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July 12, 2019

VIA ELECTRONIC FILING

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: ***Ex Parte Notification***

GN Docket No. 18-122, *Expanding Flexible Use of the 3.7 GHz to 4.2 GHz Band*

Dear Ms. Dortch:

On July 10, 2019, John Hunter and the undersigned of T-Mobile USA, Inc. ("T-Mobile");[1/] Gregory Rosston, the Gordon Cain Senior Fellow at the Stanford Institute for Economic Policy Research and Director of the Public Policy Program at Stanford University; Andrzej Skrzypacz, the Theodore J. Kreps Professor of Economics, Stanford Graduate School of Business (by telephone); and Russell Fox of Mintz met with Anna Gentry, Kamran Etemad, Thomas Derenge, Jeffrey Tignor, and Matthew Pearl of the Wireless Telecommunications Bureau; Giulia McHenry, Patrick DeGraba, Margaret Wiener, Evan Kwerel, Craig Bomberger, and Joseph Calascione of the Office of Economics and Analytics; Michael Ha, Robert Pavlak, and Barbara Pavon of the Office of Engineering and Technology; Jose Albuquerque and Kerry Murray of the International Bureau; Max Staloff of the Office of General Counsel; and by telephone with Becky Schwartz, Peter Daronco, Paul Powell, Deborah Broderson, Brian Wondrack, and Ira Keltz.

We pointed out that there is widespread agreement on the record that mid-band spectrum is needed for Fifth Generation ("5G") services and that the C-Band Alliance's ("CBA") proposal to make available only 180 megahertz of spectrum in the 3.7-4.2 GHz band ("C-band") is inadequate to meet those requirements and promote a competitive environment.[2/] A number of parties have proposed means to make more spectrum available, including, for example, by

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1/ T-Mobile USA, Inc. is a wholly-owned subsidiary of T-Mobile US, Inc., a publicly traded company.

2/ *See* Letter from Bill Tolpegin, Chief Executive Officer, C-Band Alliance, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122, (filed June 12, 2019) ("CBA *Ex Parte* Letter"); Auctionomics, *White Paper – FUEL for 5G: Flexible Use and Efficient Licensing* (June 12, 2019) ("FUEL White Paper"), *attached to* CBA *Ex Parte* Letter.

auctioning more C-band spectrum for 5G services using traditional Commission procedures.[3/] There is also widespread support for an FCC-run auction.[4/] Bidders know and understand the rules, policies, and practices the Commission has developed over more than twenty years of conducting spectrum auctions. These rules, policies, and practices are not easily replicated and offer full transparency, including for any payment terms. There is increasing support that band clearing can be achieved by deployment of alternative transmission mechanisms, such as fiber, that can also be used to help bridge the digital divide and that the transition of the band for terrestrial use should be the focus of this proceeding rather than efforts to preserve existing operations in the C-band.[5/]

As detailed further below, during the meeting, we discussed why the CBA's proposed Flexible Use and Efficient Licensing ("FUEL") auction design is unnecessary, has significant complications, and should be rejected. Contrary to its claims, the CBA's proposal would (i) not provide a sufficient amount of spectrum for 5G services in a timely manner; (ii) involve a complex auction process that would create opportunities for predatory bidding and deter participation; (iii) place control of, and direct the financial gains from, terrestrial use of the C-band in the hands of only a few satellite operators; (iv) supposedly address issues that do not exist such as the "exposure problem"; and (v) exclude other critically important stakeholders from the process, such as earth station registrants and U.S. taxpayers.

In addition, we discussed T-Mobile's incentive auction proposal to make up to 500 megahertz of spectrum available for high-value terrestrial use. We provided further details on each step of the process,[6/] including a forward auction to determine the quantity of C-band spectrum desired by terrestrial providers and the price they are willing to pay; a reverse auction to determine if satellite operators and earth station registrants accept that price, plus a payment to the U.S. Treasury; and post-auction satisfaction of the communications requirements now satisfied by satellite operators. We described how an incentive auction would provide an efficient, market-

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3/ *See* Letter from Ross Lieberman, Senior Vice President, Government Affairs, ACA Connects – America's Communications Association, *et al.*, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 (filed July 2, 2019) ("ACA/CCA/Charter *Ex Parte* Letter").

4/ *See, e.g.*, Comments of ACA Connects – America's Communications Association, GN Docket No. 18-122, at 9-11 (filed July 3, 2019); Comments of Charter Communications, Inc., GN Docket No. 18-122, at 1-2 (filed July 3, 2019); Comments of the Open Technology Institute at New America, GN Docket No. 18-122, at 14-17 (filed July 3, 2019); *see also* Comments of Competitive Carriers Association, GN Docket No. 18-122 (filed July 3, 2019).

5/ *See, e.g.*, Letter from Pantelis Michalopoulos and Georgios Leris, Steptoe & Johnson LLP, Counsel to ACA Connects – America's Communications Association, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 (filed July 9, 2019) ("ACA *Ex Parte* Letter"); ACA/CCA/Charter *Ex Parte* Letter at 3; Letter from Jason E. Rademacher and Christina Burrow, Cooley, Counsel for the Church of Jesus Christ of Latter-day Saints, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 (filed July 9, 2019) ("LDS *Ex Parte* Letter").

6/ *See* Letter from Steve B. Sharkey, Vice President, Government Affairs, Technology and Engineering Policy, T-Mobile USA, Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122 (filed Feb. 15, 2019) ("T-Mobile Feb. 15 *Ex Parte* Letter").

based mechanism for licensing terrestrial wireless operations in the C-band and would promote the public interest by:

- converting up to 500 megahertz of C-band spectrum for terrestrial services, including 5G wireless networks;
- Using an open, transparent, and market-based process to select new licensees for the spectrum, consistent with the Communications Act (the "Act");
- Returning value to U.S. taxpayers upon the conversion of the spectrum for terrestrial use;
- Taking into consideration the rights of both incumbent satellite space station operators and earth station operators, including accommodating their operations post-auction; and
- Offering the opportunity to expand fiber into currently unserved or underserved areas, potentially closing the digital divide and providing new economic opportunities in those locations.

The CBA's FUEL Proposal Should Be Rejected

In proposing its auction mechanism, the CBA continues its attempt to divert attention from the main point – the C-band can and should be converted for terrestrial use to the maximum extent feasible and as quickly as possible based on market demand. Any plan that merely preserves the current delivery structure while rewarding incumbents for selling excess capacity and forgoes the opportunity to modernize the communications infrastructure in the U.S. is a waste of resources and a missed opportunity. T-Mobile has demonstrated, and others agree, that there are more efficient alternative transmission mechanisms to support traffic now carried by C-band satellites. And deployment of any additional fiber needed to meet current needs will have the significant added benefit of bringing broadband to areas where it does not exist today. Accordingly, the CBA's premise of merely selling excess spectrum without taking advantage of alternative delivery mechanisms misses the mark. But even beyond the fundamental flaws of the CBA's approach, the auction structure it proposes does not live up to the CBA's promises.

Speed. The CBA argues that its proposal would bring C-band spectrum to market for wireless use more quickly than any other auction.[7/] But its claims regarding speed are overstated and come at the expense of stranding most of the spectrum for inefficient use, contrary to the specific mandate of the Communications Act to manage the electromagnetic spectrum in the public interest. Other proposals, including T-Mobile's, will take no longer to implement overall and will result in much more spectrum being made available for terrestrial use. Even if the Commission implemented the CBA's proposed plan, the CBA would make only 60 megahertz of spectrum available within 18 months of a final FCC Order[8/] – a far cry from the amount of spectrum that is needed for 5G deployment. While the CBA's proposal, if implemented, would eventually make available 180 megahertz of C-band spectrum within 36 months of a final FCC order, that amount is far less than the amount required for competitive 5G deployments and far less than the full 500 megahertz of C-band spectrum that could be made available through other mechanisms, including by relocating services to alternative transport mechanisms, such as fiber. The CBA plan would strand 320 megahertz of spectrum in inefficient use. The record in this

7/ *See* CBA *Ex Parte* Letter at 1.

8/ *See* FUEL White Paper at 5.

proceeding is clear that hundreds of megahertz of C-band spectrum are necessary to satisfy the demand for spectrum for 5G services.[9/] Anything less would negate the benefit of getting a small fraction of this spectrum to market quickly.

