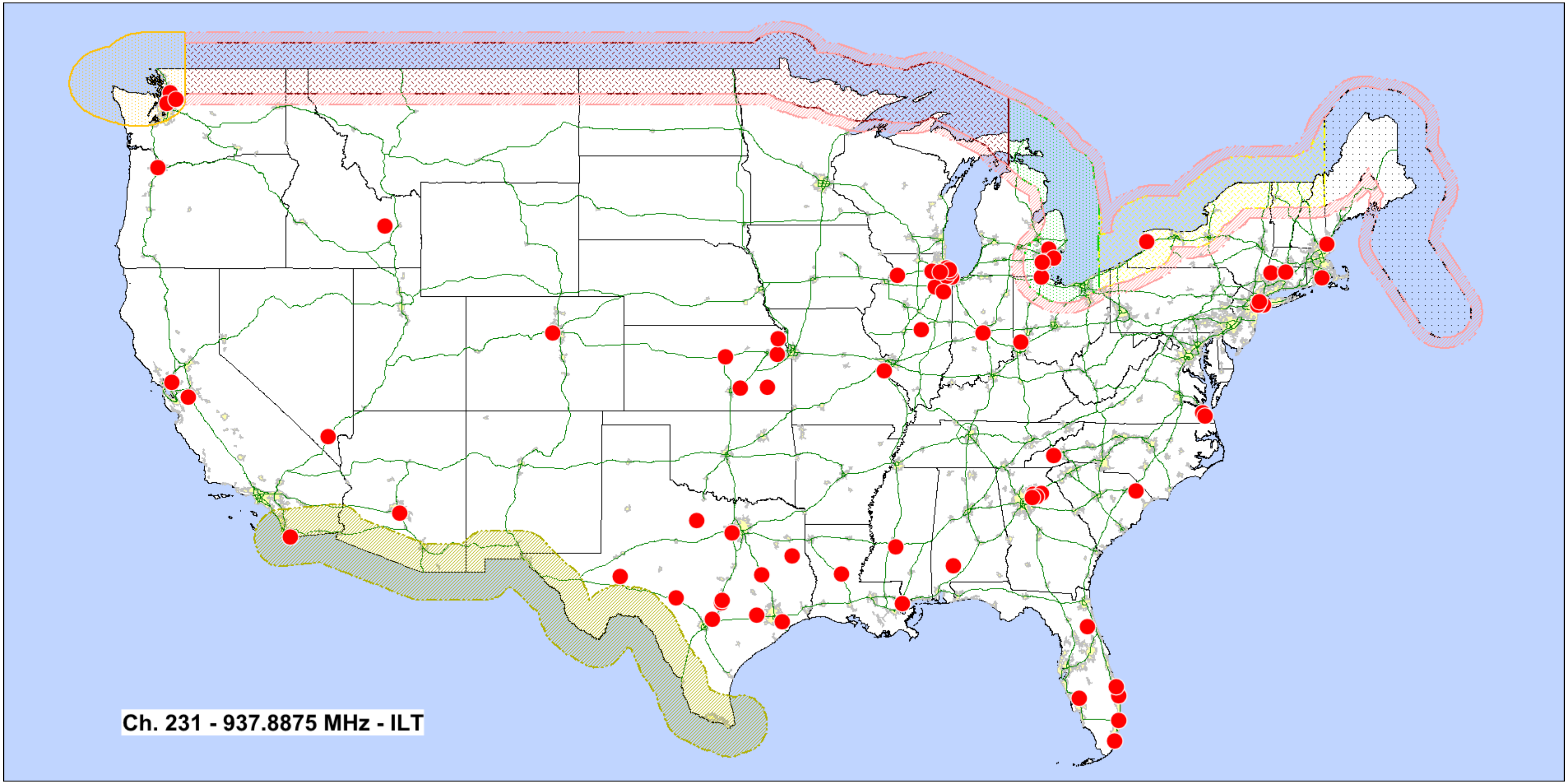
936.2125 MHz



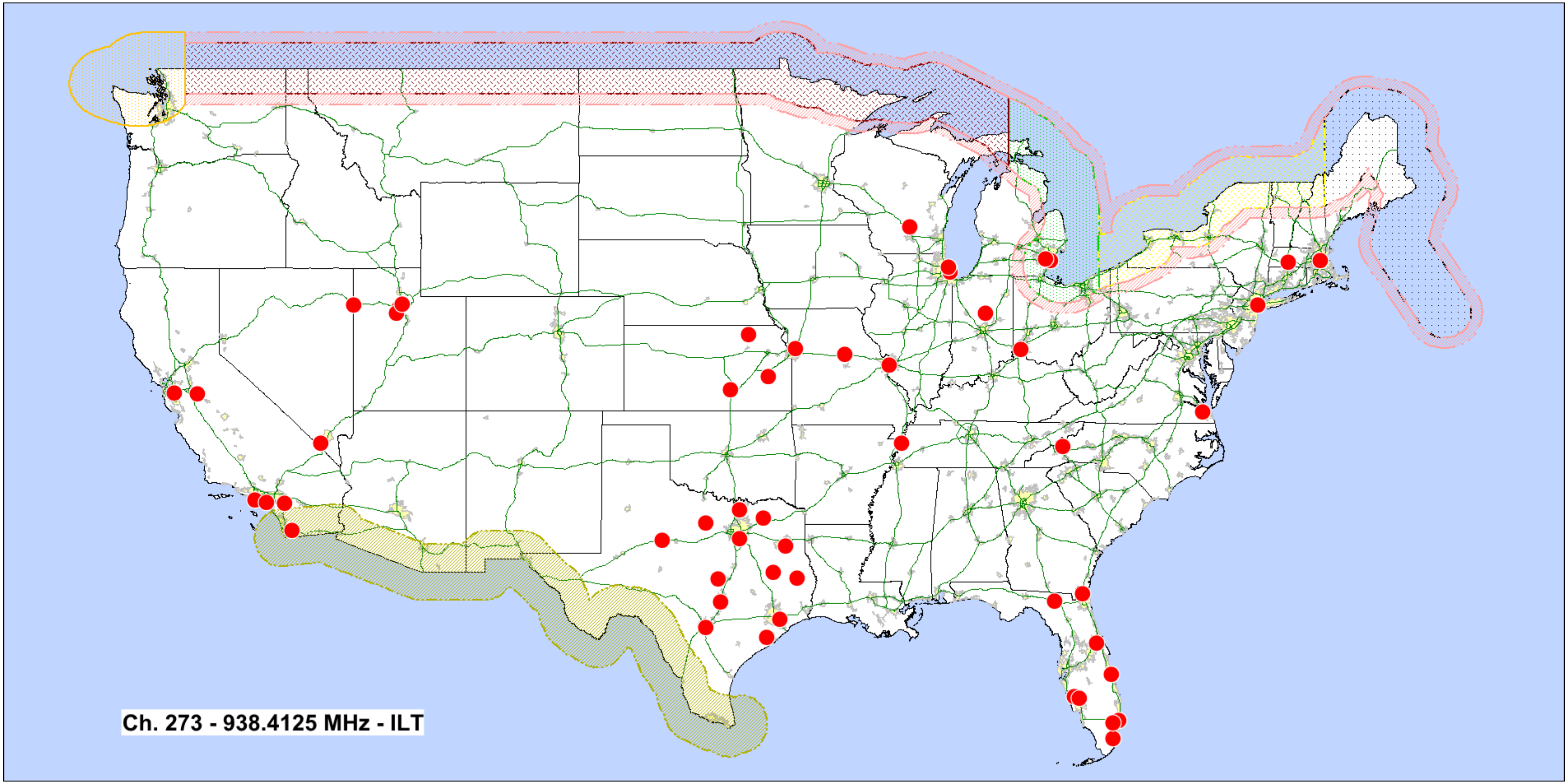
937.7250 MHz



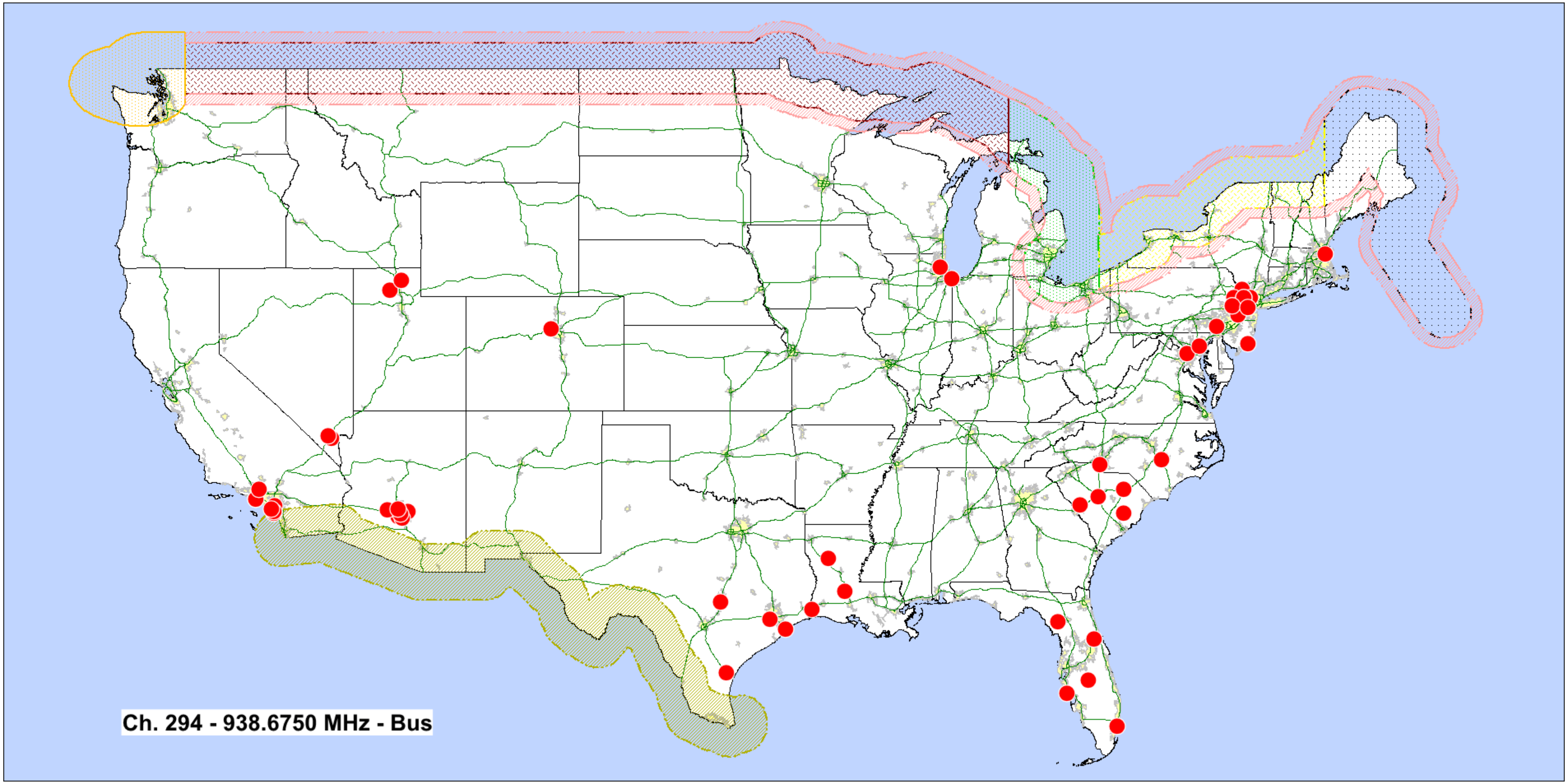
937.8875 MHz



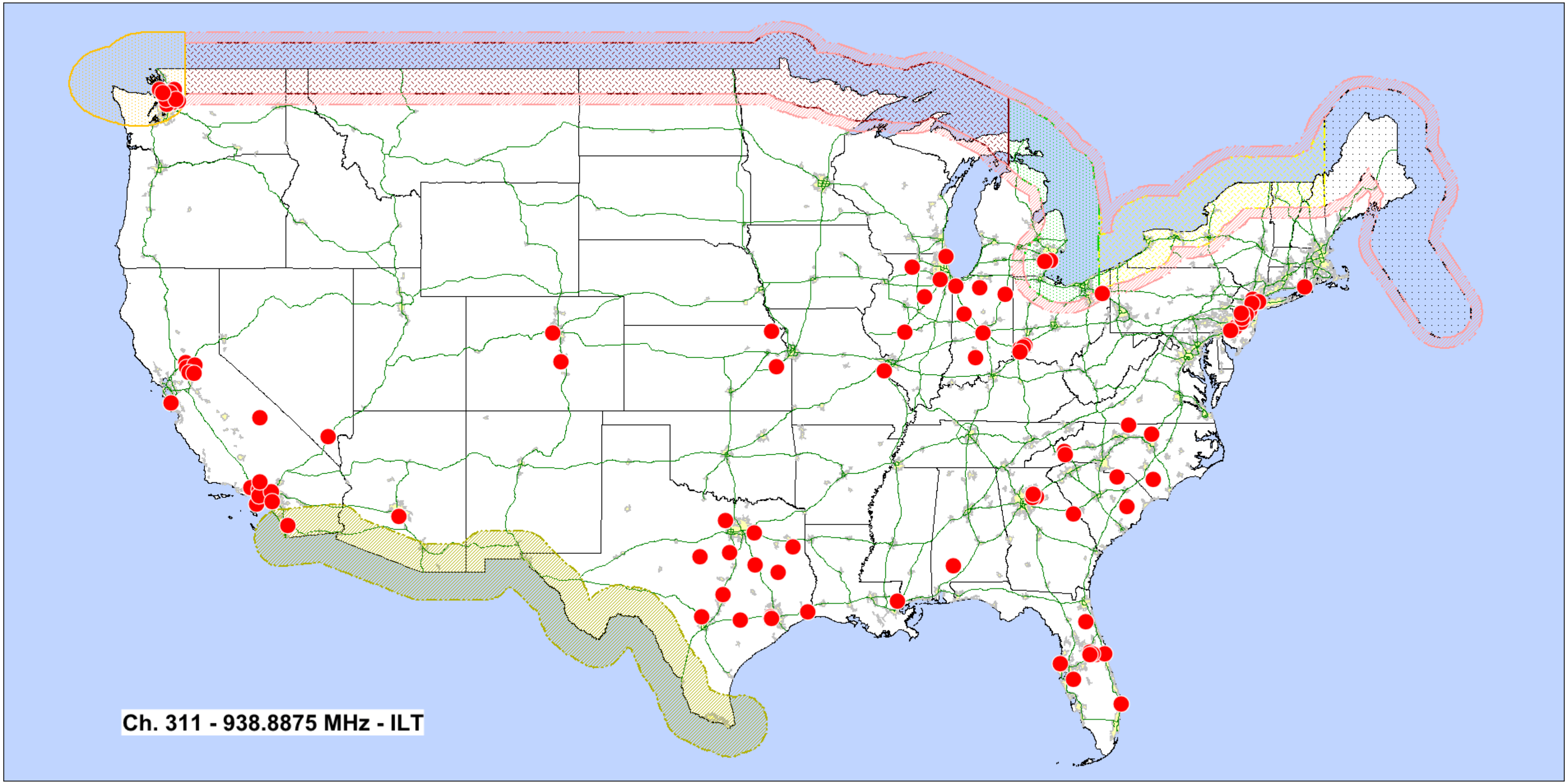
938.4125 MHz



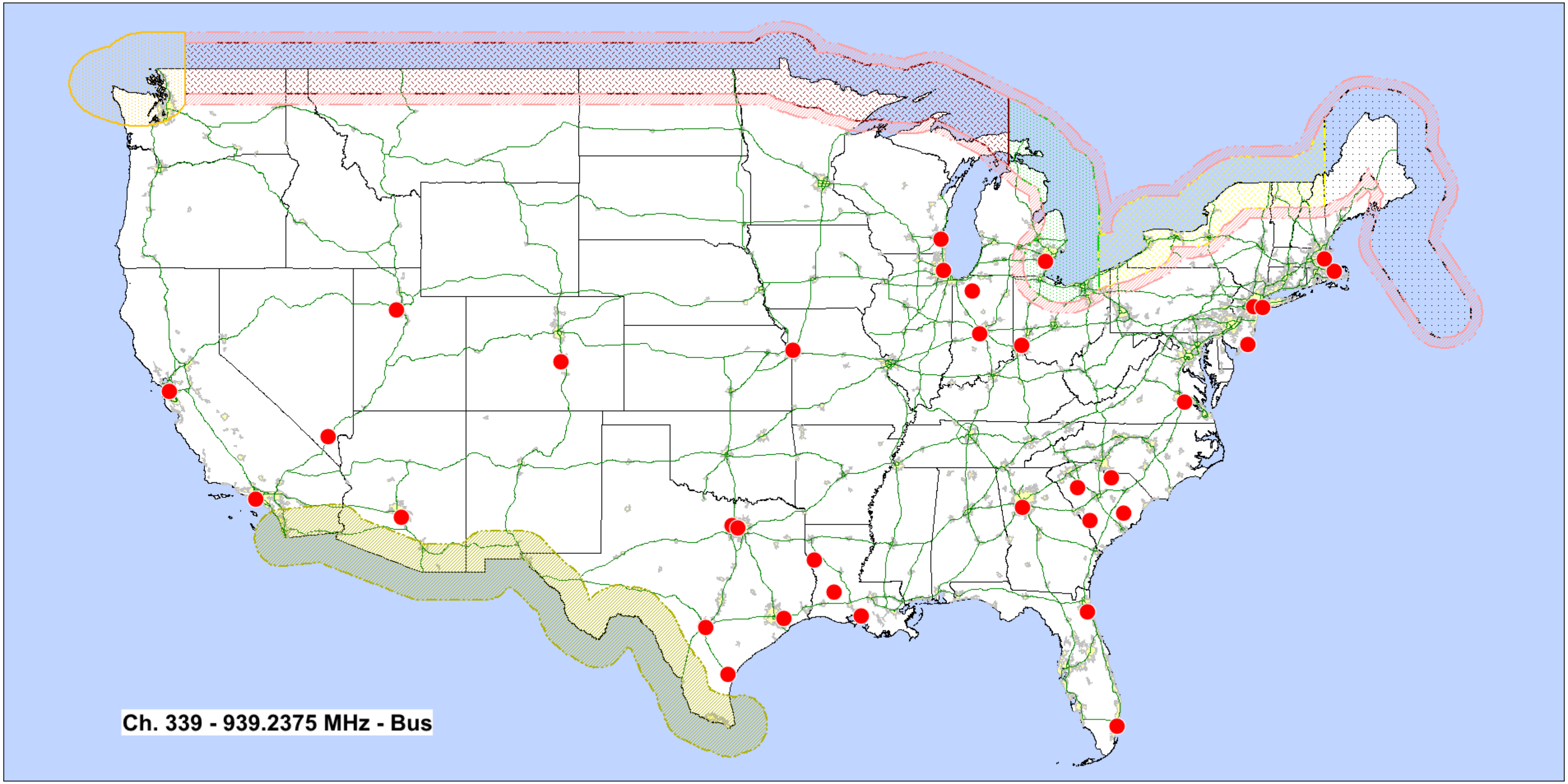
938.6750 MHz



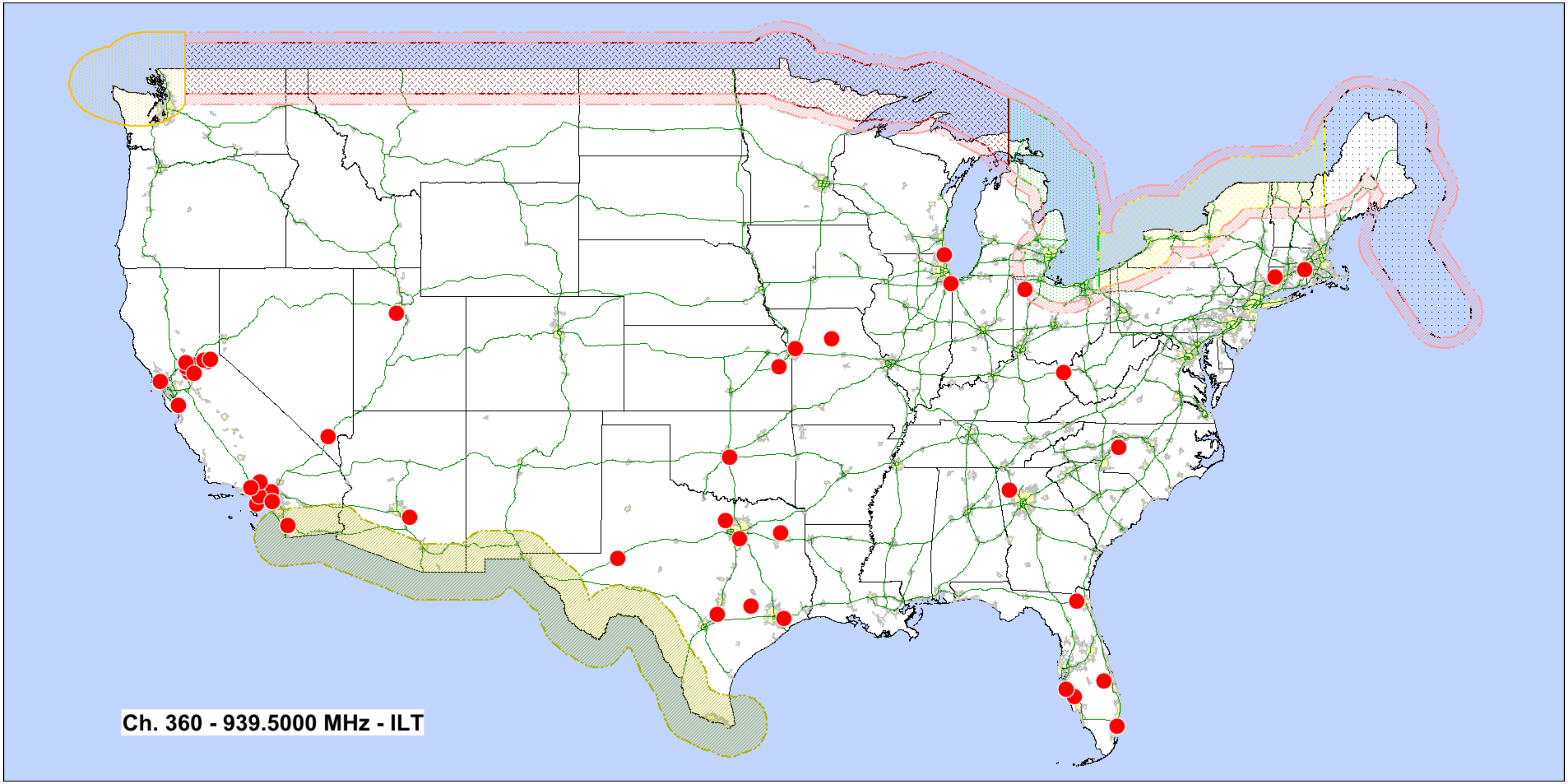
938.8875 MHz



939.2375 MHz



939.5000 MHz



ATTACHMENT 4

2017 UTC TELECOM & TECHNOLOGY

MAY 8-12, 2017 | CHARLOTTE CONVENTION CENTER | CHARLOTTE, NC

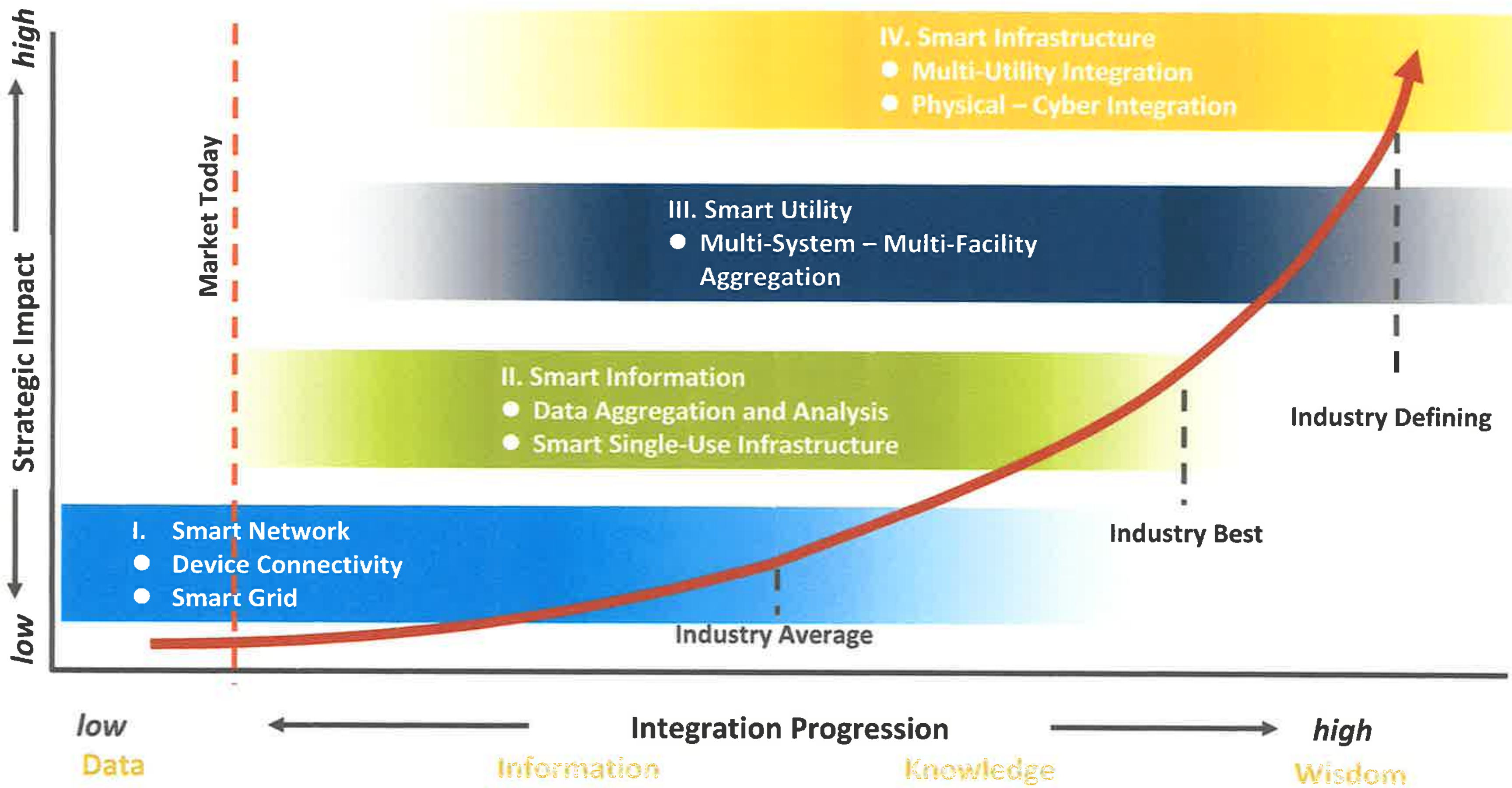
Communications for the Modern Age: Is Your Network Ready for the Next Big Thing?

Scott Dicus, P.E., P.Eng.
RF Engineering Group Lead
Telecommunications, Black & Veatch

BLACK & VEATCH

www.utctelecom.org | networks.utc.org

Smart Infrastructure Evolution



What's Driving Communication Upgrades

- New applications = bandwidth growth + scale
- Sunsetting equipment and services
- IP transition

- IT/OT Convergence (system-level view)
- Network consolidation and modularization
- Public network incidents