Simplicity. The CBA contends that its sealed-bid, "Vickrey-nearest core-selecting" combinatorial auction with a two-round bidding process is "dramatically simpler" than traditional processes.[10/] But a sealed-bid, "Vickrey-nearest core-selecting" combinatorial auction, which the CBA has dubbed FUEL, has never before been conducted for U.S. spectrum resources. The CBA's novel approach is not only unnecessary, but also untested, and it could create confusion for those who are unfamiliar with the process, particularly given the scope of the potential bidding options. It is also likely to create new strategic problems that are not present in standard designs, like clock auctions.[11/] As CBA acknowledges, a bidder under its proposed FUEL auction design could possibly bid on 10^{406} packages, which is "vastly more than any bidder can realistically evaluate and consider individually."[12/] Indeed, one-shot combinatorial auctions are often viewed as impractical for real-world applications because they require bidders to submit bids for an extremely large number of possible packages of items.[13/]

The better approach would be to use an auction format that has been shown to work and is familiar to bidders, such as a traditional clock auction. Because many potential FCC auction participants are already familiar with the clock auction format, they would be more comfortable conveying their spectrum needs and therefore allow for more meaningful participation in an auction of C-band spectrum. Moreover, as the Commission has recognized, a dynamic procedure such as a clock auction would provide bidders with the flexibility to bid throughout the auction, rather than require bidders to specify an exact bid at the beginning of the auction, which may make participation simpler.[14/]

9/ *See* Letter from Steve B. Sharkey, Vice President, Government Affairs, Technology and Engineering Policy, T-Mobile, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122, at 2 (filed June 21, 2019) ("T-Mobile June 21 *Ex Parte* Letter"); *see also* FUEL White Paper at 3 (recognizing that "[r]epurposing a significant amount of C-Band spectrum is a vital part" to securing U.S. leadership in 5G and other advanced services).

10/ *See* FUEL White Paper at 4.

11/ For example, as Ausubel and Milgrom describe the following problem of combinatorial auctions with Vickrey pricing: "Budget constraints are serious. If budget limits applied to bids, then, as we showed, they can destroy the dominant strategy property even when there is no chance that the price charged will exceed the bidder's budget." *See* Lawrence M. Ausubel and Paul Milgrom, *The Lovely but Lonely Vickrey Auction*, Combinatorial Auctions, 2006, edited by Peter Cramton, Yoav Shoham, and Richard Steinberg, 17-40.

12/ *See* FUEL White Paper at 7.

13/ *See* Jonathan Levin and Andrzej Skrzypacz, *Properties of the Combinatorial Clock Auction*, American Economic Review, Sept. 2016 106(9), 2528 ("Levin and Skrzypacz").

14/ *See Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Notice of Proposed Rulemaking, 27 FCC Rcd 12357, ¶ 40 (2012).

Auction Process and Participation. The CBA claims that its proposed auction will encourage the greatest range of participants.[15/] However, the CBA proposal would do just the opposite. Contrary to its assertion, the CBA would place control of valuable spectrum resources in the hands of only a few satellite operators, allowing them to work together as a consortium that would effectively serve as a monopoly. Their proposal leaves out other important stakeholders including earth station operators and American taxpayers. The CBA's proposal would give satellite operators carte blanche to decide how much spectrum to sell and at what price. Moreover, either because of strategic bidding or because of the "core adjustment" rule, the CBA's proposal could require bidders to pay amounts different than the "second price" that is envisioned under truthful bidding and Vickrey pricing, resulting in arbitrary prices and an inefficient allocation. Finally, because the CBA's proposal includes the "second price" rule, bidders would likely end up paying disparate prices for the same amount of spectrum.[16/]

The CBA also asserts that its proposed auction will allow successful participation by entities of every size and allow bidders flexibility in the packages on which they wish to bid.[17/] However, package bidding coupled with Vickrey pricing creates complexity that would discourage participation from smaller bidders. In particular, it can create situations where there is considerable ambiguity about the prices a bidder faces at any point in the auction, requiring a high level of bidder sophistication that many smaller bidders do not have or have the resources to acquire.[18/] The proposed FUEL auction design would also create opportunities for predatory bidding by enabling larger entities to bid on areas in which they have little interest in order to block other bidders or to increase their payments.[19/] As others have noted,[20/] the FUEL auction design is particularly problematic for smaller carriers because smaller carriers have well-defined and easily identifiable footprints that could reveal their identities during the coordination round, further allowing larger entities to engage in strategic bidding and anticompetitive behavior.

Efficiency. The CBA asserts that its proposal will improve efficiency by avoiding the "exposure problem" associated with the Commission's traditional auction designs.[21/] The CBA claims that its proposal "precludes the possibility that a bidder might win too little spectrum in an area for a viable network, or too few areas for a viable business plan."[22/] The CBA, however, is attempting to solve a problem that does not exist or is limited in comparison to the strategic and complexity issues that the FUEL design would bring. In fact, the best solution to the "exposure problem" is

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15/ *See* CBA *Ex Parte* Letter at 2.

16/ This has been observed in several combinatorial spectrum auctions with the "second price" rule. *See* Levin and Skrzypacz at 2550 n.26 (noting, for example that Telus paid roughly twice the amount that Bell Canada paid for roughly similar amounts of spectrum in the Canadian 700 MHz auction).

17/ *See* CBA *Ex Parte* Letter at 2.

18/ *See* Levin and Skrzypacz at 2550.

19/ *See id.* at 2549.

20/ *See* Letter from Edward D. Moise, Jr., Principal, Moise Advisory, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122, at 2-3 (filed July 1, 2019).

21/ *See* CBA *Ex Parte* Letter at 2; FUEL White Paper at 2.

22/ *See* FUEL White Paper at 4.

not complex. In contrast to a satellite-run, non-transparent, and untested auction for only 180 megahertz of spectrum, making 500 megahertz of spectrum available in an FCC-led auction will limit the chance of stranding bidders and therefore better reduce or eliminate the exposure risk.

Fairness. Despite the claims that its proposal is fair, the CBA would exclude earth station operators from the process. As T-Mobile has explained, the ability of terrestrial licensees to use the C-band will depend on the need to protect earth station operations, not space-to-earth transmissions.[23/] It is therefore vital that earth station operators are included in any proposal to clear the C-band. Excluding earth station operators would not only fail to adequately address the needs of and compensate a critical component of the satellite ecosystem, but it would also likely result in legal disputes that would only further delay terrestrial use of the C-band.

Additionally, the CBA's proposal would provide no benefit to U.S. taxpayers, despite the fact that the U.S. government – not the CBA – owns the highly valuable terrestrial rights the CBA proposes to sell. The CBA's proposal would offer no payments to the U.S. Treasury or result in additional fiber builds that could facilitate the deployment of advanced services in unserved or underserved areas.[24/] Instead, the CBA proposal would direct control and all financial gains related to terrestrial use of the C-band to the satellite operators, undermining the very principles of fairness that the CBA proposal purports to uphold.

A C-Band Incentive Auction is Simpler and Superior to the CBA Approach

As noted above and previously explained by T-Mobile,[25/] a C-band incentive auction is one option that would use a simple and tested approach to licensing terrestrial wireless operations in the C-band and would offer many advantages over the CBA proposal. As discussed in further detail below, an incentive auction process would rely on calculations and mechanisms the Commission has already employed and can be modified as appropriate to accommodate all C-band interests.

Forward Auction

Reserve Prices

A C-band incentive auction would begin with a forward auction among potential wireless broadband licensees for all 500 megahertz of C-band spectrum in each Partial Economic Area

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23/ *See* Comments of T-Mobile USA, Inc., GN Docket No. 18-122 *et al.*, at 4 (filed July 3, 2019); Letter from Russell H. Fox, Mintz, Counsel to T-Mobile USA, Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122, at 8 (filed Apr. 11, 2019) ("T-Mobile Apr. 11 *Ex Parte* Letter"); Letter from Russell H. Fox, Mintz, Counsel to T-Mobile USA, Inc., to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122, at 6 (filed Mar. 19, 2019) ("T-Mobile Mar. 19 *Ex Parte* Letter"); T-Mobile Feb. 15 *Ex Parte* Letter at 4.

24/ *See* T-Mobile Feb. 15 *Ex Parte* Letter at 6-7, 8.

25/ *See generally id.*

("PEA").[26/] One of the steps the Commission would be required to take before the forward auction is to establish a reserve price – the minimum price below which a license would not be sold in the forward auction[27/] – for the generic licenses offered in each PEA.[28/] The function of the reserve price would be to ensure that all earth station registrants receive appropriate compensation and that a portion of the auction proceeds are allocated to the U.S. Treasury for the benefit of American taxpayers.