- NERC-CIP compliance
- FCC moves toward dynamic spectrum sharing

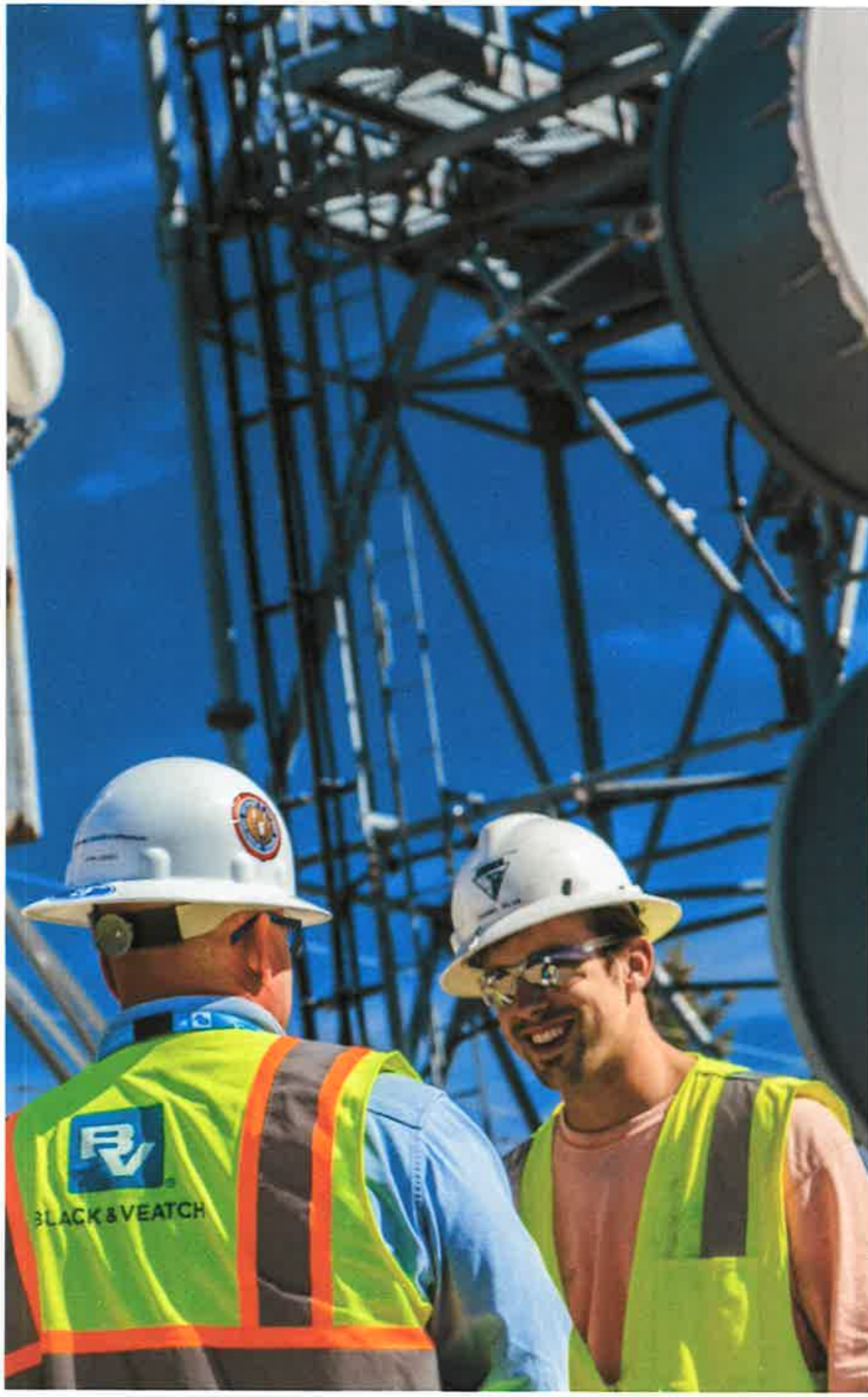
A Word on Networking

- IT/OT convergence brings:
  - Larger networks, therefore increased labor skills/bodies
    - Enterprise IT ≠ Utility IT
  - Jargon reconciliation
- Utility networks are ideally suited for a "service provider" network architecture
  - Hard to sell internally since profit and operational mission (keeping the lights on) are the business drivers
  - Mission critical service providers:
    - Run NOC/SOC
    - Do proactive network architecture
    - Do not rely on SLAs
    - Do not outsource mission critical applications
    - Understand total cost of ownership
- Choose a strategy that works for your business:
  - Invest in many disparate networks (OT approach)
  - Outsource telecom services (IT approach)
  - Invest in becoming a mission critical service provider (IT/OT approach)
  - Do nothing and retire soon! (no strategic approach)

What does a converged network look like?