If the reserve price is *not* met in a PEA or *is* met in a PEA, *but*, as discussed in further detail below, neither satellite operators nor earth station registrants meet the threshold to accept the offered purchase price in the reverse auction, the Commission would reduce the clearing target (*i.e.*, the amount of spectrum offered) in that PEA and conduct another round of the forward auction at the lower clearing target.[29/]

Setting the Reserve Price. The reserve price for a PEA would be 120 percent of the estimated MHz-pop cost of relocating 100 percent of the earth station registrants covering the PEA to an alternative geographic area or to alternative transmission media, such as fiber.[30/] The Commission could use the estimated maximum of $1.4 billion in relocation costs determined by Roberson and Associates, LLC[31/] as a base or establish a mechanism by which incumbents could provide their estimated relocation costs to the Commission prior to the auction, as it has in past

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[26/] While this letter discusses conducting a C-band incentive auction on a PEA basis, the Commission could also conduct a C-band incentive auction on an Economic Area or Regional Economic Area Grouping ("REAG")-basis to accommodate earth station registrants that cover more than one PEA. Indeed, the Commission may wish to conduct a reverse auction on an REAG basis and a forward auction using smaller geographic areas.

[27/] *See* 47 C.F.R. § 1.2104(c).

[28/] As T-Mobile has explained, after the auction is complete, the Commission would conduct an assignment round to assign specific frequencies. *See* T-Mobile Feb. 15 *Ex Parte* Letter at 3 n.6.

[29/] However, as T-Mobile has suggested, the Commission should set a minimum level of spectrum, such as 300 megahertz, for which it will conduct only a forward auction. *See id*.

[30/] As discussed further below, relocation costs could include the hard and soft costs (*e.g.*, operating costs) of relocating earth stations to alternative locations or for leasing fiber for a specified period of time. Consistent with Commission precedent, incumbents would be compensated only for any *increased* recurring costs for that specified period of time – *i.e.*, the difference between an incumbent's current costs and the costs it would incur to continue operating using alternative facilities. *See Amendment of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems,* Ninth Report and Order, 21 FCC Rcd 4473, ¶ 81 n.291 (2006); 47 C.F.R. § 27.1251(c)(3) ("Operating costs are the cost to operate and maintain the BRS system. AWS licensees would compensate BRS licensees for any increased recurring costs associated with the replacement facilities (*e.g.*, additional rental payments, and increased utility fees) for five years after relocation."). As also discussed further below, an earth station registrant that relocates its operations to a new geographic area could operate in any new location provided that any conditions imposed by the Commission related to the relocation are satisfied. *See infra* note 45.

[31/] *See* Attachment at 23-24.

auctions.[32/] The Commission could set aside some percentage (*e.g.*, 10 percent) of the estimated relocation costs for the U.S. Treasury.[33/] Thus, in a simple example, if there are 100 earth stations in a PEA, and the estimated cost to relocate an earth station is $100,000 (based on one of the methodologies described above), then the reserve price for that PEA would be $10,000,000 ($100,000 x 100) plus a 20 percent margin ($100,000,000 x .20) for a total reserve price of $12,000,000. Of that amount, $1,000,000 ($10,000,000 x .10) could be set aside to cover costs above the estimated relocation costs and $1,000,000 ($10,000,000 x .10) could be set aside for payments to the U.S. Treasury.

Reverse Auction

Bidding and Acceptance Thresholds

As discussed in further detail below, forward auction proceeds would be offered to the incumbent satellite operators in the form of a purchase price and simultaneously to earth station operators in the form of a minimum purchase price up to a certain maximum amount after the payment of relocation expenses. Each reverse auction participant would indicate to the Commission whether it would accept the offered purchase price.[34/]

Bidding. Each bid by a reverse auction participant could be counted with each bid carrying equal weight. So, for example, each separate earth station registrant in a PEA could have one bid, regardless of the population covered by the registered earth station. And each satellite operator could have one bid. Alternatively, as discussed further below, earth station registrants'

32/ *See, e.g., Auction of Advanced Wireless Services Licenses Scheduled for November 13, 2014; Comment Sought on Competitive Bidding Procedures for Auction 97*, Public Notice, 29 FCC Rcd 5217, ¶ 8 (2014) ("The [Commercial Spectrum Enhancement Act] requires the NTIA to notify the Commission at least six months in advance of a scheduled auction of eligible frequencies of eligible Federal entities' estimated relocation or sharing costs and the timelines for such relocation or sharing."); *Auction of Advanced Wireless Services Licenses Scheduled for November 13, 2014; Comment Sought on Competitive Bidding Procedures for Auction 97*, Public Notice, 25 FCC Rcd 13874, n.160 (2010) ("Under the reimbursement plan we are adopting, future AWS entrants may have to satisfy their reimbursement obligation as early as 30 days after grant of their long form application. The amount owed should be known prior to auction, so AWS applicants can take this into account when they file applications and bid for licenses.").

33/ Allocating a certain percentage of the estimated relocation costs for the U.S. Treasury ensures that the public will receive some payment if the forward auction proceeds *equal* the reserve price. The Commission could also set aside some percentage of the forward auction proceeds for the U.S. Treasury if those proceeds *exceed* the reserve price.

34/ *See* T-Mobile Apr. 11 *Ex Parte* Letter at 8 (explaining that the key decision for earth station operators would be to either relinquish authorizations in exchange for an incentive payment or elect to receive modified licenses).

bids could be weighted based on the population covered by the earth station's authorized protection zone in the area or another criteria.[35/]

Acceptance. For each group of reverse auction participants, *i.e.*, satellite operators or earth station registrants, a critical percentage of bids to accept would be necessary to declare the offer accepted by that group for the PEA. For satellite operators, the percentage would be 100. For earth station registrants, the percentage of bids to accept the offered purchase price necessary to declare the offer accepted would be 51. Therefore, if earth station registrants' bids are unweighted, earth station registrants would be deemed to have accepted the offer as a group if 51 percent of the earth station registrants covering a PEA bid to accept the minimum offered purchase price. If earth station registrants' bids are weighted, earth station registrants would be deemed to have accepted the offer as a group if the earth station registrants covering 51 percent or more of the population or other metric bid to accept the minimum offered purchase price.

Calculation of Offered Purchase Price

Satellite Operators. Because each satellite operator covers 100 percent of every PEA, each would be considered to cover the entire population of a PEA. The Commission could therefore establish the offered purchase price for each satellite operator by dividing the forward auction proceeds equally among the satellite operators, less any percentage reserved for the U.S. Treasury. Alternatively, the Commission could base the allocation of the forward auction proceeds on the number of satellites operated, number of transponders in operation, or number of earth stations served in a PEA, or utilize another metric.[36/]

To illustrate how the offered purchase price would be calculated for each individual satellite operator using a simple example, assume that there are 10 satellite operators covering a PEA and the forward auction results in proceeds of $200,000,000 for that PEA. Of the $200,000,000, $1,000,000 (*i.e.*, 10 percent of the total estimated relocation costs) would be set aside for the U.S. Treasury and $199,000,000 ($200,000,000 - $1,000,000 = $199,000,000) would be allocated among the satellite operators. If the Commission determined to divide the forward auction proceeds equally, then each satellite operator would be offered a purchase price of $19,900,000 ($199,000,000/ 10 = $19,900,000) to clear the band.

Earth Station Registrants. Because earth station registrants may cover differing percentages of the population in a PEA, forward auction proceeds, after payment of relocation expenses, could be allocated among earth station registrants based on their population coverage in a PEA using the Commission's two-by-two kilometer grid cell methodology.[37/] For instance, if one earth

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35/ The Commission need not consider weighting the bids of satellite operators because, as explained below, the percentage of bids to accept the offered purchase price necessary to declare the offer accepted would be 100.

36/ *See, e.g.*, Letter from Scott Blake Harris, Counsel to the Small Satellite Operators, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122, at Attachment (filed Dec. 18, 2018) (proposing a distribution-and-scoring model to distribute proceeds).

37/ Under this approach, the Commission would superimpose a grid made up of two-by-two kilometer cells on a map of each PEA, sum up the population of each grid cell included within a PEA's

station registrant's protection zone covers 20 percent of the population in a PEA and another earth station registrant's protection zone covers the remaining 80 percent of the population in a PEA, the first earth station registrant would be allocated 20 percent of the forward auction proceeds after the payment of relocation expenses in the PEA, and the second earth station registrant would be allocated 80 percent of the forward auction proceeds after the payment of relocation expenses in the PEA. While the Commission could base the allocation among earth station registrants on an alternative metric, a population-based metric would be equitable and easily administered. Thus, the Commission should consider using a population-based metric as the default.