	Tier 1 Site	Tier 2 Site	Tier 3 Site	Tier 4 Site
Site Type (OT)	Control Center	Transmission Sub, Microwave Hub	Distribution Sub, Collectors	Pole Top, Meter
Network Tier (IT)	Core	Distribution	Access	
Bandwidth	10+ Gbps	1 Gbps	10 Mbps	<1 Mbps
Node Quantities	10	100	1,000	10,000
Cost per node	$$$$	$$$	$$	$
Wired Technology	Fiber	Fiber/copper	Copper	N/A
RF Technology	N/A	Microwave	Broadband PTMP/Mesh	Wide/Narrowband PTMP/Mesh
RF Technology Maturity	N/A	High	Low	High (Serial) Medium (IP)

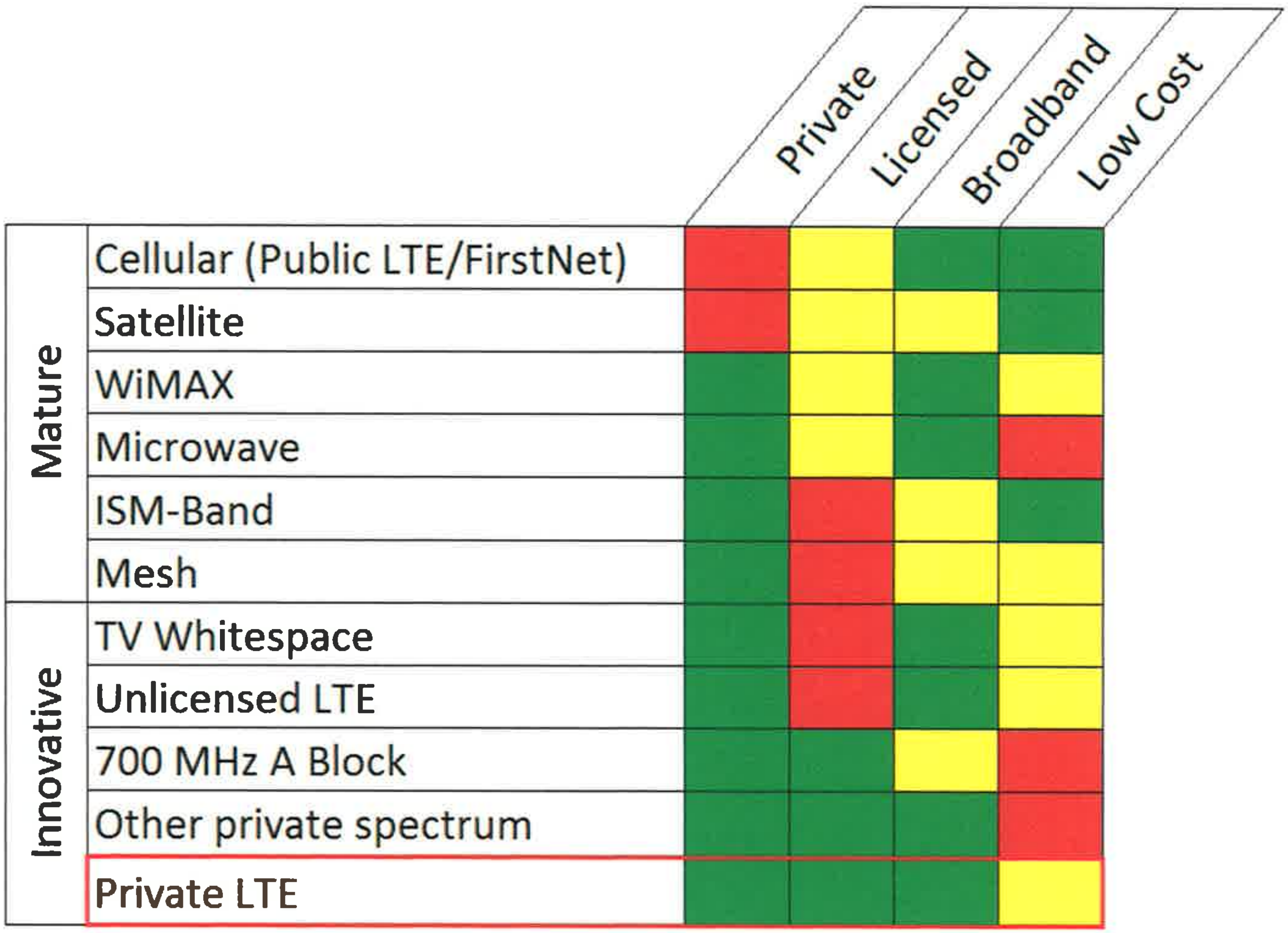
Problem Area



Tier 3 primary RF solution: Ideal attributes

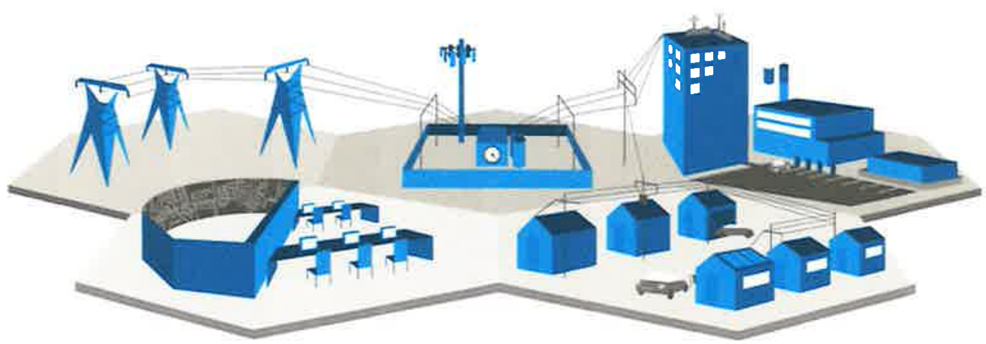
- Private
- Licensed
- Broadband
- Low-cost
  - Scalable
  - Standardized
  - IP

Tier 3 Primary RF Solution: Technology Arsenal



Tier 3 primary RF solution: Private LTE

- Solution Impetus
  - Other technologies fall short
  - Popularity and maturity of public LTE
  - Spectrum supply currently outpacing demand
    - FCC saying "use it or lose it" adding to supply
    - Recent AWS auction, underwhelming demand
  - Smart grid and IP transition are making utility market non-trivial
    - Verizon IoT revenue nearing $1B



Tier 3 primary RF solution: Private LTE

- Solution Details
  - AT&T/Nokia solution
    - In pilot phase
    - Ameren FAN/DA/substation backhaul and mobile workforce
  - Other Private LTE solutions
    - In pilot phase
    - Need partnerships with spectrum holders, OEMs and integrators for success
    - Investigate non-traditional business models and suppliers

Tier 3 primary RF solution: Private LTE

- Expected “Low” Cost
  - Evolved Packet Core: $100K
    - Less than cell carriers
    - Can be virtualized
    - Many options based on scale and redundancy
  - eNodeB: $25K
    - $500K for small utility RAN
    - $3M for large utility RAN
  - UE: <$1K per device
    - $50K for small utility RAN
    - $2M for large utility RAN

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ATTACHMENT 5

LTE in 900 MHz (Band 8) Market Status

July 2017

v2 Aug 3

This report by the GSA (Global mobile Suppliers Association) gives an overview of the status of LTE mobile broadband deployments using 900 MHz spectrum (3GPP band 8) and the supporting user devices ecosystem. It confirms growing industry traction for LTE systems in this band. *v2 update Aug 3 with Vodafone Turkey.*

Headlines

28 LTE900 networks in 19 countries have been launched with 2,222 LTE900 devices logged in GAMBoD

28 LTE900 networks are known to have commercially launched to provide LTE or LTE-Advanced services in 19 countries, with 900 MHz used to support Cat-NB1/NB-IoT networks being deployed in China and Turkey. **26% of LTE user devices** known to GSA can operate in 900 MHz spectrum; **2,222 LTE900 user devices** had been identified and logged in the GAMBoD devices database as of July 2017.

900 MHz (3GPP band 8)

900 MHz (3GPP band 8) is used globally for GSM voice and basic data mobile communications. Technology-neutral licensing enabled 900 MHz to become a mainstream spectrum choice for mobile broadband using HSPA/HSPA+ (UMTS900). It has excellent propagation characteristics for wide area coverage (in rural areas) and in-building penetration (rural and urban). Over 100 UMTS900 networks have been commercially launched around the world.

Over 100 UMTS900 networks have been launched over the world and LTE is gaining traction in this band

900 MHz spectrum is typically limited in its availability for LTE due to its prior use for GSM networks; however, using 900 MHz as an LTE band is gaining traction amongst operators and the main infrastructure vendors all offer LTE900 solutions.

Operators are known to have commercially launched LTE mobile broadband service in 900 MHz (band 8) spectrum (LTE900), either as a single band system, or as part of a multi-band deployment, many of the latter using LTE-Advanced carrier aggregation technology to deliver higher speeds for users. In addition, China Unicom has launched commercial Cat-NB1/NB-IoT networks in various Chinese cities using the 900 MHz and 1800 MHz bands.

900 MHz auctions have been held in Norway and Singapore with Denmark expected in 2018

Country	LTE900 Operator
Australia	Telstra
Czech Republic	Vodafone
China	China Unicom (Cat-NB1/NB-IoT)
Germany	Deutsche Telekom
Hong Kong (China)	Smartone
Hong Kong (China)	Hutchison 3
Indonesia	Indosat Ooredoo
Indonesia	Telkomsel
Indonesia	XL Axiata
Liechtenstein	Swisscom
Malaysia	Digi
Netherlands	T-Mobile
Nigeria	Ntel
Norway	Ice.net
Peru	Bitel
Saudi Arabia	Zain
Singapore	Singtel
Slovenia	Telekom Slovenije
South Africa	Vodacom
South Korea	KT
Sweden	Tele2
Sweden	TeleNor
Taiwan	Ambit Microsystems
Taiwan	Chunghwa Telecom
Taiwan	Taiwan Star
Thailand	AIS
Thailand	TrueMove H
Turkey	Vodafone Turkey

Table 1: Operators with Commercially Launched LTE900 networks, July 2017

Note - China Unicom are using the 900 MHz spectrum for Cat-NB1 only

Telstra and Optus have already closed down their 2G 900 MHz networks and re-farmed the spectrum for LTE

More 900 MHz spectrum is likely to become available as regulators increasingly tend to make the spectrum technology neutral when it comes up for auction. Auctions have been recently held in Norway and Singapore, and more auctions are likely to take place in the next year, for example in Denmark. 900 MHz spectrum used for 2G is also being re-farmed by operators, and in some cases there are plans to close 2G networks. In Australia Telstra and Optus have already shut down their 2G systems, and Vodafone plans to do so in September 2017. However, it is not always clear that the 900 MHz spectrum is being re-farmed for 4G once it has been liberated; sometimes 900 MHz spectrum is re-farmed to provide 3G services, leaving the 1800 MHz frequency band available for LTE networks. Nonetheless the 900 MHz spectrum is increasingly used for LTE services, and there have been launches both of LTE900 networks and of LTE-Advanced networks in which 900 MHz spectrum is one of several carriers aggregated to deliver faster mobile broadband speeds.

11 new LTE900 networks have been launched since the last GSA LTE900 report in March 2016

900 MHz for LTE: Global Status

GSA reported 17 LTE 900 networks in its "LTE in 900 MHz (band 8)" market status report March 27, 2016. In addition to the above stated 28 LTE900 commercial service launches, details and developments regarding 900 MHz spectrum allocations and usage for LTE systems are indicated below.

ALBANIA: In August 2014 regulator Electronic and Postal Communications Authority AKEP approved the re-farming of GSM bands (900 MHz, 1800 MHz) for LTE.

ANGOLA: On December 18, 2013 Unitel demonstrated LTE-Advanced carrier aggregation by combining 900 MHz and 1800 MHz spectrum on its live network.

ARGENTINA: Nextel acquired 900 MHz and 2.5 GHz spectrum which it plans to use for LTE networks.

AUSTRALIA: Telstra uses 900 MHz spectrum for its LTE network, and in December 2016 shut down its 2G/GSM network which operated in this band. Optus also shut down its 2G/GSM network in March 2017, and Vodafone plans to do the same by the end of September 2017 in order to improve 4G services.

AUSTRIA: On July 28, 2014 RTR approved proposals by the incumbent mobile operators to re-farm their existing GSM spectrum for 3G and 4G/LTE use. 3 Austria will gain additional 900 MHz spectrum in early 2016 which will be used for coverage enhancement.

BAHRAIN: Batelco, Viva and Zain received permits in 2013 to deploy LTE networks using 900 MHz.

BANGLADESH: In July 2017, the regulator BTRC published guidelines for a 4G spectrum auction that is expected to take place in August 2017. 900 MHz is to be included in the auction (along with 1800 MHz and 2100 MHz).

BELGIUM: Telenet trialled LTE in 2010 and in June 2011 acquired 900, 1800, and 2100 MHz spectrum.

BULGARIA: 900 MHz is an option for LTE deployment.

CHINA: China Unicom received approval to re-farm 900 MHz, 1800 MHz and 2100 MHz spectrum for LTE.

CROATIA: HAKOM launched a consultation into use of 900 MHz (and 1800 MHz) for LTE.

CYPRUS: PrimeTel acquired technology-neutral 900, 1800 and 2100 MHz spectrum.

DENMARK: Hi3G Denmark has been granted 900 and 1800 MHz spectrum, which could be used to deploy 2G, 3G or LTE technologies nationally. The Danish Energy Agency (DEA) is planning an auction of 700 MHz, 900 MHz and 2.3 GHz to take place before the end of 2018.

EGYPT: Spectrum in the 900 MHz and 2100 MHz has been redistributed for 4G services.

ESTONIA: Tele2 has said it may deploy LTE in 450 MHz, 900 MHz, and 2.3 GHz spectrum in addition to 2.1 GHz presently in commercial use.

GERMANY: Regulator BNetz auctioned 270 MHz of 700, 900 and 1800 MHz spectrum in 2015. All three incumbent operators acquired spectrum in these bands. Deutsche Telekom in March 2017 announced plans to re-farm its 900 MHz spectrum, previously deployed for GSM services. It intends to use the spectrum to deliver improved indoor coverage for its LTE network.

GUATEMALA: In September 2016 SIT announced an auction of two 900 MHz spectrum licences although this still appears to have not happened yet.

HONG KONG: Hutchison 3 announced in July 2016 that it has re-farmed its 900 MHz spectrum to enhance its 4G/LTE services.

HUNGARY: In 2014 NMHH held an auction of 800 MHz, 900 MHz, 1800 MHz and 2.6 GHz spectrum. Magyar Telekom, Vodafone and Telenor all won 900 MHz spectrum.

INDIA: Various auctions of 900 MHz spectrum have occurred in India in recent years, with licences covering different telecoms regions (circles). To date the capacity has been used for 3G services. In the 2016 auction the lots of spectrum in Band 8 went unsold, and are expected to be re-auctioned in 2017 alongside many other lots of '5G' spectrum.

INDONESIA: XL Axiata and Indosat Ooredoo have cooperated to run wider 4G-LTE network services through MORAN (multi-operator RAN) since January 2016.

IRELAND: An auction by the regulator ComReg in 2012 concluded with Hutchison 3, Meteor, Telefónica and Vodafone each receiving 900 MHz spectrum (and 1800 MHz).

JAPAN: Softbank Mobile owns licences to operate mobile systems in 2.1 GHz FDD (band 1), 1.5 GHz (band 11) and 900 MHz (band 8).

LITHUANIA: The regulator RRT held an auction in January 2017 of 900 MHz and 1800 MHz spectrum which was won by Omnitel, Tele2 and Bité Lietuva. Tele2 is expected to use this spectrum to enhance its LTE and LTE-Advanced networks.

MALAYSIA: MCMC announced the reallocation of spectrum in the 900 MHz and 1800 MHz bands between the four operators, Celcom, Digi, Maxis and U Mobile. In July 2017 Digi has started using 900 MHz spectrum alongside 1800 MHz and 2.6 GHz spectrum to improve its LTE-Advanced network.

MYANMAR: In January 2017 a new operator MNTC was licensed and allocated spectrum in the 900 MHz and 2.1 GHz bands.

MOLDOVA: Orange acquired additional spectrum for LTE in 800 MHz and 900 MHz in November 2015. Moldcell commercially launched LTE using 2.6 GHz in 2012. Moldcell also acquired new spectrum licences for use from November 2014 continuing use of 900 MHz and buying new technology-neutral 1800 MHz (Band 3) and 800 MHz (Band 20) spectrum.

NEPAL: In 2017 Ncell has been given permission to launch 4G/LTE services using its existing spectrum (including at 900 MHz).

NETHERLANDS: T-Mobile who was an early user of LTE900 spectrum for LTE, launched LTE-Advanced in January 2016 using carrier aggregation across the 900 MHz and 1800 MHz bands.