If the protection zones of earth station registrants overlap in a particular PEA, the Commission would allocate the incentive pool based on a *pro rata* share of the proceeds attributable to their covered grid cells. For example, if two earth station registrants are the only two earth station registrants with protection zones covering a grid cell, then each earth station registrant would receive one-half of the incentive pool allotted to that grid cell. Similarly, if three earth station registrants have authorizations in the same grid cell, each earth station registrant would receive one-third of the incentive pool allotted to that grid cell.

Unlike satellite operators, the amount of forward auction proceeds received by an individual earth station registrant from the incentive pool (*i.e.*, after the payment of relocation expenses) would vary depending on the decisions of other earth station registrants in the same area. This is because, as discussed above, the threshold percentage necessary to declare an offer accepted by the earth station registrants could be less than 100 percent. The greater the earth station registrants that bid *not* to accept the offered purchase price, the higher the payment will be for those that bid to accept the offered purchase price. Accordingly, the Commission would offer each earth station registrant a minimum purchase price – which would be based on 100 percent of the earth station registrants committing to relinquish their spectrum usage rights – up to a maximum purchase price – which would be based on only 51 percent of the earth station registrants (or 51 percent of earth station registrants representing some alternative metric) committing to relinquish their spectrum usage rights. An earth station registrant that bids to accept the minimum offered purchase price would be guaranteed the minimum offered purchase price up to the maximum offered purchased price as an incentive payment in return for relinquishing its spectrum usage rights. An earth station registrant that bid *not* to accept the minimum offered purchase price would receive only its actual relocation costs and no percentage of the incentive payment.

To illustrate how the minimum and maximum offered purchase price would be calculated for each individual earth station registrant using a simple example, assume that there are 100 earth station registrants covering a PEA – with each earth station registrant covering an equal percentage of the population in the PEA – and that the forward auction results in proceeds of

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geographic area, and offer forward auction proceeds, after the payment of relocation expenses, based on the population covered by each incumbent. *See Broadcast Incentive Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, Public Notice, 30 FCC Rcd 8975, ¶ 20 (2015); *Notice of Initial 39 GHz Reconfiguration Procedures et al.*, Public Notice, 34 FCC Rcd 1386, ¶¶ 21, 22 (2019).

$200,000,000 for that PEA. Based on estimated relocation costs of $100,000 per earth station registrant, $1,000,000 (*i.e.*, 10 percent of the total estimated relocation costs) of the $200,000,000 would be set aside for the U.S. Treasury. Of the remaining $199,000,000, the estimated relocation costs of $10,000,000 plus the 10 percent buffer of $1,000,000, for a total of $11,000,000, would be set aside to cover the actual relocation costs of 100 percent of the earth station registrants, leaving $188,000,000 to be allocated as an incentive payment. Of the $188,000,000, an earth station registrant that committed to relinquishing its spectrum usage rights could receive a minimum incentive payment of $1,880,000 up to a maximum of $3,686,275. This is because if 100 percent of the earth station registrants committed to relinquishing their spectrum usage rights, each would receive $1,880,000 ($188,000,000 / 100 = $1,880,000). On the other hand, if only 51 percent of the earth station registrants committed to relinquishing their spectrum usage rights, each of those 51 earth station registrants would receive $3,686,275 ($188,000,000 / 51 = $3,686,275). Post-auction, *all* earth station registrants would receive funds to cover their actual relocation costs.[38/] In the event that actual relocation costs are less than the estimated relocation costs, the difference between the two amounts could be set aside for the U.S. Treasury. Those that bid to accept the minimum offered purchase price would also be provided with an incentive payment, the amount of which would be guaranteed to be in between the minimum and maximum purchase price offered.

Potential Outcomes

As T-Mobile has explained,[39/] offering the purchase price to both groups of incumbents could result in one of the four possible outcomes discussed below. Once satellite operators and/or earth station registrants agree to clear all areas,[40/] the auction proceeds would be provided to the winning bidders, subject to whatever portion of the proceeds the Commission retains for the benefit of American taxpayers and any relocation costs necessary for the areas in which the earth station registrants were the winning bidders.

Satellite Operators Accept the Offered Purchase Price. If the satellite operators meet the threshold to accept the offered purchase price for an area, but the earth station registrants do not, the auction would end for that area. The satellite operators would receive the purchase price and clear the band in the area for terrestrial use. Because satellite operators would be responsible for clearing earth station registrants (by paying to relocate earth station registrants to areas that satisfy Commission-imposed guidelines or using fiber),[41/] satellite operators would receive 100

38/ Winning forward auction bidders would be required to deposit those funds into an account (administered by a private transition administrator if the Commission lacks the authority to establish the fund itself) that would disperse the proceeds to earth station registrants.

39/ *See* T-Mobile Feb. 15 *Ex Parte* Letter at 3.

40/ As T-Mobile previously observed, if the satellite operators are the winning bidders in an area, they could determine among themselves how to divide the total proceeds consistent with a consortium agreement or, in case they do not form an agreement, according to a default sharing rule established by the Commission. *See id.*

41/ While satellite operators would be financially responsible for clearing earth station registrants, earth station registrants would remain responsible for complying with the Commission's relocation requirements discussed below.

percent of the forward auction proceeds, minus any percentage designated by the Commission for deposit to the U.S. Treasury.[42/]

Earth Station Registrants Accept the Minimum Offered Purchase Price. If the earth station registrants meet the threshold to accept the minimum offered purchase price for an area, but the satellite operators do not, the auction would end for that area. The earth station registrants that bid to accept the offer would receive their actual relocation costs plus an incentive payment and clear the band in the area for terrestrial use. If the earth station registrants meet the threshold, but less than 100 percent of the earth station registrants bid to accept the minimum offered purchase price, then the forward auction proceeds (less any percentage reserved for the U.S. Treasury and the cost of relocating earth stations) would be divided among the earth station registrants that bid to accept the minimum offered purchase price as discussed above. The earth station registrants that bid *not* to accept the minimum offered purchase price would receive actual relocation costs only.

T-Mobile recognizes that if the Commission utilizes PEAs in the reverse auction, it is possible that earth station registrants' protection zones could cover multiple PEAs. In the event that the acceptance threshold for a PEA is met and the protection zone of an earth station registrant that bid to accept the offer covers one or more adjacent PEAs but the acceptance threshold in the adjacent PEA(s) is not met: (i) the earth station registrant that bid to accept the offer would receive an incentive payment based on the population cleared in *all* PEAs at the per MHz-pop price of the cleared PEA; and (ii) the population covered by the earth station registrant in the remaining PEA(s) would be removed from the MHz-pop calculation of the purchase price for the lower clearing target in remaining PEA(s) by virtue of shutting down that earth station at the price set in the cleared geographic area. While this approach may reduce the minimum purchase price offered to incumbents in any remaining PEA, the earth station registrant would not be permitted to bid in that PEA (because it has already agreed to clear the adjacent PEA), which could result in a higher incentive payment per incumbent. As noted above, the Commission could reduce substantially the instances of multiple PEA coverage by conducting the reverse auction on a REAG-basis.

Both Satellite Operators *and* Earth Station Registrants Accept the Offered Purchase Price. If the threshold to accept the offered purchase price for an area is met by *both* the satellite operators and the earth station registrants, the purchase price would be reduced for that area until only one group meets the threshold to accept the offer. The Commission could initiate the process by first randomly selecting one of the groups and reducing its offer by a small percentage – T-Mobile suggests 2.5 percent. If the group meets the threshold to accept the reduced offer, the Commission could then reduce the offer for the *other* group by a larger percentage – T-Mobile suggests 5 percent. Under this approach, the purchase price offered to a particular group would be 5 percent lower than the purchase price previously offered to that group, but only 2.5 percent lower than the offer to the other group. The Commission would continue offering a reduced purchase price to each group in an alternating fashion until only one group meets the threshold to

[42/] The Commission should hold the satellite operators' proceeds in escrow until all earth station registrants' relocation claims have been paid.

accept the offer. Once that occurs, the auction would end for that area, and the winning group would receive the purchase price and clear the band in the area for terrestrial use.

Neither Satellite Operators *nor* Earth Station Registrants Accept the Offered Purchase Price. If neither the satellite operators nor the earth station registrants meet the threshold to accept the offered purchase price for an area, the forward auction would resume at a lower clearing target, such as 400 megahertz instead of 500 megahertz (or some other appropriate decrement),[43/] for that area. The two groups would then bid on the resulting offer for the reduced clearing target in the area as before.

Post-Incentive Auction

As outlined above, if the earth station registrants meet the threshold to accept the offer for an area, but the satellite operators do not, the auction would end for that area and the band would be cleared. If the band is cleared but less than 100 percent of the earth station registrants bid to accept the offer (*i.e.*, somewhere between 51 percent and 100 percent of the earth station registrants bid to accept the offer), the remaining earth station registrants would be provided with relocation costs that would allow them to relocate their operations.[44/] In order to ensure that earth station registrants do not impede terrestrial operations, while still providing earth station registrants with the flexibility to relocate, the Commission could allow earth station registrants to operate in *any* new location provided that certain conditions are met.[45/]

[43/] Because satellite transponder bandwidth is 36 megahertz, a 40- or 50-megahertz (the transponder bandwidth plus a potential guard band) decrement could be used to reduce the clearing target.

[44/] *See also* Letter from Henry Gola, Counsel for the C-Band Alliance, to Ms. Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-122, Attachment A at 14 (filed Apr. 3, 2019) (recognizing that relocation will be an easy process as frequency changes "are a standard part of earth station operations and generally require little effort or technical expertise"). Because terrestrial operations could cause harmful interference to earth station registrants, earth station registrants would be allowed to relocate only to those geographic areas in which terrestrial operations would not cause such harmful interference. Alternatively, earth station registrants could be permitted to relocate to any geographic area provided that they agree to accept any interference from terrestrial operations or coordinate their operations with terrestrial wireless service providers.

[45/] For instance, the Commission determined in the 28 GHz proceeding that an earth station could operate on a protected basis in the same band as terrestrial licensees provided that: (i) no more than three earth stations are located in the same county; (ii) the earth station's protection zone together with the protection zones of other earth stations in the same county do not, in the aggregate, cover more than 0.1 percent of the population of the county; (iii) the earth station's protection zone does not infringe upon any major event venue, arterial street, interstate or U.S. highway, urban mass transit route, passenger railroad, or cruise ship port; and (iv) if the earth station relocates to an area where there is an existing terrestrial licensee, the earth station coordinates its operations with that licensee. *See Use of Spectrum Bands Above 24 GHz for Mobile Radio Services, et al.*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014, ¶ 54 (2016); *see also id.* ¶ 93 (adopting a similar approach for the 37.5-40 GHz band). For purposes of the C-band, it would be most appropriate for the Commission to adopt only the criteria set forth in (ii) and (iii). These criteria would be required to be satisfied across all earth station registrants in an area, not just a single earth station registrant. One solution might be to have several earth station hubs across the country.

To reimburse earth station registrants, the Commission would, as described above, establish a fund, administered if necessary by a third party that would pay actual relocation costs to earth station registrants.[46/] The Commission could require earth station registrants to file post-auction cost estimates and supporting documentation, based on a list of predetermined cost estimates or price quotes provided by vendors, for the services and equipment needed to complete the relocation.[47/] While an earth station registrant's recurring costs would be capped for a specified period of time, it could nonetheless request the relocation costs in a lump sum payment.[48/]

***

T-Mobile urges the Commission to move quickly to adopt rules for a C-band incentive auction and implement the procedures outlined above. There is a critical need for mid-band spectrum in carrier networks to satisfy the growing demands of consumers for next-generation wireless services. The time is ripe for the Commission to act, and it must do so now in order to maintain the Nation's leadership in the wireless industry.

Pursuant to Section 1.1206(b)(2) of the Commission's rules, an electronic copy of this letter is being filed in the above-referenced docket and a copy is being provided to the staff with whom we met. Please direct any questions regarding this filing to the undersigned.

Respectfully submitted,

/s/ Steve B. Sharkey

Steve B. Sharkey
Vice President, Government Affairs
Technology and Engineering Policy

46/ *See supra* note 38.

47/ As noted above, the Commission could alternatively require the submission of cost estimates *prior to* the auction in order to establish a reserve price.

48/ *See, e.g.*, 47 C.F.R. § 27.1164 (stating that "[i]ncreased recurring costs represent part of the actual cost of relocation and, even if the compensation to the incumbent is in the form of a commitment to pay five years of charges, the AWS or MSS/ATC relocator is entitled to seek immediate reimbursement of the lump sum amount based on present value using current interest rates").

Attachment

cc: (each by e-mail)
Anna Gentry
Kamran Etemad
Thomas Derenge
Jeffrey Tignor
Matthew Pearl
Giulia McHenry
Patrick DeGraba
Margaret Wiener
Evan Kwerel
Craig Bomberger
Joseph Calascione
Michael Ha
Robert Pavlak
Barbara Pavon
Jose Albuquerque
Kerry Murray
Max Staloff
Becky Schwartz
Peter Daronco
Paul Powell
Deborah Broderson
Brian Wondrack
Ira Keltz

Attachment

Estimating Cost of Fiber Replacement for C-Band Sites

Nat Natarajan
Mike Needham
Dennis Roberson

Roberson and Associates LLC
Schaumburg, IL 60173

19 June 2019

Roberson and Associates, LLC
Technology and Management Consultants ®

Outline

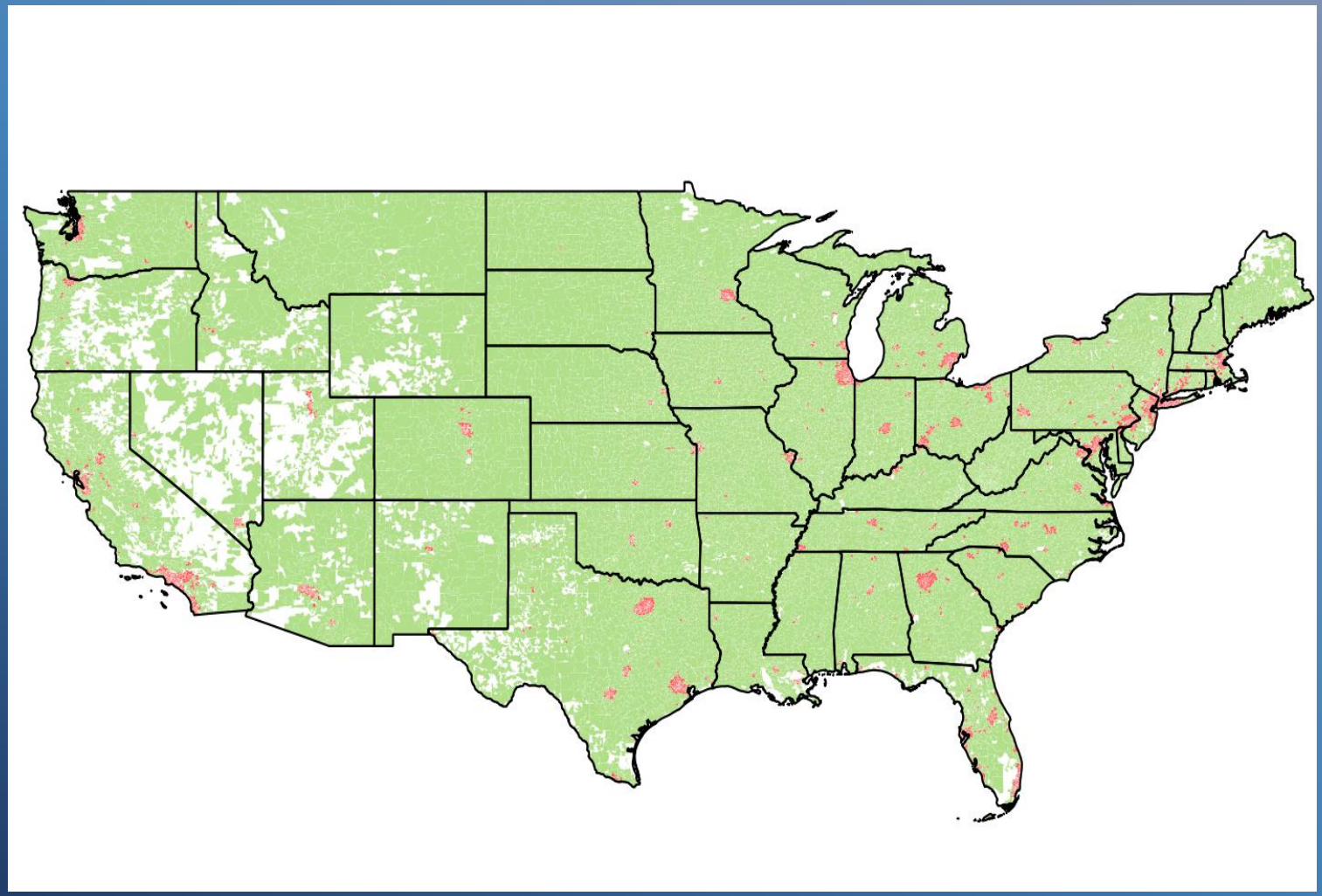
- Methodology and Summary
- Mapping of Satellite Earth Stations
- Fiber Availability in the US
- Fiber Penetration Analysis with Representative Example PEAs
- Cost Models and Sensitivity analysis
- Conclusion