NIGERIA: In April 2016 ntel launched its LTE-Advanced network in three cities (Lagos, Abuja, Port Harcourt). It uses carrier aggregation across 900 MHz and 1800 MHz spectrum.

NORWAY: Telenor and Telia each won 2x10 MHz of 900 MHz spectrum in the auction held by Nkom in May 2017.

PERU: In December 2016 Bitel launched its LTE service in the 900 MHz frequency band.

PHILIPPINES: In January 2017 PLDT announced plans to use spectrum at 700 MHz, 800 MHz and 900 MHz to improve indoor coverage for 2G and 3G networks.

ROMANIA: Orange, Vodafone and Cosmote obtained new 900 MHz spectrum.

RUSSIA: The Communications Ministry said in October 2015 that technology neutrality applies to the 900 MHz band, following a similar earlier decision for 1800 MHz

SAUDI ARABIA: Zain re-farmed its 900 MHz GSM network for use in its LTE-Advanced network, launched in May 2016, which uses three component carrier aggregation of Bands 1, 3 and 8.

SINGAPORE: M1, Singtel and StarHub closed 2G/GSM services from April 2017, with spectrum to be re-farmed for 3G/HSPA and 4G/LTE. Singtel has launched LTE in 900 MHz.

SLOVENIA: KOS auctioned additional 900 MHz spectrum in April 2014 to Si.mobil, Telekom Slovenije, and Tušmobil. Telekom Slovenije has launched LTE900 services.

SOUTH AFRICA: Vodacom demonstrated speeds above 500 Mbit/s on its LTE-Advanced network using carrier aggregation of spectrum in the 900 MHz, 1800 MHz and 2100 MHz bands at its regional office in Nelspruit.

SOUTH KOREA: KT provides LTE-Advanced service using carriers in various spectrum bands including 900 MHz.

SPAIN: Vodafone plans to re-farm 900 MHz for rural mobile broadband coverage. Additional 900 MHz spectrum was acquired by Vodafone, Telefonica and Orange following an auction. Orange also intends to soon bring into service re-farmed 2.1 GHz, 900 MHz and 1,800 MHz spectrum for LTE.

SWEDEN: Tele2 and Telenor have in place an agreement to run their 2G and 4G networks jointly, and part of their 900 MHz spectrum licences were transferred to joint company Net4Mobility in 2012.

THAILAND: Two 900 MHz licences were auctioned in December 2015 and won by TrueMove H and fixed operator Jasmine (Jas Mobile), the latter planning to enter the mobile market. Jas Mobile failed to pay for the licence by the deadline, and the licence was then sold to AIS. Both TrueMove H and AIS have launched LTE-Advanced networks over 900 MHz spectrum.

TURKEY: BTK auctioned 390 MHz of 800, 900, 1800, 2100 MHz and 2.6 GHz LTE spectrum on August 26, 2015. Avea, Turkcell and Vodafone acquired spectrum at 900 MHz. In April 2017, Vodafone collaborated with Huawei to demonstrate GL spectrum sharing technology, which, enables spectrum sharing between GSM and LTE with unprecedented overlap between the two technologies increasing both LTE data rate and cell capacity available in the 900 MHz spectrum allocation. Vodafone Turkey launched LTE in April 2016 using the 900 MHz band and are also deploying NB-IoT in Band 8.

UK: All operators are allowed to re-farm 900 MHz for LTE networks.

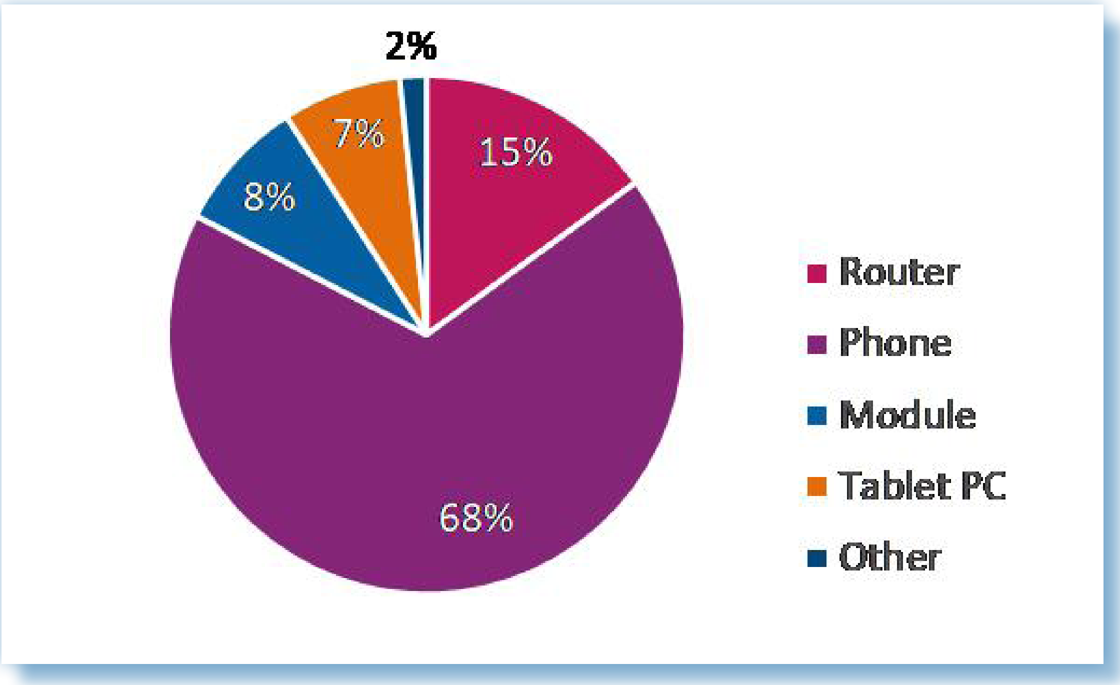
UKRAINE: Some operators are seeking technology neutrality principles for 900 MHz to allow LTE to be deployed in Band 3.

URUGUAY: Antel paid for a reserved block of 900 MHz spectrum following an auction in March 2013 but currently are using this for GSM voice services.

IMPORTANT NOTE: Technology-neutral 900 MHz licences have been granted in many countries. It is possible that 900 MHz will be used in LTE network deployments by many more network operators.

LTE900 Devices

Devices supporting LTE900 are now very common. GSA has identified 2,222 LTE900 devices (around 26% of all LTE devices) including operator variants.



LTE900 Devices by Form Factor, July 2017

There are 1,502 LTE900 smartphones which is equivalent to over 67.5% share of all LTE900 devices. 165 of LTE900 devices are tablet PCs and 185 are modules.

About GSA

GSA (the Global mobile Suppliers Association) is a not-for-profit industry organisation representing companies across the worldwide mobile ecosystem engaged in the supply of infrastructure, semiconductors, test equipment, devices, applications and mobile
support services.

GSA actively promotes the 3GPP technology road-map – 3G; 4G; 5G – and is a single source of information resource for industry reports and market intelligence. GSA Members drive the GSA agenda and define the communications and development strategy for the Association.

Membership of GSA is open to any supplier of products; systems or services related to the mobile industry and brings many benefits including access to the GAMBoD database. The range of benefits includes enhanced discussion, networking and influencing opportunities on the key industry topics, and unique promotional/visibility opportunities for your company name, capabilities, positioning and messages. More details can be found at https://gsacom.com/gsa-membership/

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NOTES:
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Tel: +44 330 113 1572

GSA website: www.gsacom.com

ATTACHMENT 6

AFFIDAVIT

I, William M. Jenkins, hereby state under penalty of perjury that the following is true and correct:

1) I am Vice President Dispatch Networks at pdvWireless, Inc. ("PDV");

2) For approximately fifteen years prior to joining PDV, I was employed by Nextel Communications, Inc., later Sprint Corporation ("Sprint"), as Vice Present Spectrum Management;

3) My responsibilities at Sprint included active involvement in the economic analyses and approval processes related to both the "upper 200 800 MHz" rebanding and the more recent rebanding called for in WT Docket No. 02-55. As part of that responsibility I worked closely with Sprint management and, as to WT Docket No. 02-55, with the 800 MHz Transition Administrator ("TA") in overseeing costs incurred by Sprint, including those that required TA approval. Thus, I am personally familiar with the costs associated with the rebanding of a wide variety of 800 MHz systems, including those operated by utilities and other business enterprise entities.

4) Based on my experience, the actual number of transmitters licensed in a band typically is greater than the actual number of transmitters that will be constructed at the time of realignment; therefore, the licensed number of transmitters is greater than the number that would need to be realigned in a band.

5) I provided the average per transmitter cost referenced in this pleading based on my extensive experience with the financial aspects of numerous 800 MHz rebanding projects.

William M. Jenkins

October 2, 2017

ATTACHMENT 7

DYNAMIC SPECTRUM SHARING

Prepared by:

Robert K. Burkhardt, BSE
Director, pdvWireless
Technology and Strategy

Dr. Arif Ansari, PHD, EE
Consultant to PDV

Introduction

The Commission requested comments on the feasibility of employing dynamic spectrum sharing methodologies for the 896-901/935-940MHz allocation. EWA/PDV concludes, after careful analysis, that due to the limited amount of spectrum for this allocation, spectrum sharing, although a desired approach for efficient use of spectrum, is not feasible. This exhibit outlines the analysis approach and rationale for this conclusion.

Dynamically Shared 5/5MHz band

For this NOI EWA/PDV define “broadband” (BB) to mean the development and delivery of LTE standards based broadband systems that achieve Mbps data rates over the air interface. EWA/PDV assume the Commission seeks comment on the feasibility of employing current authorized dynamic sharing schemes in the 935-940MHz band allocation or the potential for simultaneous/concurrent dynamic band sharing between narrowband (NB) and BB systems across the entire band.

Irrespective of which of the aforementioned schemes is employed, EWA/PDV contend that none of the schemes overviewed below nor any other dynamic scheme is feasible due to the limited spectrum allocation (5MHz) that is the focus of this proceeding, the fact that there will be dissimilar technologies sharing the band (NB/BB), the need to retain an FDD duplexing scheme driven by the existing Part 90 NB or future BB operations which would preclude the use of TDD schemes, and the central requirement for immediate access to network resources for voice services provided by either NB or BB systems.

Therefore, in response to the questions raised regarding dynamic sharing in this band, EWA/PDV propose that the Commission create separate narrowband and broadband allocations within the 896-901 MHz/935-940 MHz spectrum bands as outlined by EWA/PDV in RM-11738. This is the most effective means to allow incumbent NB licensees to continue to operate and provide a means for the introduction of BB services into the band.

Sharing Schemes Background -

The current Commission authorized sharing schemes are as follows:

Access Sharing Scheme 1: Universal Access - Contention Based Sharing:

- Example: 2.4 and 5 GHz ISM band (Figure 2)
- All users have equal access to all allocated spectrum /contend for access based on IEEE 802.11 or 3GPP LTE for LAA or LTE-U from the LTE-U forum
- Based on time division duplex (TDD) scheme; no paired channels; all channels are used for uplink and downlink
- Four current channel sizes: 20, 40, 80, 160MHz

On-air access limited to fixed transmit/receive/re-access times to prevent monopolization of channels by any given user/entity – this is also known as hopping sequences and occupancy time.

Access Sharing Scheme 2: Mixed Grandfathered - Licensed Sharing:

- Example: CBRS / Part 96 / 3.5GHz / 150MHz Allocation (Figure 3)
- 150MHz Allocation divided into fifteen – 10MHz channels
- All channels are TDD.
- Five classes of users:
  1. Incumbent Federal Users (IFU) – All 150MHZ of allocated spectrum/primary user basis
  2. Fixed Satellite Users (FSU) – Access to 100MHz of allocation spectrum/primary user basis

  10MHz Channel Assignments

  3. Licensed: Grandfathered Broadband Wireless Licensee (GBL) / 5 Channels (e.g. Wireless Internet Service Provider)
  4. Licensed: Priority Access Licensee (PAL) – 10 Channels – 3-year contour based license term
  5. Licensed: General Authorized Access (GAA) – Access to all 15 channels with a contention based access method similar to Part 15 on any channel not in use by licensed operators
- IFU and FSU users have priority over GBL/PAL/GAA users
- GBL and PAL systems/users are assigned channels by a spectrum access system (SAS); a spectrum management database system authorized by the FCC and operated by a private entity
- GBL and PAL systems/users have priority over GAA systems or users and must cease operations when active IFU/FSU users are detected
- If any licensed CBRS channels are in use or not licensed then the GAA users / systems can operate on all channels for both license types at any time as provided by the SAS.

Other Access Sharing Schemes:

The Commission sought comments on other potential schemes. To that end PDV also reviewed the feasibility of concurrent spectrum sharing of the 900MHz (896-901 MHz / 935-940 MHz) band between incumbent NB licensees and future BB licensee(s). As described below this

sharing scheme, due to the presence of a broadband channel and a large number of narrowband operations, especially in major metropolitan areas, precludes a dynamic sharing scheme. This is a direct result of the lack of broadband channel availability when continual narrowband usage across the 900MHz band is considered.
See Figure 1.

Schemes 1 and 2 Sharing Feasibility

Sharing schemes 1 and 2 would not be feasible with multiple 1.4MHz or a mixed 1.4MHz / 3MHz channel assignment due to the fact that those sharing schemes rely on (i) larger spectrum allocations, (ii) a TDD duplexing scheme and (iii) a large number of channels and channel sizes, and (iv), in the case of CBRS, large uniform channel sizes that like WiFi schemes enable hopping algorithms and limited channel dwell times.

The current structure of the 896-901MHz/935-940MHz allocation is FDD for incumbent NB operations. If such NB FDD operations are to continue and co-exist with broadband then any broadband service rules and licensing must also follow a FDD scheme. Otherwise, there is a high risk that interference would be introduced by broadband TDD transmissions into narrowband portables due to the uncoordinated nature of their operations. That is, if the timing of narrowband and broadband operations is not tightly controlled, then an uplink in one service would likely cause interference to a downlink in the other service. This issue also precludes a 900MHz broadband channel from employment of the flexibility provided by TDD access scheme 1 or 2 described above.

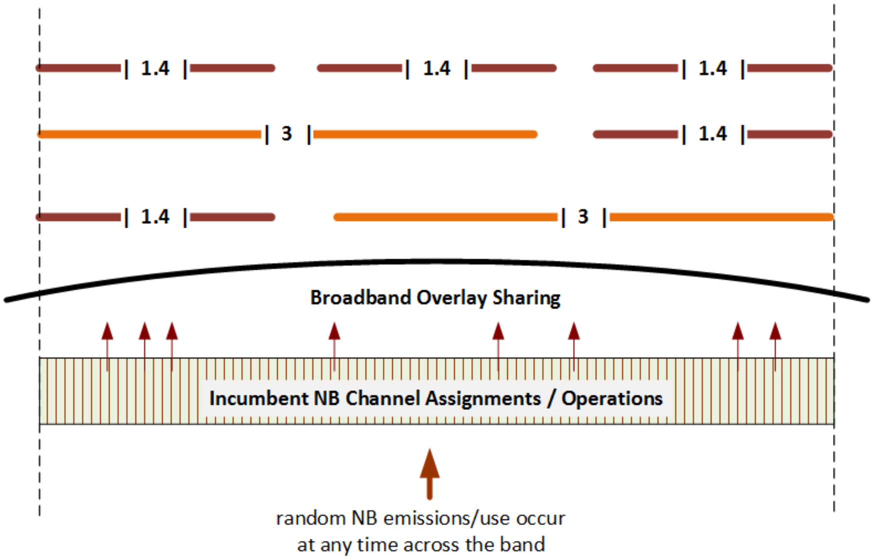
EWA/PDV understand that WiFi channel sizes, as shown in Figure 2, are defined in increments of 20, 40, 80 and 160MHz. The newly defined Part 96 CBRS service in the 3.5GHz band is parsed into 10MHz channels as shown in Figure 3.

However, the total spectrum available in the 896-901 MHz / 935-940 MHz band is two 5-megahertz channels. Thus, neither example provides constrained channel quantities or a channel size model that can be accommodated in the 896-901 MHz / 935-940MHz band. This precludes the ability to incorporate similar sharing schemes in the 900 MHz band.

Concurrent Narrowband / Broadband Use of 5/5MHz Example

As Broadband LTE can operate in a variety of channel sizes as small as 1.4MHz, EWA/PDV assumed 1.4MHz only and 1.4/3MHz channel assignment configurations for its study. A broadband sharing overlay scheme would then accommodate three configurations as shown in Figure 1.

Figure 1 – Potential LTE Broadband Channel Schemes Sharing With Incumbent NB



In the scheme illustrated in Figure 1 there would be *limited* numbers of broadband channels available. Per the ULS there are currently NB licensees that operate across the entire 935-940MHz band which absent any realignment would ensure there would be continual NB use across the entire band by incumbent NB operators. In this environment, the BB channel would never have an opportunity to operate due to this continual NB use in the same spectrum to which the BB channel is assigned.

The operational reality, as illustrated in Figure 1, precludes a dynamic spectrum sharing scheme by either a contention based protocol or a SAS because NB systems continued use of the entire band would result:

- In there being no place for BB systems to hop to find both (i) a free channel not being employed by another BB operator (in the case of multi-BB systems) or itself and (ii) a channel where no NB transmissions are occurring or about to occur, again with the premise that voice applications require immediate resource access and are delay sensitive.
- In the requirement that broadband operators *immediately cease* transmission upon detection of NB use (assuming NB operations are provided higher priority). Part 96 CBRS rules call for lower priority transmissions to cease within 300 seconds of detection and notification by a SAS. NB voice systems are expected to be available and have no more than a 500ms – 1 second setup delay for the start of a voice session. The ability of a broadband system to be notified and cease transmission in this type of timeframe is not feasible. Conversely should the broadband system offer CII voice services such as PTT any interruption to these services would not be accepted by CII enterprises and users.
- In impacts to the LTE system's ability to perform normally. An example of this is the continual transmission of signaling information to ensure reliable device (UE) access and attachment to eNodeB's. These types of impacts illustrate that high rates of random interruption to BB would have a negative impact on BB systems performance and may

ultimately jeopardize users due to the inability to attach to the network in an emergency (911).

For these reasons, EWA/PDV have concluded that a dynamic sharing scheme would introduce more complexity into the band than by simply segregating narrowband and broadband operations.

Furthermore, such complexity would not increase spectrum efficiency, rather it would likely result in a decrease in efficiency. More specifically, the existing TDD structure of the narrowband operations makes implementing a contention based dynamic sharing scheme similar to the Wi-Fi band infeasible due to an increased risk of interference to narrowband operations. Also, the total aggregate amount of available spectrum limits the utility of a SAS based dynamic sharing scheme as it would likely need to segregate narrowband and broadband operations to ensure each is able to operate. Given this likely outcome, it would be more efficient to simply segregate the band by rule rather than injecting a complex database controlled spectrum management scheme which would produce the same outcome. In sum, without segregating the narrowband and broadband segments, broadband operations may have limited opportunities to access the spectrum while segregating such operations would not detrimentally impact narrowband operations and allow for broadband operations. Thus, segregating narrowband and broadband operations is the optimal method for band sharing for the 900 MHz band.

Figure 2: Part 15 - 5GHz Unlicensed TDD Allocation and Channel Scheme

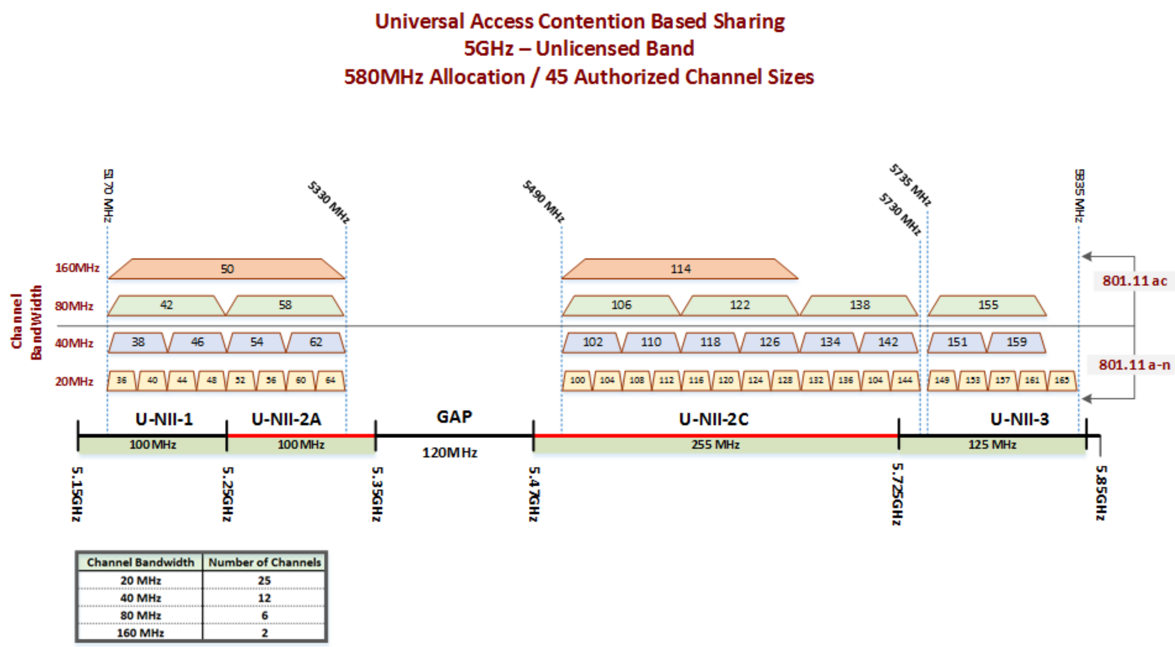
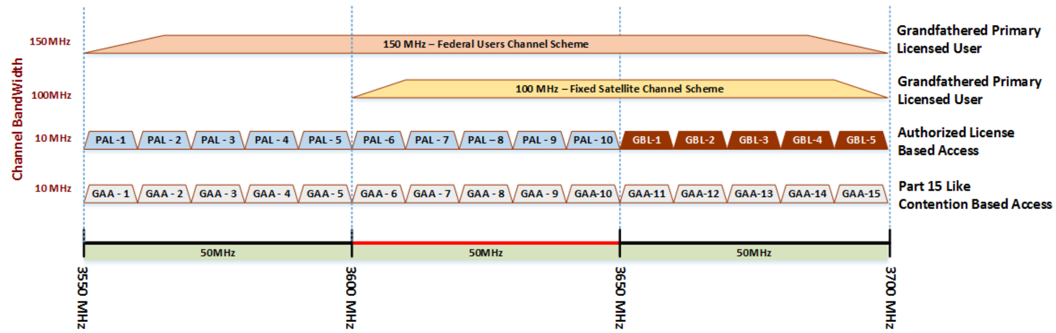


Figure 3: Part 96 – Citizens Broadband Radio Service – 3.5GHz – 10MHz TDD Channel Scheme

Part 96 Citizens Broadband Radio Service / 3550-3700MHz
Combined Grandfather / Licensed / Unlicensed Sharing
150MHz Allocation / 15 Broadband Channels – 10MHz Channel



License Type	Channel Count	Allocation Use	Allocation Range			
CBRS Allocation Total	15	150 MHz	3550 MHz	<< >>		3700MHz
Incumbent Federal Users	N/A	150MHz	3550MHz	<< >>		3700MHz
Fixed Satellite	N/A	100MHz		3600MHz	<< >>	3700MHz
GBL - Grandfathered Wireless Broadband Licensee	5	50 MHz			3650 MHz	3700 MHz
PAL - Priority Access License	10	100 MHz	3550MHz		3650 MHz	
GAA - General Authorized Access	15	150 MHz	3550MHz			3700MHz

ATTACHMENT 8

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LLGS LUKAS LAFURIA GUTIERREZ & SACHS LLP

M E M O R A N D U M

TO: pdvWireless, Inc.

FROM: Russell D. Lukas

RE: Auction Analysis

DATE: October 2, 2017

You have asked me to review the Notice of Inquiry in WT Docket No. 17-200, Review of the Commission's Rules Governing the 896-901/935-940 MHz Band, which poses the question "whether using spectrum holdings to select the broadband licensee," as proposed by EWA/PDV, "would allow the licensee to obtain a windfall benefit without having to pay for it, and, if so, whether cost to the public of that windfall is outweighed by the benefits of rebanding."[1]

The fact that a PEBB licensee may get an "unexpectedly large" benefit[2] from being able to provide broadband service over the realigned spectrum does not mean either that the public interest requires that the licensee "pay" the government for the benefit, or that there will be any "cost" to

[1] NOI at ¶ 31.
[2] The word "windfall" means an "unexpected gain, piece of good fortune," or "accruing in unexpectedly large amounts." *Random House Webster's Unabridged Dictionary* 2177(2d ed. 2001).

the public. Witness the experience of the Wireless Communications Service ("WCS") licensees that paid $9.7 million for frequency Blocks A and B licenses in 1997.[3]

The WCS licensees were awarded two licenses (for Blocks A and B) in 52 MEAs, which authorized them to provide service on 10 MHz of spectrum in the 2.3 GHz band.[4] By 2010, there were no mobile operations in the WCS spectrum, because the "severe" technical restrictions that the Commission had placed on such operations made them infeasible.[5] The Commission found this situation to "unacceptable because it effectively makes valuable spectrum unusable for the provision of mobile broadband services."[6] It changed its technical rules specifically to enable the A and B Block licensees to provide mobile broadband services in 25 MHz of the WCS band.[7] The Commission's rule changes benefitted the A and B Block licensees enormously by making their WCS spectrum holdings exponentially more valuable.

Two and one-half years after the WCS rule changes, the Commission approved transactions whereby AT&T acquired 10-20 MHz of WCS spectrum in 608 CMAs covering 82 percent of the population of the contiguous 48 states.[8] It found that the transaction were "likely to result in certain public interest benefits by facilitating the transition of long-underutilized WCS spectrum towards mobile broadband use, thereby supporting our goal of expanding mobile broadband deployment throughout the country."[9]

The rule changes that were intended to facilitate the deployment of broadband services in the WCS bestowed a "windfall" benefit on the A and B Block licensees for which they paid

[3] *See WCS Auction Closes, Winning Bidders in the Auction of 128 WCS Licenses*, Public Notice, 12 FCC Rcd 21653, 21658-67 (1997).
[4] *See id*. at 21653 n.1.
[5] *See Amendment of Part 27 of the Rules to Govern the Operation of Wireless Communications Services in the 2.3 GHz Band*, Report and Order and Second Report and Order, 25 FCC Rcd 11710, 11757 (¶ 108) (2010).
[6] *Id.*
[7] *See id.* at 11711(¶ 1).
[8] *See AT&T Mobility Spectrum LLC*, 27 FCC Rcd 16459, 16461 (¶ 4) (2012).
[9] *Id*. at 16460 (¶ 1).

nothing. But the "windfall" the Commission conferred on the WCS licensees came at no cost to the public. To the contrary, the public stood only to benefit when AT&T put the previously underutilized WCS spectrum to "more efficient use in its LTE operations."[10] It could anticipate that AT&T would use the WCS spectrum to "provide more robust broadband services to the public across the country."[11]

Like the WCS licensees in 2010, some 900 MHz licensees stand to benefit by the rule changes proposed by EWA/PDV. Also like the WCS licensees, the PEBB licensees will pay nothing for the benefit beyond the auction prices they paid for their spectrum and the costs they will bear relocating incumbent B/ILT and SMR licensees. But, as was the case with the WCS rule changes, the changes proposed by EWA/PDV will entail no cost to the public. Rather, the public interest will be served when long-underutilized 900 MHz Band spectrum is finally put to use to provide robust mobile broadband service to the CII/PE community.

Even if the EWA/PDV proposal portended some loss of federal revenues, such loss is not particularly relevant when the Commission selects the mechanism by which the PEBB licenses are assigned. As alluded to in the NOI, the choice of the licensing scheme to employ boils down to whether or not the Commission should "accept mutually exclusive applications that would require it to use competitive bidding to assign a license."[12] In that regard, it is well-established that § 309(j)(6)(E) of the Act provides "the Commission broad authority to create or avoid mutual exclusivity in licensing, based on [its] assessment of the public interest."[13] However, when making

[10] *Id.* at 16462 (¶ 5).
[11] *Id.*
[12] *Id*. at ¶ 32.
[13] *Metropolitan Transportation Authority*, 31FCC Rcd 1436, 1454 (¶ 56) (2016) (quoting *Improving Public Safety Communications in the 800 MHz Band*, 19 FCC Rcd 14969, 15021 (¶ 85) (2004)). Section 309(j)(6)(E) specifies that the Commission has "the obligation in the public interest to continue to use engineering solutions, negotiation, threshold qualifications, service regulations, and other means to avoid mutual exclusivity in application and licensing proceedings." 47 U.S.C. § 309(j)(6)(E).

its assessment of the public interest, the Commission is prohibited from considering the Federal revenues that may be generated by using competitive bidding to assign PEBB licenses.[14] Rather, it must assess its "obligations under the Communications Act, the costs and benefits of different approaches, and whether and to what extent the policies would benefit users."[15]

Certainly, the Commission is not required to auction licenses.[16] It has maintained its "freedom to consider all available spectrum management tools and the discretion to evaluate which licensing mechanism is most appropriate for the services being offered."[17] The Commission has chosen the licensing mechanism on a service-by-service basis "focus[ing] on the application of the public interest factors enumerated in [§] 309(j)(3) and [its §] 309(j)(6)(E) obligation in the public interest to avoid mutual exclusivity in application and licensing proceedings."[18] We submit that the repurposing of the 900 MHz Band outside the auction context will further the § 309(j)(3) public interest objectives.

The Commission's spectrum management responsibility under § 309(j)(3)(A) is to promote "the development and rapid deployment of new technologies, products, and services for the benefit of the public, including those residing in rural areas, without administrative or judicial delays."[19] As we have shown, there is an undisputed, compelling need for the rapid deployment of broadband facilities to serve the CII/PE community. The Commission would minimize the delay in issuing

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[14] *See* 47 U.S.C. § 309(j)(7)(A). *See also Improving Public Safety Communications in the 800 MHz Band*, Report and Order, Fifth Report and Order, Fourth Memorandum Opinion and Order, and Order, 19 FCC Rcd 14969, 15019 (¶ 81) (2004) ("*800 MHz Rebanding Order*") (§ 309(j)(7) "prohibits the Commission from basing the decision whether to auction spectrum on a desire for federal revenue").

[15] NOI at ¶ 30 (footnote omitted).

[16] *See Improving Public Safety Communication in the 800 MHz Band*, Memorandum Opinion and Order, 20 FCC Rcd 16015, 16046 (¶ 70) (2005) ("Although the Commission had the authority to auction licenses, it was not required to do so").

[17] *Implementation of §§ 309(j) and 337 of the Communications Act*, Report and Order and Further Notice of Proposed Rulemaking, 15 FCC Rcd 22709, 22721 (¶ 25) (2000).

[18] *Id*. at 22717 (¶ 18).

[19] 47 U.S.C. § 309(j)(3)(A).

PEBB licenses to meet that need by avoiding mutual exclusivity. When the Commission has elected to repurpose spectrum by auction, it took an average of nearly two years from the Commission's decision to employ competitive bidding just to complete the auction process.[20] By comparison, the Commission could authorize the deployment of CII/PE broadband networks immediately upon its decision to repurpose the 900 MHz Band spectrum by license modification.

Section 316(a)(1) of the Act authorizes the Commission to modify any station license "if in the judgment of the Commission such action will promote the public interest, convenience, and necessity, or the provisions of [the Act] … will be more fully complied with."[21] The Commission has been afforded "significant latitude" when it exercises its § 316(a)(1) authority to modify licenses. Indeed, the Commission's power under § 316(a)(1) is so broad that it can "remove spectrum from the spectrum auction process" and award it by "license modification"[22] simply by finding that the modification would serve the public interest.[23] Thus, the Commission has the authority to modify the 900 MHz Band licenses necessary to effectuate the spectrum realignment proposed by EWA/PDV, if it finds that license modifications would be in the public interest.