Methodology and Summary

- Analyzed IBFS databases to get up-to-date count of Receive Only and Tx-Rx Satellite Earth Stations (SES). Our findings are in line with similar but independent assessments.
- Mapped SES sites into urban and rural categories based on population density in zip codes (ZCTAs).
- Developed cost model to get first-cut estimates of cost for providing fiber connection to each SES location on a nationwide basis (All 415 PEAs).
- Used conservative assumptions for parameter values (using ACA filings) to obtain bounds on cost
- Detailed fiber availability analyses (based on a subset of available fiber runs) indicate actual fiber runs expected to be shorter than assumed by models.
- Further optimization of fiber runs leveraging geographic clusters of sites possible to further decrease cost.
- Performed sensitivity analysis with respect to key parameters.
- Median distance to fiber in representative PEAs: 272 meters in urban and 465 meters in rural PEAs.
- Results show the economic feasibility of providing fiber as an alternative to satellite C-Band downlink with fiber deployment costs of less than $1 Billion.

Population Density of ZCTAs in CONUS

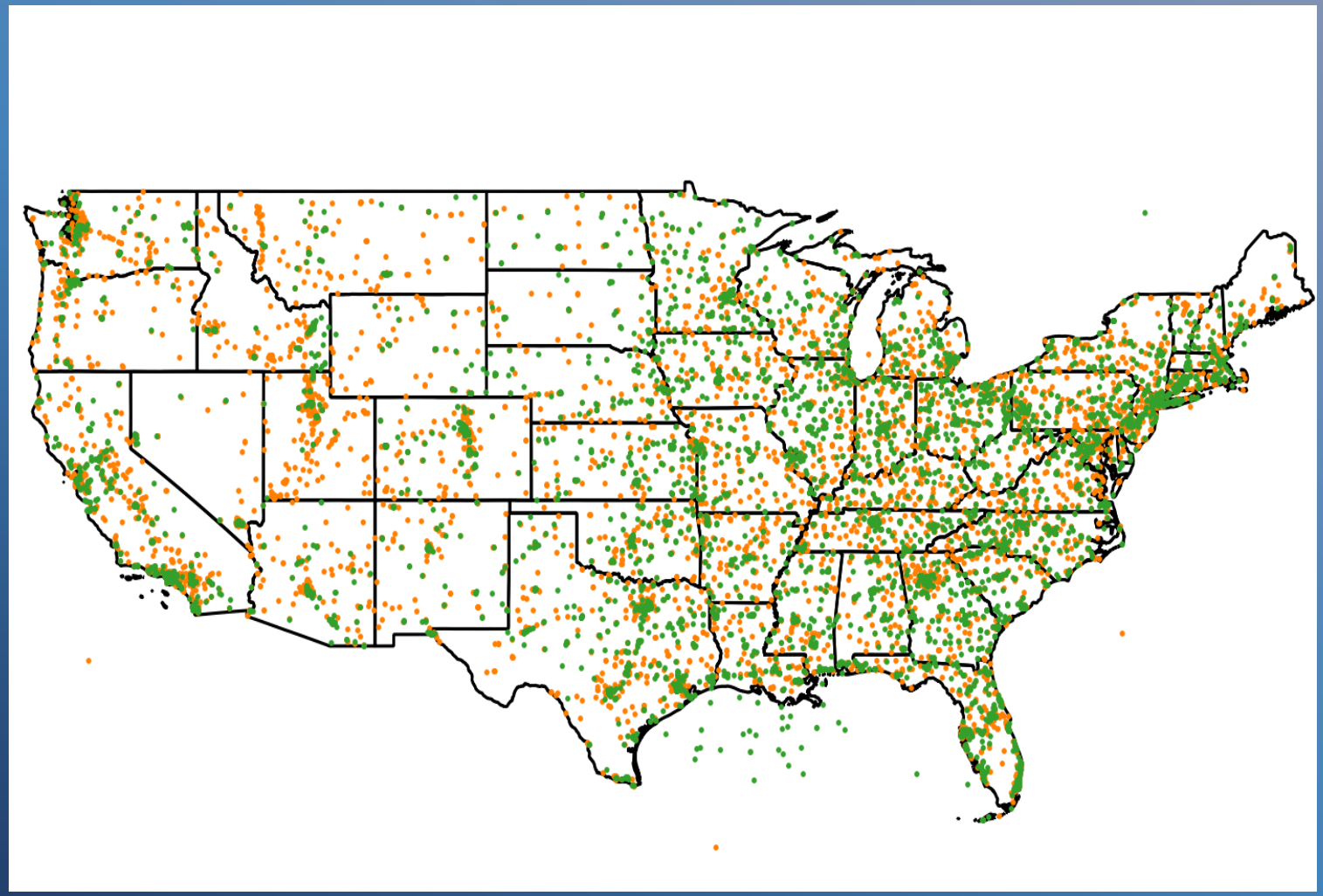
- Zip Code Tabulation Areas (ZCTAs)
  - Over 33,000 in US
- Broken down by rural vs. non-rural
  - “Rural” defined as < 1000 per square-mile – shown in green
  - “Urban” defined as ≥ 1000 per square-mile – shown in pink
  - Water and mostly uninhabited areas lack ZCTAs



C-Band Receive Sites in CONUS (RO and Tx-Rx)

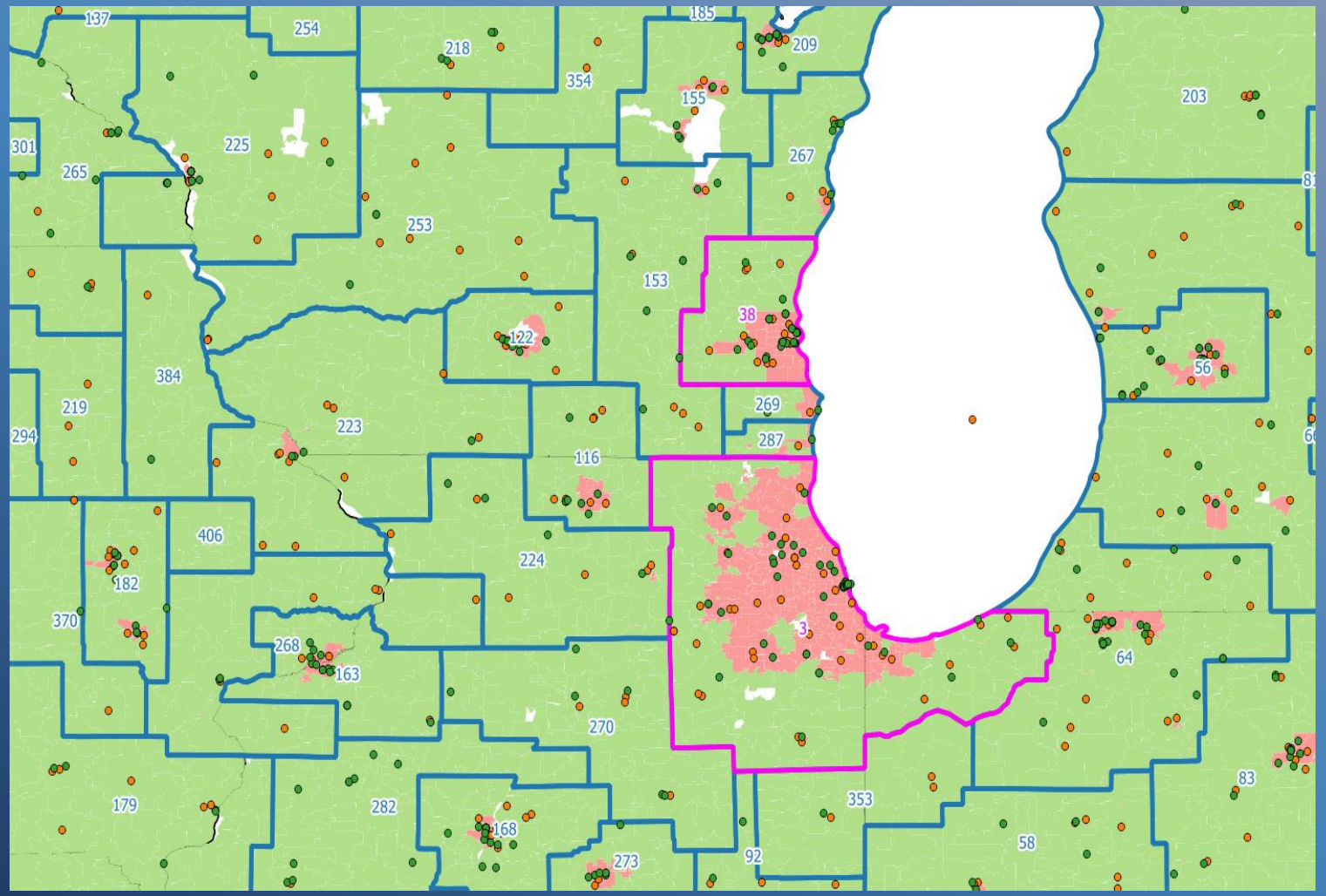
- Satellite Earth Station sites from IBFS database
  - 3700 – 4200 MHz
  - Receive-Only (RO) or Transmit-Receive (Tx-Rx)
  - 13,704 overall
- Graphed based on registration status
  - Currently Licensed or Pending (6607) – shown in Green
  - Filed but not processed (7097) – shown in Orange
  - Exclude those with status “Closed”