Section 316(a)(1) empowers the Commission to take the steps necessary to reconfigure the 900 MHz Band without recourse to competitive bidding. As noted, § 316(a)(1) allows the Commission to assign spectrum without providing any opportunity for competing applications. For example, the Commission exercised its § 316(a)(1) license modification authority to assign up to 20 MHz of spectrum across the entire L-band to the country's only licensee that was authorized

[20] We examined ten auctions that involved repurposed spectrum. We found that a total of 7,053 days elapsed between the decisions to employ competitive bidding and the completion of the auctions. *See* Attachment _.
[21] 47 U.S.C. § 316(a)(1).
[22] *Metropolitan Transportation*, 31FCC Rcd at 1455 (¶¶ 56, 57).
[23] *See id*. at 1454 (¶ 54) (the D.C. Circuit "recognized the Commission's 'broad power to modify licenses' under [§] 316(a)(1), explaining that the Commission 'need only find that the proposed modification serves the public interest'") (quoting *California Metro Mobile Communications v. FCC*, 365 F.3d 38, 45 (D.C. Cir. 2004)).

to provide mobile-satellite service ("MSS") in that frequency band.[24] The Commission rejected the argument it was barred from "limiting eligibility for newly allocated spectrum to just one company."[25] It determined that the public interest was "best served by ensuring that the existing MSS licensee … is afforded sufficient spectrum to [expeditiously] provide a viable service, before opening up this spectrum to additional applications."[26]

Most recently, the Commission modified a 218-219 MHz service license to authorize the use of spectrum from its "inventory" in order to implement a Positive Train Control safety system in four new counties.[27] The Commission decided that the public interest would not be served by permitting the filing of mutually exclusive applications.[28] Rather, it found that the license modification would serve the public interest – the "touchstone" for modification of a license under § 316(a)(1)[29] – and be consistent with its "fundamental obligation" under § 151 of the Act to "promot[e] safety of life and property through the use of wire and radio communications."[30]

Section 316(a)(1) also authorizes the Commission to modify licenses on a service-wide basis to relocate existing licensees to new spectrum,[31] and to allocate the relocation costs among the affected licenses.[32] In the *800 MHz Rebanding Order*, the Commission exercised its § 316(a)(1) license modification authority to reconfigure the upper portion of the 800 MHz band,

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[24] *See Establishing Rules and Policies for the Use of Spectrum for Mobile Satellite Services in the Upper and Lower L-Band*, Report and Order, 17 FCC Rcd 2704, 2705 (¶ 1) (2002).
[25] *Id*. at 2714-15 (¶ 26).
[26] *Id*. at 2714 (¶ 25). The Commission concluded that, by modifying the license, "the public interest will be served by expeditiously providing MSS to areas that are too remote or sparsely populated to receive service from terrestrial communications systems." *Id.*
[27] *See Metropolitan Transportation,* 31FCC Rcd at 1455-58 (¶¶ 58-63).
[28] *See id*. at 1455 (¶ 56).
[29] *Id*. at 1455 (¶ 58).
[30] *Id*. (quoting 47 U.S.C. § 151).
[31] *See 800 MHz Rebanding Order*, 19 FCC Rcd at 15011 (¶ 65) (§ 316(a)(1) license modifications "do not need to be consensual" and "license holders may be moved on a service-wide basis, without license-by-license consideration"), 15012 (¶ 67) (license modifications may "involve relocating existing licensees to new spectrum, outside of the auction process").
[32] *See id*. at 15011 (¶ 66) (the Commission has the "authority to allocate the relocation costs associated with license modification among the affected licensees").

which entailed assigning 10 MHz of spectrum for nationwide use and relocating existing licensees.[33] The Commission showed that the breadth of its § 316(a)(1) authority was sufficient to allow it take all the actions necessary to effectuate an efficient and effective band restructuring plan based entirely on license modifications that served the public interest.

The choice of the licensing mechanism to employ to repurpose long-underutilized 900 MHz Band spectrum is an easy one if the Commission wants to hasten the deployment of CII/PE broadband networks across the country. It should avoid mutual exclusivity and competitive bidding by adopting the EWA/PDV proposal and assigning the PEBB licenses by rulemaking and license modifications.

[33] *See id*. at 15010-21 (¶¶ 62-87).

ATTACHMENT 9

FCC AUCTIONS INVOLVING REPURPOSED SPECTRUM

<table>
<tr><th>NO.</th><th>AUCTION NAME, SPECTRUM</th><th>FCC ACTION</th><th>ORDER DATE</th><th>AUCTION START DATE</th><th>BIDDING DAYS</th><th>AUCTION CLOSE DATE</th><th>DAYS</th></tr>
<tr><td>4</td><td>Broadband PCS (A and B Blocks)

2 GHz band

A block: 1850-1865 and 1930-1945 MHz
B block: 1870-1885 and 1950-1965 MHz</td><td rowspan="2">Repurposed spectrum for Personal Communications Service. Formerly used for microwave operations by business users, including petroleum companies, utilities, and railroads.

<u>NOTE</u>: Only the initial two auctions involving repurposed Broadband PCS spectrum are listed in this table. Auctions 10, 11, 22, 35, 58, and 71 also involved Broadband PCS spectrum. Auction 78, which is listed below, involved both AWS-1 and Broadband PCS spectrum.</td><td>8/15/1994 (9 FCC Rcd 2348)</td><td>12/5/1994</td><td>60</td><td>3/13/1995</td><td>210</td></tr>
<tr><td>5</td><td>Broadband PCS (C Block)

1895-1910; 1975-1990 MHz</td><td>8/15/1994 (9 FCC Rcd 2348)</td><td>12/18/95</td><td>83</td><td>5/6/1996</td><td>630</td></tr>
<tr><td>7</td><td>900 MHz Specialized Mobile Radio Service

Half in the 935-940 MHz band; half in the 896-901 MHz band</td><td>Repurposed spectrum for cellular-based services including Internet access, two-way acknowledgment paging and inventory tracking, credit card authorization, automatic vehicle location, fleet management, remote database access, and voice mail.” Formerly used for “mobile radios that communicated directly with other mobile or fixed radios in a dispatch mode, such as taxi fleets, or that interconnected with the public telephone network through the use of a base station.</td><td>9/23/1994 (9 FCC Rcd 7988)</td><td>12/5/1995</td><td>79</td><td>4/15/1996</td><td>214</td></tr>
</table>

NO.	AUCTION NAME, SPECTRUM	FCC ACTION	ORDER DATE	AUCTION START DATE	BIDDING DAYS	AUCTION CLOSE DATE	DAYS
16	800 MHz SMR Block A: 401-420 Channel Numbers 861.0-861.5 MHz paired with 816.0-816.5 MHz Block B: 421-480 Channel Numbers 861.5-863.0 MHz paired with 816.5-818.0 MHz Block C: 481-600 Channel Numbers 863.0-866.0 MHz paired with 818.0-821.0 MHz	See Auction 7, above, for a description of the repurposed spectrum. Licensed a total of 525 licenses in the upper 200 channels of the 800 MHz SMR service. Incumbents were subject to involuntary relocation, and it was required that they must be provided with replacement systems at least equivalent to the existing 800 MHz system. 47 CFR § 90.699.	12/15/1995 (11 FCC Rcd 1463)	10/28/1997	27	12/8/1997	724
33	Upper 700 MHz Guard Bands Block A: 746-747/776-777 MHz Bands, Block B: 762-764/792-794 MHz Bands	Repurposed for mobile wireless services, resulting from the transition of television from analog to digital service. The 700 MHz spectrum was encumbered by approximately 100 existing television stations, and it was expected to remain so, to some extent, until 12/31/2006 or later. No part of the country was totally unencumbered in the band, and in some metropolitan areas, very little of the band was currently available. New geographic area licensees operating on this spectrum were required to comply with	1/7/2000 (15 FCC Rcd 476)	9/6/2000	12	9/21/2000	258

NO.	AUCTION NAME, SPECTRUM	FCC ACTION	ORDER DATE	AUCTION START DATE	BIDDING DAYS	AUCTION CLOSE DATE	DAYS
		the co-channel and adjacent channel protection provisions of 47 CFR § 90.545. In light of continued use of this spectrum by broadcasters until 12/31/2006 or later, licenses were issued for a total of approximately 14 years. The expiration date was extended eight years beyond the date which incumbent broadcasters were required to have relocated to other portions of the spectrum, that is, until 1/1/2015. However, if a licensee commenced new broadcast-type operations on or before 1/1/2006, the licensee was required to seek renewal of its license at the end of the eight-year term following commencement of such broadcast operations.					
38	Upper 700 MHz Guard Bands Block A: 746-747/776-777 MHz Bands, Block B: 762-764/792-794 MHz Bands	Repurposed for mobile wireless services, resulting from the transition of television from analog to digital service. In light of continued use of this spectrum by broadcasters until 2006 or later, licenses were issued for a total of approximately 14 years. The expiration date was eight years beyond the initial deadline for incumbent broadcasters to relocate to other portions of the spectrum; that is, until 1/1/15. However, if a licensee commenced new broadcast-type operations on or before 1/1/06, the licensee was required to seek renewal of its license at the end of the eight-year term following commencement of such broadcast operations. All licensees meeting the substantial service requirement	3/9/2000 (15 FCC Rcd 476)	2/13/2001	6	2/21/2001	378

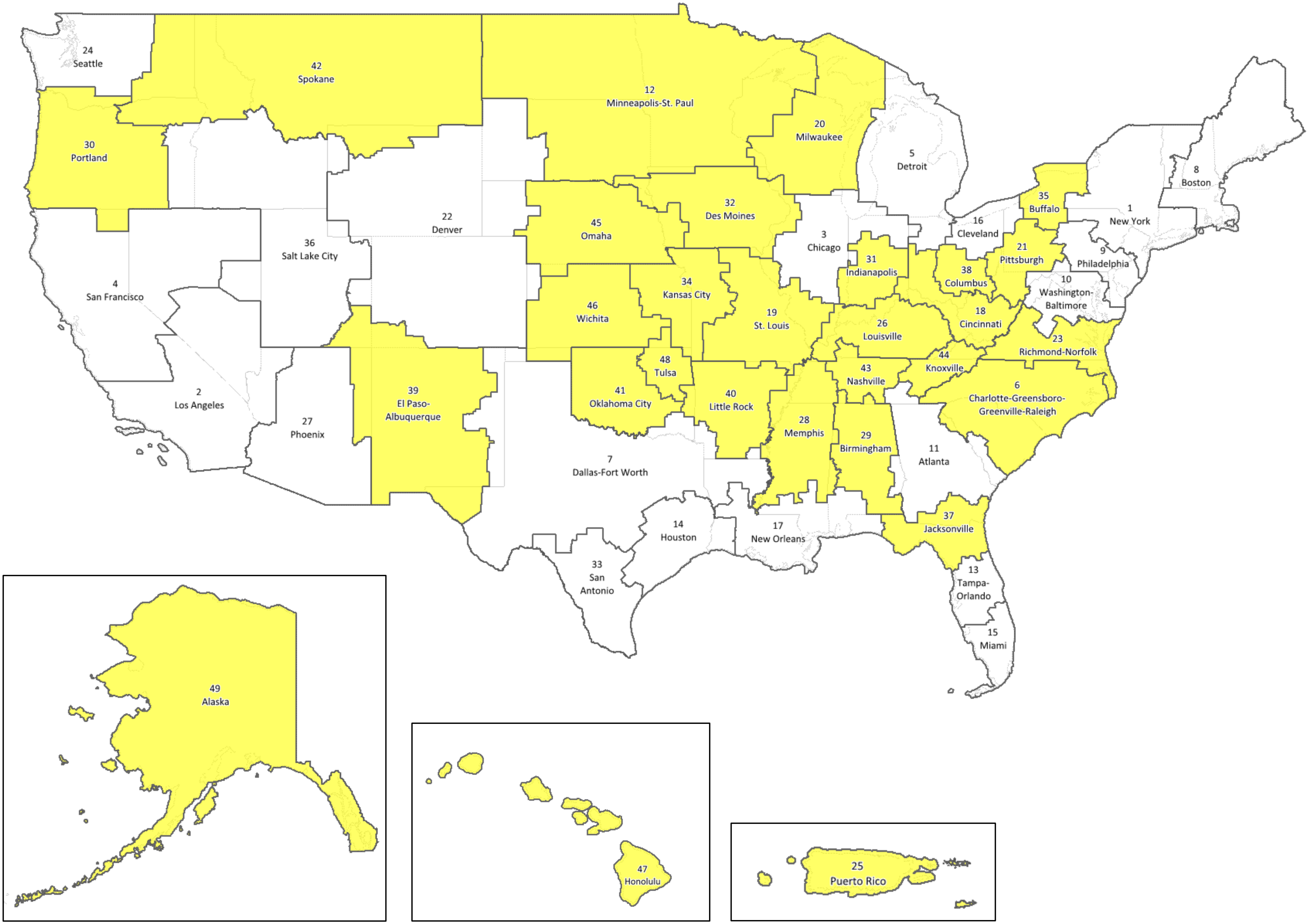
NO.	AUCTION NAME, SPECTRUM	FCC ACTION	ORDER DATE	AUCTION START DATE	BIDDING DAYS	AUCTION CLOSE DATE	DAYS
		(see First Report and Order, WT 99-168, ¶ 70, released 1/7/2000) were deemed to have met renewal expectancy regardless of which construction option the licensee chose.					
55	900 MHz Specialized Mobile Radio Service	See Auction 7, above, for a description of the repurposed spectrum. NOTE: This auction involved the reauction of recovered spectrum.	9/14/1995 (11 FCC Rcd 2639)	2/11/2004	10	2/25/2004	3,086
66	AWS-1 1710-1755, 2110-2155 bands	AWS-1 bands were being used for a variety of Government and non-Government services and required relocating incumbent operations. The lower half of the paired frequencies, i.e., 1710-1755 MHz, was currently a Government band and was covered by a congressional mandate that required that auction proceeds fund the estimated relocation costs of incumbent Federal entities. The upper half of the paired frequencies, i.e., 2110-2150 MHz band, was used by private (including state and local governmental public safety services) and common carrier fixed microwave services (“FS”). The 2150-2155 MHz band was currently used by the Broadband Radio Service (“BRS”). The FCC adopted a Ninth Report and Order establishing procedures by which new AWS licensees may relocate incumbent BRS and FS operations in spectrum that has been allocated for AWS. In addition, AWS-1 licensees must comply with the technical and operational rules set forth in 47 CFR §§ 27.50-27.66 and 27.1131-27.1135 to protect co-channel and adjacent	11/25/2003 (18 FCC Rcd 25162)	8/9/2006	28	9/18/2006	1,028

NO.	AUCTION NAME, SPECTRUM	FCC ACTION	ORDER DATE	AUCTION START DATE	BIDDING DAYS	AUCTION CLOSE DATE	DAYS
		channel incumbent Government and non-Government operations from interference.					
73	700 MHz band 698-806 MHz band	Repurposed for mobile wireless services, resulting from the transition of television from analog to digital service. A number of incumbent broadcasters were licensed and operating on these frequencies (TV Channels 52-53, 56-58, 60-62, and 65-67) and adjacent channels. In accordance with the FCC's rules, 700 MHz Band licensees must protect analog and digital TV incumbents from harmful interference through February 17, 2009, the end of the DTV transition period. After February 17, 2009, 700 MHz licensees must continue to operate in accordance with the FCC's rules to reduce the potential for interference to public reception of the signals of DTV broadcast stations transmitting on DTV Channel 51. The FCC grandfathered an incumbent guard band licensee in Major Economic Areas ("MEAs") 21 and 39 at 761-763 MHz and 791-793 MHz of the D Block. The new D Block licensee were authorized on a secondary basis at 761-763 MHz and 791-793 MHz in these markets and were prohibited from causing interference to the primary operations of the grandfathered licensee. If the grandfathered licensee, or a successor or assignee, canceled either of the grandfathered licenses, or if either license canceled	8/10/2007 (22 FCC Rcd 15289)	1/24/2008	38	3/18/2008	221

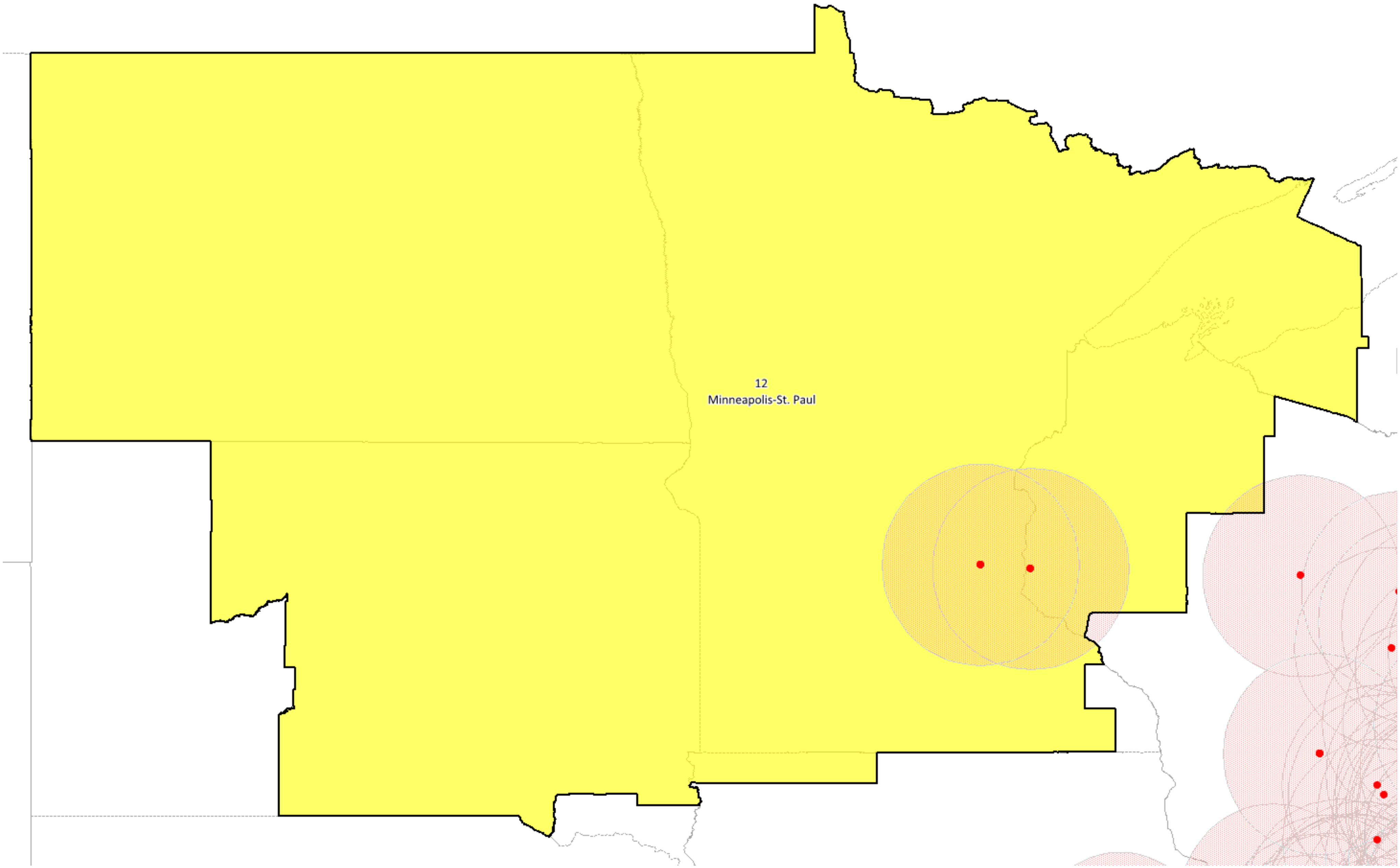
NO.	AUCTION NAME, SPECTRUM	FCC ACTION	ORDER DATE	AUCTION START DATE	BIDDING DAYS	AUCTION CLOSE DATE	DAYS
		automatically, was terminated by the FCC, or expired, then the licensed geographic area would revert to the D Block licensee automatically.					
97	AWS-3 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz bands	Spectrum in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz bands was repurposed to make available significantly more commercial spectrum for Advanced Wireless Services. The AWS-3 bands were currently being used by Federal and non-Federal incumbents for a variety of Government and non-Government services. AWS-3 licensees were subject to various requirements related these incumbent users, including Federal and non-Federal relocation, sharing, and cost-sharing obligations, coordination requirements, and protection of Federal and non-Federal incumbent operations.	3/31/14 (29 FCC Rcd 4610)	11/13/2014	45	1/29/2015	304

ATTACHMENT 10

Proposed Auction MTAs



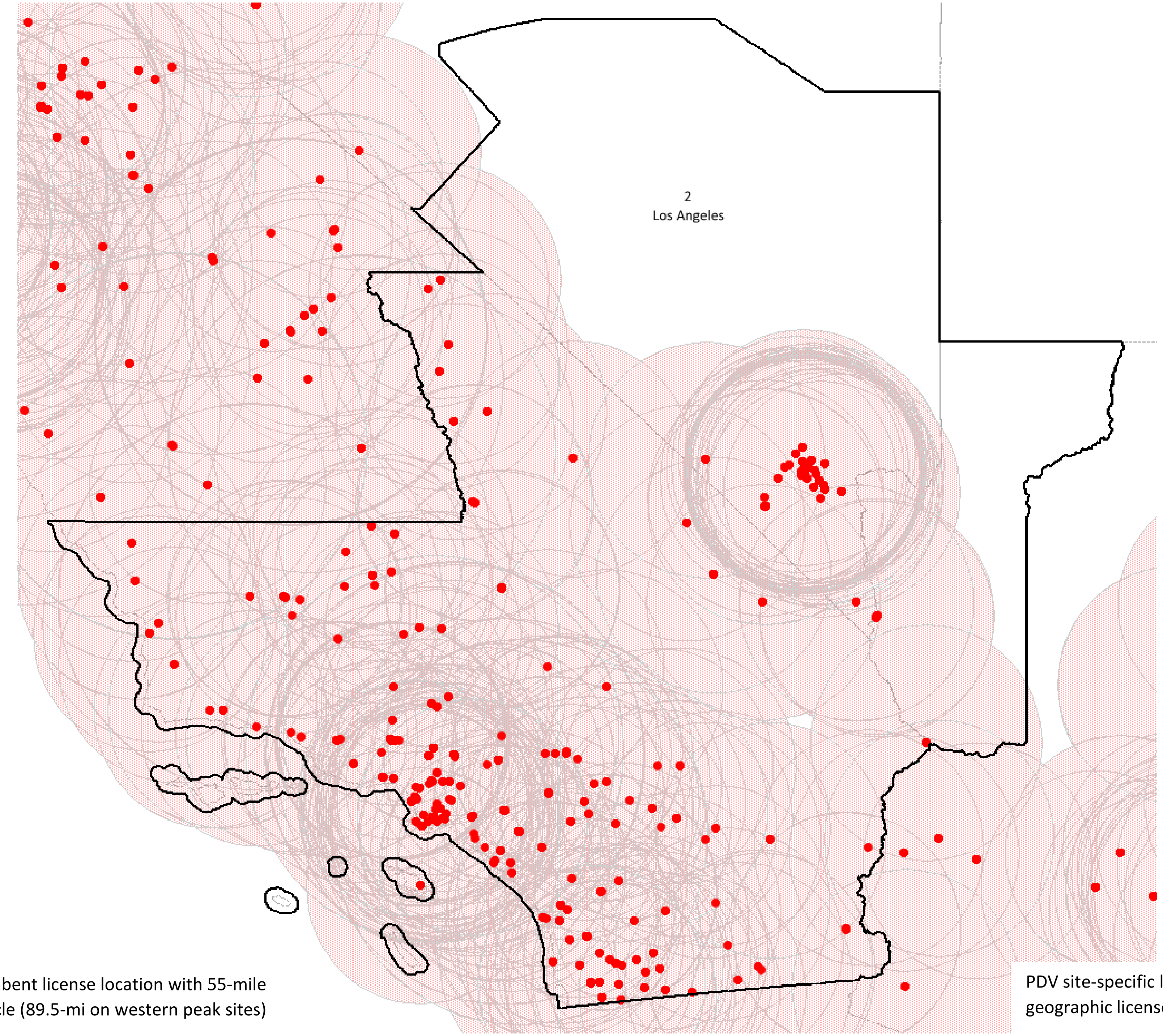
MTA With Low Number Of Site-Specific Licenses



- Incumbent license location with 55-mile circle (89.5-mi on western peak sites)

PDV site-specific licenses and all geographic licenses not included

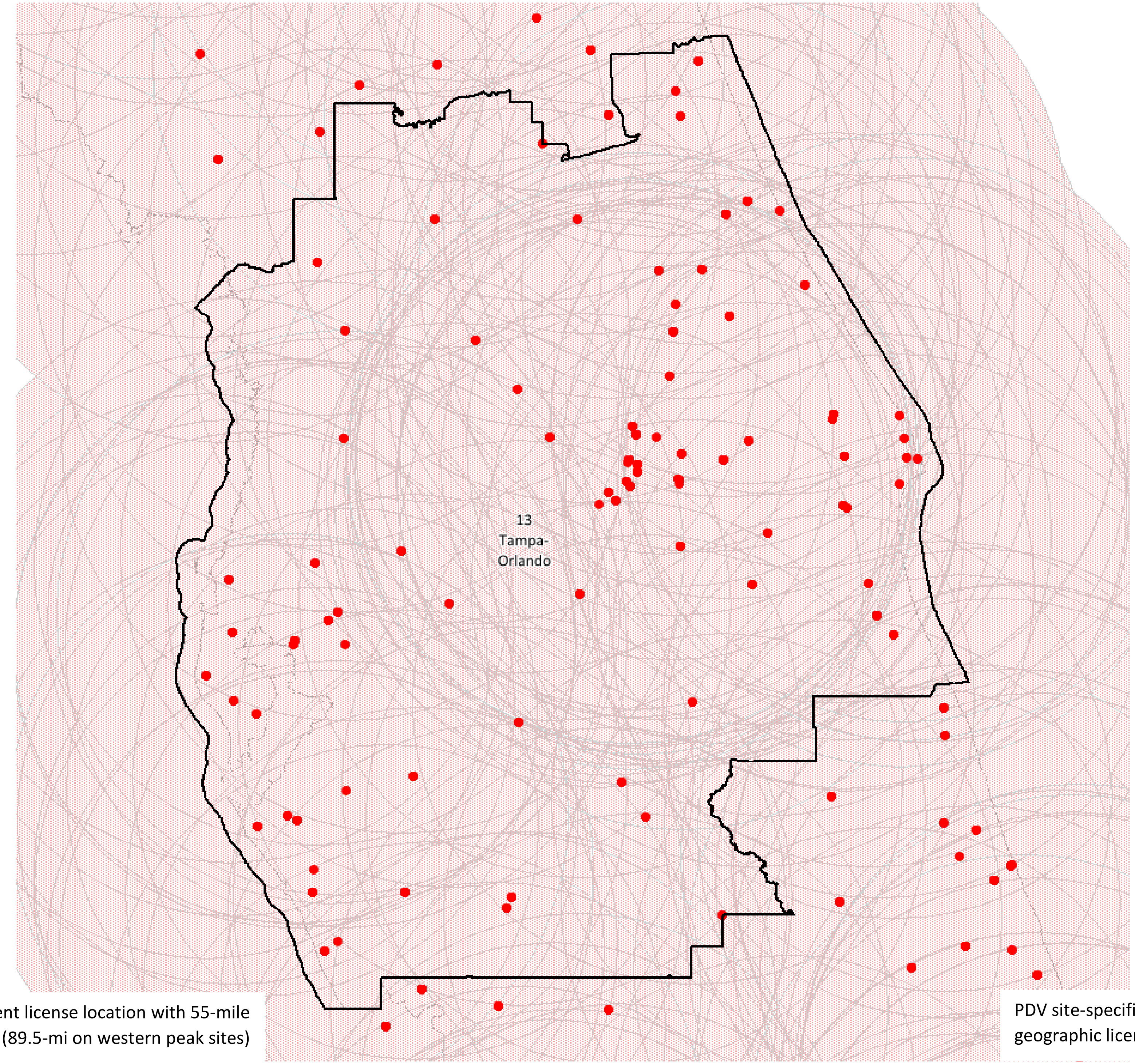
MTA With High Number Of Site-Specific Licenses



- Incumbent license location with 55-mile circle (89.5-mi on western peak sites)

PDV site-specific licenses and all geographic licenses not included

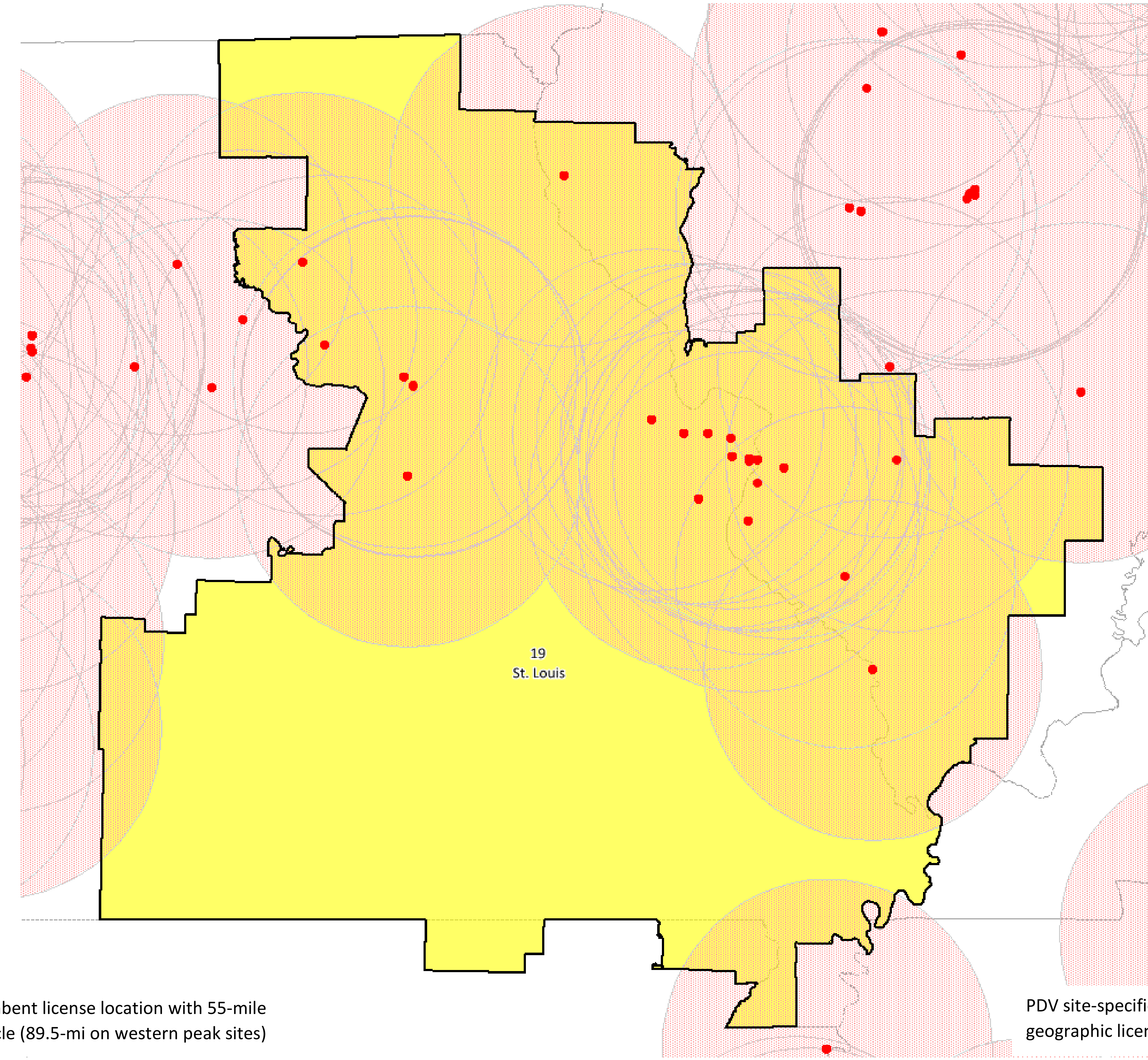
Example Of No Auction MTA (Fewer Than 80 Channels Vacant)



- Incumbent license location with 55-mile circle (89.5-mi on western peak sites)

PDV site-specific licenses and all geographic licenses not included

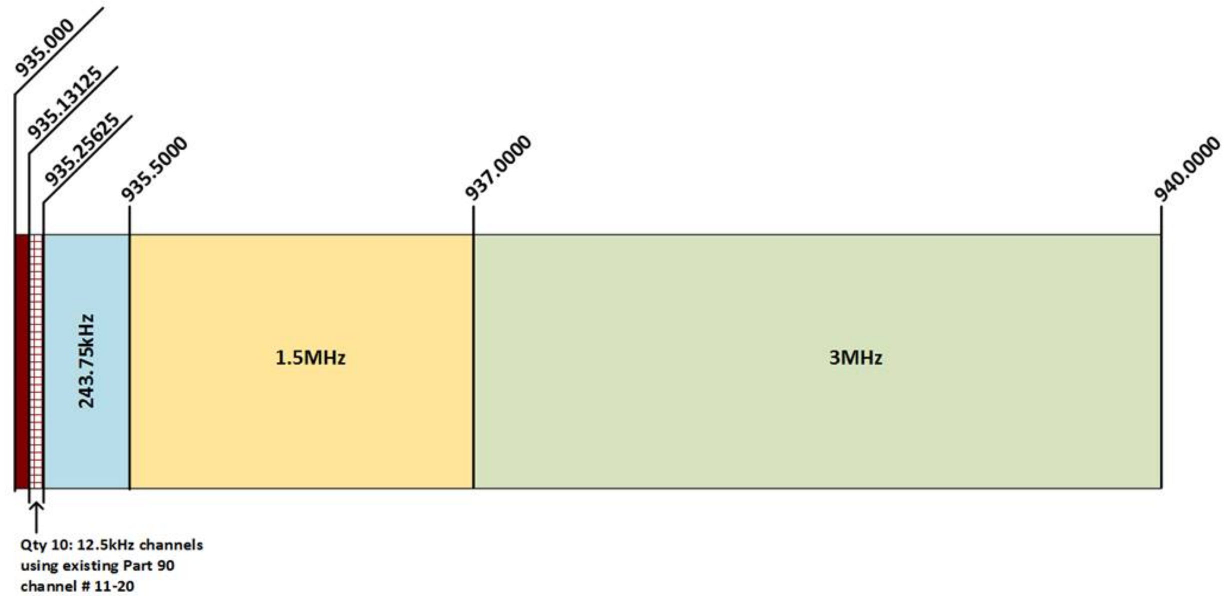
Example Of An Auction MTA (More Than 80 Channels Vacant)



- Incumbent license location with 55-mile circle (89.5-mi on western peak sites)

PDV site-specific licenses and all geographic licenses not included

ATTACHMENT 11


935.000
935.13125
935.25625
935.5000
937.0000
940.0000
243.75kHz
1.5MHz
3MHz
Qty 10: 12.5kHz channels
using existing Part 90
channel # 11-20

ATTACHMENT 12

TECHNICAL RULES

Prepared by:

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Introduction

The Commission requested comments on technical service rule changes or additions and other related matters that would be necessary to ensure that in-service and adjacent service systems could co-exist on a non-interfering basis[1]. EWA/PDV propose the following rules and approach to ensure that such systems can successfully be designed and operated.