Data downloaded from IBFS on 15-Mar-2019
(some erroneous location data in the data base)



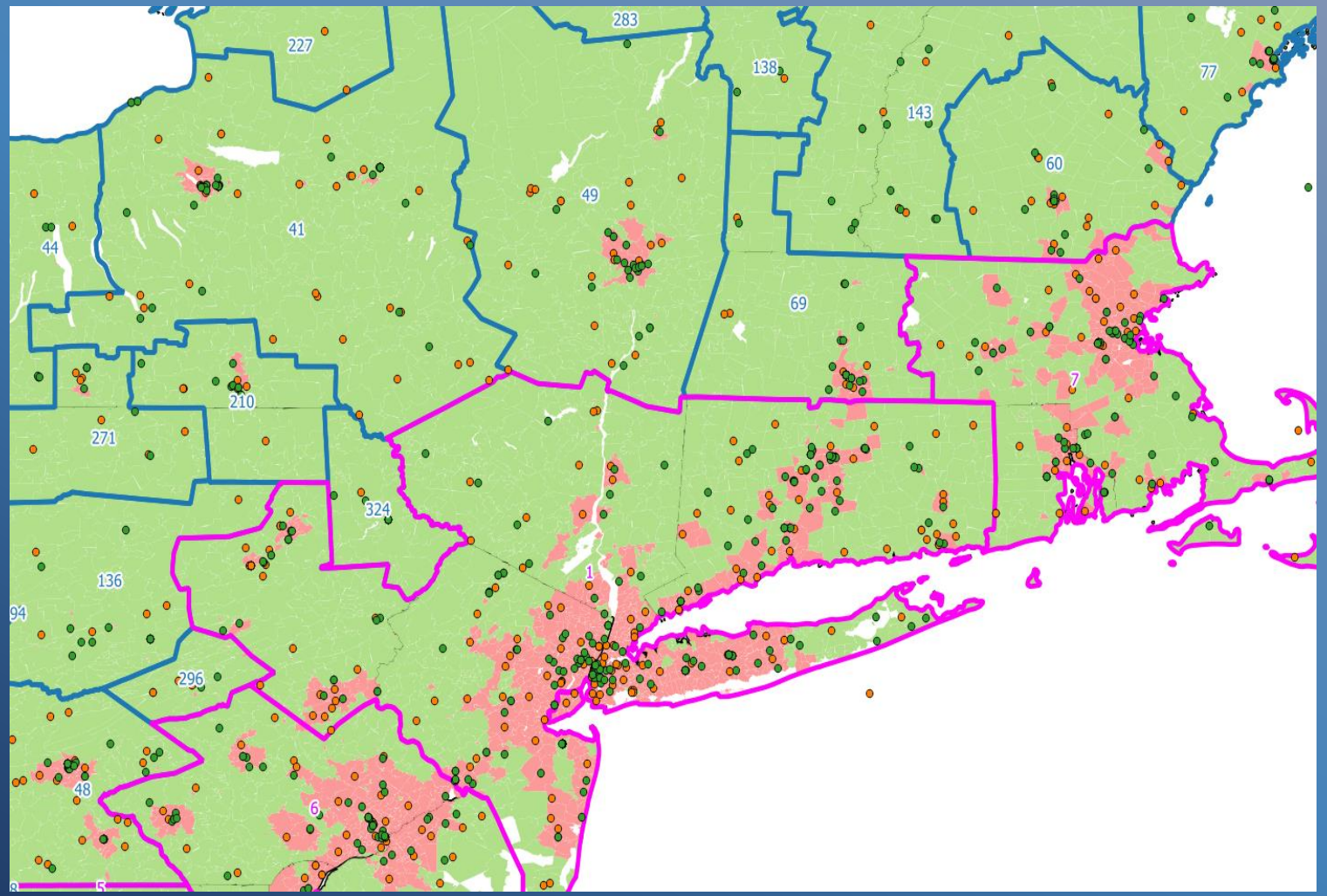
C-Band Sites in Chicago / Milwaukee Area

- Urban (pink) and Rural (green) ZCTA areas within each PEA
- C-band sites
  - Current/Pending (green)
  - Submitted/Not Accepted (orange)
- Significant amount of rural areas even in populous PEAs



C-Band Sites in Boston / New York / Baltimore-Washington PEAs

- Urban (pink) and Rural (green) ZCTA areas within each PEA
- C-band sites
  - Current/Pending (green)
  - Submitted/Not Accepted (orange)
- Significant amount of rural areas even in populous PEAs



PEA Stats and C-Band Site Counts (Top 25 listed below)

PEA	PEA Name	POP (2010)	Area (sq-mi)	Pop/sq-mi	C-Band Site Count	Urban Site Count	Rural Site Count	% Sites Urban	% Sites Rural
1	New York, NY	25,237,061	19,330	1305.6	398	273	125	68.6%	31.4%
2	Los Angeles, CA	19,410,169	48,403	401.0	396	251	138	63.4%	34.8%
3	Chicago, IL	9,366,713	6,712	1395.5	96	73	23	76.0%	24.0%
4	San Francisco, CA	9,027,937	13,845	652.1	175	128	47	73.1%	26.9%
5	Baltimore-Washington	7,842,134	7,902	992.4	196	145	51	74.0%	26.0%
6	Philadelphia, PA	7,587,252	8,613	881.0	126	88	38	69.8%	30.2%
7	Boston, MA	6,776,035	6,485	1044.9	120	94	26	78.3%	21.7%
8	Dallas, TX	6,452,472	9,541	676.3	135	104	31	77.0%	23.0%
9	Miami, FL	6,291,880	11,582	543.2	135	106	28	78.5%	20.7%
10	Houston, TX	5,891,999	7,963	740.0	116	90	26	77.6%	22.4%
11	Atlanta, GA	5,435,312	10,396	522.8	246	200	46	81.3%	18.7%
12	Detroit, MI	5,137,479	5,937	865.4	92	72	20	78.3%	21.7%
13	Orlando, FL	4,562,642	13,732	332.3	146	88	57	60.3%	39.0%
14	Cleveland, OH	4,096,678	7,689	532.8	131	70	61	53.4%	46.6%
15	Phoenix, AZ	3,817,117	9,224	413.8	108	75	33	69.4%	30.6%
16	Seattle, WA	3,792,218	10,063	376.8	105	64	41	61.0%	39.0%
17	Minneapolis-St. Paul, MN	3,390,091	7,123	475.9	96	64	32	66.7%	33.3%
18	San Diego, CA	3,095,313	4,258	726.9	63	49	12	77.8%	19.0%
19	Portland, OR	3,022,643	14,479	208.8	100	54	46	54.0%	46.0%
20	Denver, CO	2,789,669	4,685	595.4	101	73	28	72.3%	27.7%
21	Tampa, FL	2,783,243	2,683	1037.4	75	65	10	86.7%	13.3%
22	Sacramento, CA	2,722,415	12,299	221.4	77	34	43	44.2%	55.8%
23	Pittsburgh, PA	2,399,667	5,741	418.0	86	46	40	53.5%	46.5%
24	Saint Louis, MO	2,396,938	5,311	451.3	61	38	23	62.3%	37.7%
25	Cincinnati, OH	2,196,428	5,978	367.4	51	35	16	68.6%	31.4%

Data on Fiber Availability in the United States

- Multiple sources of data on fiber availability exist in the public domain. A variety of sources that are available (visible and downloadable) for the public is used in this study.