Keep pace with changing technology

To ensure that the 896-901 MHz/935-940 MHz band (hereafter “900 MHz band”) can align and evolve with global and U.S. broadband standards and keep pace with technology innovation, it is paramount that the technical rules adopted in this proceeding enable Private Enterprise (“PE”), including Critical Infrastructure Industry (“CII”) entities to leverage the scale and availability of the full range of devices, applications and network architectures rooted in harmonized broadband standards now and into the future. Such action would bring the benefits of broadband to PE/CII communications networks to support their mission critical services. For example, a broadband network would provide capacity and data speed improvements over today’s narrowband networks. This access will, in turn, allow these businesses and their work crews instant access to critical information providing for more efficient operations thus allowing them to offer new applications and services and increasing their ability to serve the public while reducing costs. Moreover, a PEBB licensee can provide a network built to the exacting standards, reliability, coverage and access requirements demanded by these industries which cannot always be met by commercial networks. As the current rules do not provide for mobile broadband in the 900 MHz band, changes to the existing Part 90 rules for this band are required to bring all the described benefits to the PE/CII ecosystem.

As the Commission noted in its NOI, the ever-increasing demand for spectrum due to the exponential adoption and growth of devices and applications (e.g. smart devices and IoT) necessitates that the pace of wireless broadband technology also continues to change. Modernizing the Part 90 rules so that PE/CII users can reap the benefits of the broadband revolution sweeping the U.S. will bestow untold benefits to the public.

Ensure the band is used efficiently

[1] WT 17-200 ¶40 – Technical Rules

The Commission has been active in ensuring that commercial services have an opportunity to keep pace with ever changing technology. Most recently, the Commission demonstrated such vision in the Cellular Service Reform 2nd Report and Order (hereafter "CR 2nd RO").[2] In that proceeding, the Commission adopted a number of rule changes to ensure that the cellular service could continue to evolve from a site based command and control regulatory regime to flexible service rules where licensees could more easily modify their systems to keep up with the latest technology. Among other issues, the CR 2nd RO made strides to align the cellular service rules with technical and administrative rules across the many other broadband spectrum allocations and specifically addressed power reform and narrowband / broadband co-existence. The situation in the 900 MHz band is no different. That is, the 900 MHz band is suitable for updating to a more flexible framework for a broadband channel to provide the advanced data services that are expected today while also continuing to accommodate critical narrowband voice communications that PE/CII users require.

EWA/PDV applauds the Commission for taking steps to harmonize technical, operational and service rules across the many spectrum allocations which support broadband operations, including the cellular radio service. Recognizing that many of the same issues the Commission reconciled in the CR 2nd RO (e.g., potential interference from broadband to narrowband) would be present in a realigned 900 MHz band, EWA/PDV proposes that, to the extent possible, many of the rules adopted in that proceeding be applied to the 900 MHz band. Such action would ensure that PE/CII users can leverage supplier scale, cost, and device/applications synergies while keeping pace with U.S. and global technology change and evolution of the dynamic mobile broadband eco-system.

Rules that would be necessary

EWA/PDV submitted proposed technical and interference protection rule parameters and language as part of the RM-11738 proceeding.[3] Since that time, the Commission's Technological Advisory Council (TAC) has undertaken studies and convened working groups to further the means and procedures that promote the co-existence of broadband/narrowband systems. Additionally, the Commission adopted the CR 2nd RO which established harmonized technical service rules for broadband. These rules were established to ensure more efficient use of spectrum, harmonization of technical rules across all broadband allocations and to promote a shared responsibility to enable co-existence between broadband and narrowband operator systems and their subscribers. EWA/PDV observe that many of the parameters from the CR 2nd RO are relevant to this proceeding and propose that certain of those rules should be considered for adoption in the 900 MHz band technical and administrative rules. As detailed below, EWA/PDV propose the following modifications to its previously proposed rules. It does this after review of existing Commission broadband rules for other broadband allocations, extensive analysis and modeling, technical sessions with incumbent licensees, network and device OEM equipment suppliers, and *ex-parte* meetings with the FCC WTB and OET. The rules

[2] *See* Amendment of Parts 1 and 22 of the Commission's Rules with Regard to the Cellular Service, Including Changes in Licensing of Unserved Area, WT Docket No. 12-40, *Second Report and Order, Report and Order, and Second Further Notice of Proposed Rulemaking*, 32 FCC Rcd 2518 (2017).

[3] *See* Enterprise Wireless Alliance, Inc. and Pacific DataVision, Inc. *ex parte* Notice filed May 3, 2015.

proposed by EWA/PDV in this section will prevent both in-service band and adjacent service band interference. PDV and 3rd party modeling and lab testing have validated this position.

Physical and Technical Parameters

Building upon the commissions goal of harmonized and better use of spectrum for broadband, EWA/PDV propose that the following rules. Many of the proposed rules are from the aforementioned CR 2nd RO and we recommend that they be adopted and incorporated into subsequent technical service rules for the 900 MHz band.

(1) Broadband Fixed and Base Station power spectral density (PSD) in the 935-940 MHz band are limited as follows:
   (a) 400 W/MHz ERP in non-rural areas, and 800 W/MHz ERP in rural areas, both non-rural and rural have no power flux density (PFD) requirement.
   (b) Higher PSD limits. To ensure flexibility in the deployment of broadband service beyond the ERP limits outlined in (1)(a) that would limit coverage and potential inability to deliver broadband services, broadband operators would be allowed, with the PFD rules outlined in (1)(d) to deploy at PSD levels outlined in (1)(c). A five-year sunset timeframe would allow for the evolution and adoption of narrowband LMR technologies that enable operations adjacent to broadband systems without a PFD limit.
   (c) Higher Power Broadband rules: up to 1000 W/MHz ERP in non-rural areas, and up to 2000 W/MHz ERP in rural areas with a five-year PFD limit and an advance notification requirement.
   (d) Higher Power Broadband PFD limit of 3,000µW/m^2/MHz not to be exceeded over 98 percent of the served area within 1 km of the base station as measured 1.6 meters above ground.
   Note: PDV/EWA propose that the commission (OET) will determine the HAAT tables associated with these ERP limits.

(2) PEBB Control and Mobile Stations PSD operating in the 896-901 MHz band up to 10W ERP.

(3) PEBB Portable stations PSD operating in the 896-901MHZ band up to 3W ERP.

(4) PEBB Emission limitations.
   As codified in the CR 2nd RO, the measurement bandwidth for broadband emissions shall be specified in a 100 kHz measurement bandwidth. In RM-11738 EWA/PDV specified broadband emissions referenced to a 30 kHz measurement bandwidth. To conform with the recent FCC rules that establishes the 100 kHz standardized measurement bandwidth EWA/PDV converted its RM-11738 emission specifications from 30 kHz to 100 kHz. Thus, we now propose a limit of $50+10\log_{10}(P)$ dB in 100 kHz which was converted from the originally proposed $55+10\log_{10}(P)$ dB in 30 kHz.

   Proposed emission limits as follows:
   (a) For operations in the 898-901/937-940 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter

power (P) within the licensed band(s) of operation, measured in watts, by a factor not less than $50+10 \log_{10}$ (P) dB in a 100 kHz band segment, for base, fixed, mobile and portable stations.

(5) Peak to Average Power Ratio (PAR) Limit

(a) Power shall be measured on an average basis with a PAR limit of 13 dB.

(b) As specified in Section 22.913, the measurement of average power broadband operations in the 896-901/935-940MHz band must be made during a period of continuous transmission based on Commission-approved average power techniques.

(6) Field Strength Measurement

(a) As stipulated in §22.983 but referenced and aligned to the 900 MHz MTA licensing scheme, a licensee's predicted or measured median field strength limit must not exceed 40 dBµV/m at any given point along the SMR Metropolitan Trading Area (MTA) boundary of a neighboring licensee on the same channel block, unless the affected licensee of the neighboring MTA on the same channel block agrees to a different field strength. This also applies to MTA's partitioned pursuant to §22.948.

(b) Licensees shall be subject to all applicable provisions and requirements of treaties and other international agreements between the United States government and the governments of Canada and Mexico.

Adjacent area Co- Channel Interference

EWA/PDV propose that compliance with the proposed technical service rules outlined in this exhibit and the existing 40 dBµV/m field strength limit at the MTA boundary are sufficient to avoid interference between co-channel broadband licensees. Additionally, provisions that provide flexibility to alter this rule should be adopted to allow consenting adjacent licensees to reach mutual agreement on modifications.

Factors in the development of these technical rules

The orientation of the proposed EWA/PDV technical rules focused on harmonization, where possible, with rules in other broadband allocations. The proposed technical service rules outlined in this exhibit, in conjunction with continued adherence to applicable 3GPP specifications, provide flexibility to adapt to other technologies in the future as new advancements are developed.

Additional considerations for broadband / narrowband operational co-existence

In RM11738 EWA/PDV submitted protocols[4] that would provide an approach to allow system operators remediation procedures upon identification of external interference that caused disruption to their operations. EWA/PDV provided threshold values that would trigger remediation actions, upon verification via a series of analysis steps, as part of this protocol.

[4] RM11738, *§90.1421 – Interference Protection Rights*

EW/PDV propose that these procedures be adopted for WT 17-200, and also incorporate the updated threshold values stipulated in this language as follows:

Interference protection rights.

(a) *In General*. Harmful interference from a PEBB licensee to systems operating on frequencies in the 896-898/935-937 MHz band and to systems operating on frequencies in the 901-902/940-941 MHz band (pursuant to the provisions of subpart D of Part 24) will be deemed to occur when a transceiver at a site at which interference is encountered—

(1) Is in good repair and operating condition;

(2) Is receiving—

(i) A median desired signal strength of −98[5] dBm or higher if operating in the 896-898/935-937 MHz band, as measured at the R.F. input of the receiver of a mobile unit;

(ii) A median desired signal strength of –95[6] dBm if operating in the 896-898/935-937 MHz band, as measured at the R.F. input of the receiver of a portable station (hand-held device); or

(iii) A median desired signal strength of –95[7] dBm if operating in the 901-902/940-941 MHz band (pursuant to the provisions of subpart D of Part 24), as measured at the R.F. input of the receiver of a base station; and

(3) Is either—

(i) A voice transceiver—

(A) With manufacturer-published performance specifications for the receiver section of the transceiver equal to, or exceeding, the minimum standards set out in paragraph (b) of this section; and

(B) Receiving an undesired signal or signals which cause the measured Carrier to Noise plus Interference (C/(I+N)) ratio of the receiver section of such voice transceiver to be less than 17 dB if operating on frequencies in the 896-898/935-937 MHz band, or

(ii) A non-voice transceiver receiving an undesired signal or signals which cause the measured bit error rate (BER) (or some comparable specification) of the receiver section of such non-voice transceiver to be more than—

[5] Value changes from -88 to -98
[6] Value change from -85 to -95
[7] Value change from -85 to -95

(A) The value reasonably designated by the manufacturer for transceivers operating on frequencies in the 896-898/935-937 MHz band; or

(B) A bit error rate (BER) of 10^{-2} for systems operating on frequencies in the 901-902/940-941 MHz band (pursuant to the provisions of subpart D of Part 24);

except that, if the receiver section of the mobile or portable voice transceiver does not conform to the standards set out in paragraph (b) of this section, then such voice transceiver shall be deemed subject to harmful interference only at sites where the median desired signal satisfies the applicable threshold measured signal power specified in paragraph (a)(2)(i), paragraph (a)(2)(ii), or paragraph (a)(2)(iii) of this section after an upward adjustment to account for the difference in receiver section performance. The upward adjustment shall be equal to the increase in the desired signal required to restore the receiver section of the subject transceiver to the 17 dB C/(I+N) ratio specified in paragraph (a)(3)(i)(B) of this section. The adjusted threshold levels shall then define the minimum measured signal power(s), in lieu of the signal powers specified in paragraph (a)(2)(i), paragraph (a)(2)(ii), and paragraph (a)(2)(iii) of this section, at which the licensee using such non-compliant transceiver is entitled to interference protection.

(b) *Minimum Receiver Requirements*.—Voice transceivers capable of operating on frequencies in the 896-898/935-937 MHz band shall have the following minimum performance specifications in order for the system in which such transceivers are used to claim entitlement to full protection against harmful interference. Voice units intended for mobile or portable use in the 896-898/935-937 MHz band: 60 dB intermodulation rejection ratio; 60 dB adjacent channel rejection ratio; –116 dBm reference sensitivity.

(c) *Harmful Interference Claims; Mitigation Steps*.—(1) If there is a claim of harmful interference related to PEBB licensee equipment that is certified and operated in compliance with the emission limitations in paragraph (a) of this section, the claimant shall have the right to submit its complaint to a website to be established and maintained by PEBB licensees collectively. The complaint, at a minimum, shall include the following information:

(i) The coordinates, street address, county, and state of the location where the interference is experienced, and the time or times at which it occurred;

(ii) A description of the scope and severity of the issue, including the source, if known;

(iii) The affected party's call sign(s); and

(iv) A single point of contact for the complainant.

(2) If the PEBB licensee is responsible for causing any harmful interference, the PEBB licensee shall resolve such interference in the shortest time practicable. The PEBB licensee shall

provide all necessary test apparatus and technical personnel skilled in the operation of such equipment as may be necessary to determine the most appropriate means of timely eliminating the interference. However, the means whereby interference is abated or the cell parameters that may need to be adjusted is left to the discretion of the PEBB licensee, whose affirmative measures may include, but not be limited to, the following techniques:

(i) Increasing the desired power of the claimant's signal;

(ii) Decreasing the power of the signal generated by the PEBB licensee's equipment;

(iii) Modifying the height of antennas utilized by the PEBB licensee's system;

(iv) Modifying the characteristics of such antennas;

(v) Incorporating filters into the PEBB licensee's transmission equipment; and

(vi) Supplying interference-resistant receivers to the claimant.

(3) If the technique described in paragraph (b)(2)(vi) is used, then, in all circumstances, the PEBB licensee shall be responsible for all costs thereof.

(4) Whenever short-term interference abatement measures prove inadequate, the incumbent licensee shall, consistent with but not compromising safety, make all necessary concessions to accepting interference until a longer-term remedy can be implemented.