- Some individual fiber service providers have published their fiber network maps – regions of the US (spanning multiple states) or local within a single state. Other providers keep their fiber deployments confidential for business or other reasons.

- There are public websites such as:
  - https://broadbandnow.com/Fiber-Providers/
  - https://decisiondata.org/COVERAGE
  - https://decisiondata.org/internet-providers-by-zip-code-plus-tv/

- Please see a partial list of fiber service providers in the next two slides.
- Fiber availability may also be extracted from Form 477 data. Limited use for this study.
  - https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477

1253 providers offer Fiber service in the US.

(Source: BROADBANDNOW® See https://broadbandnow.com/Fiber-Providers/)

Partial list of Providers Offering Fiber Service (listed in decreasing order of population coverage) (1 of 2)

Service Provider	Population Coverage	# of States & union territories covered	Max Speed
Verizon Fios	34,396,280	10	940 mbps
AT&T Fiber	20,403,883	21	1000 mbps
Frontier Communications	10,923,883	8	100 mbps
CenturyLink	8,156,001	53	1000 mbps
Google Fiber	2,127,072	10	1000 mbps
Windstream	1,816,354	44	1000 mbps
Cincinnati Bell	1,335,440	5	1000 mbps
C Spire Fiber	1,265,251	8	1000 mbps
Consolidated Communications	1,106,682	14	1000 mbps
Armstrong	982,867	5	1000 mbps
Metronet	910,151	3	1000 mbps
Hawaiian Telcom	687,829	1	1000 mbps
En-Touch Systems	535,246	1	1000 mbps
Shentel	524,635	4	1000 mbps
Ultimate Internet Access	523,446	1	1000 mbps
TDS Telecom	486,643	23	1000 mbps
Veracity Networks	403,788	1	1000 mbps
Sonic	397,789	1	1000 mbps
EPB	359,866	2	1000 mbps
North State Communications	302,294	1	1000 mbps
Peoples Telephone Cooperative	279,575	1	1000 mbps
UTOPIA	270,973	1	1000 mbps
Hotwire Communications	236,830	9	1000 mbps
Point Broadband	232,352	4	1000 mbps
Summit Broadband	219,539	1	1000 mbps
Air Advantage	214,740	1	1000 mbps
Columbia Energy	211,731	1	100 mbps
Campus Communications Group	201,239	5	1000 mbps
CentraCom	195,682	1	1000 mbps

Service Provider	Population Coverage	# of States and union territories covered	Max Speed
Optimum by Altice	183,136	3	1000 mbps
Horry Telephone Cooperative	165,487	1	1000 mbps
Comporium Communications	159,541	2	1000 mbps
Bristol Tennessee Essential Services	156,823	1	1000 mbps
Direct Communications	154,618	4	100 mbps
MTCO Communications	153,465	1	1000 mbps
NTS Communications	138,124	2	1000 mbps
LocalTel Communications	132,976	1	100 mbps
Community Fiber Solutions	129,914	2	50 mbps
Morris Broadband	124,470	1	1000 mbps
LUS Fiber	116,690	1	1000 mbps
CDE Lightband	113,984	1	1000 mbps
GoNetspeed	110,396	2	1000 mbps
GVTC Communications	109,212	1	1000 mbps
EATEL	107,417	1	1000 mbps
i3 Broadband	105,755	1	1000 mbps
Dalton Utilities	102,599	1	1000 mbps
LightSpeed Communications	100,907	2	1000 mbps
Benton PUD	97,360	1	100 mbps
Owensboro Municipal Utilities	96,656	1	1000 mbps
Allo Communications	91,270	1	1000 mbps
Kaptel	90,592	1	100 mbps
Brandenburg Telecom	88,004	1	1000 mbps
Paul Bunyan Telephone	87,608	1	1000 mbps
Socket Telecom	87,307	2	1000 mbps
City of Longmont	83,709	1	1000 mbps
Casair	82,825	1	1000 mbps

Partial list of Providers Offering Fiber Service (2 of 2)

Plateau	80,135	2	1000 mbps
Ting	79,530	5	1000 mbps
Nex-Tech	79,506	2	1000 mbps
Greenlight Networks	78,680	1	1000 mbps
Home Telecom	77,825	1	1000 mbps
Jackson Energy Authority	76,235	1	1000 mbps
Troy Cablevision	75,436	1	1000 mbps
Empire Access	75,066	1	1000 mbps
Farmers Telecommunications Cooperative	69,057	1	1000 mbps
Yadtel	68,821	1	100 mbps
Orbitel Communications	68,665	1	100 mbps
Co-Mo Connect	66,418	1	1000 mbps
Ocala Telecom	66,297	1	100 mbps
GCI Communication	66,246	2	1000 mbps
Clearnetworx	64,614	1	977 mbps
Bulloch Telephone Cooperative	63,353	1	1000 mbps
Jaguar Communications	63,050	1	1000 mbps
Highland Telephone Cooperative	63,022	2	1000 mbps
Morristown Utility FiberNET	62,544	1	1000 mbps
Cascade Networks	62,126	2	100 mbps
FTC	60,758	1	1000 mbps
Twin Lakes Telephone	60,385	1	1000 mbps
Skybest Communications	59,423	3	1000 mbps
Douglas Fast Net	59,036	1	1000 mbps
Silver Star Communications	57,948	2	1000 mbps
NineStar Connect	57,773	1	1000 mbps
Pend Oreille Valley Networks	57,716	2	100 mbps
Greenlight	56,684	1	1000 mbps
Smithville Communications	56,045	1	1000 mbps
Lumos Networks	55,889	2	1000 mbps
CTC	55,586	1	250 mbps
Mainstream Fiber Networks	55,028	1	200 mbps
North Central Telephone Cooperative	54,878	2	1000 mbps
South Central Rural Telephone	54,877	1	1000 mbps
Eagle Communications	54,850	1	100 mbps
VTX Communications	54,840	1	1000 mbps
Slic Network Solutions	54,546	1	500 mbps
Golden West Telecommunications	54,525	2	100 mbps
WK&T	52,915	2	1000 mbps
Randolph Telephone Membership Corporation	52,550	1	100 mbps
Acentek	52,234	2	1000 mbps
United Services	51,908	1	1000 mbps
Midwest Connections	51,387	2	1000 mbps
Pineland Telephone Company	50,913	1	1000 mbps
Adams Networks	50,009	1	1000 mbps
SenaWave	49,736	1	1000 mbps
Nittany Media	49,477	1	1000 mbps
Burlington Telecom	49,373	1	1000 mbps
Wilkes Communications	48,580	1	1000 mbps
HBC	47,337	1	1000 mbps
Bluewave Communications	46,887	1	100 mbps
Planters Rural Telephone Cooperative	46,553	1	1000 mbps
USA Communications	46,136	2	200 mbps
US Internet	44,293	1	1000 mbps
Spanish Fork Community Network	43,188	1	1000 mbps
Foothills Broadband	43,149	1	1000 mbps
Palmetto Rural Telephone Cooperative	42,892	1	500 mbps
Winn Telecom	42,763	1	1000 mbps
Blue Ridge Mountain EMC	42,128	2	1000 mbps
Star Communications	41,823	1	100 mbps
BOLT Fiber Optic Services	41,678	1	1000 mbps
CommZoom	41,541	1	1000 mbps
Cedar Falls Municipal Communications Utility	40,971	1	1000 mbps
Montana Opticom	40,558	1	1000 mbps

For the sake of brevity the remaining providers in the list of 1253 fiber service providers are not shown.

Fiber availability continues to expand over time in rural, remote and/or sparsely populated areas of the US.

Fiber Penetration Analysis

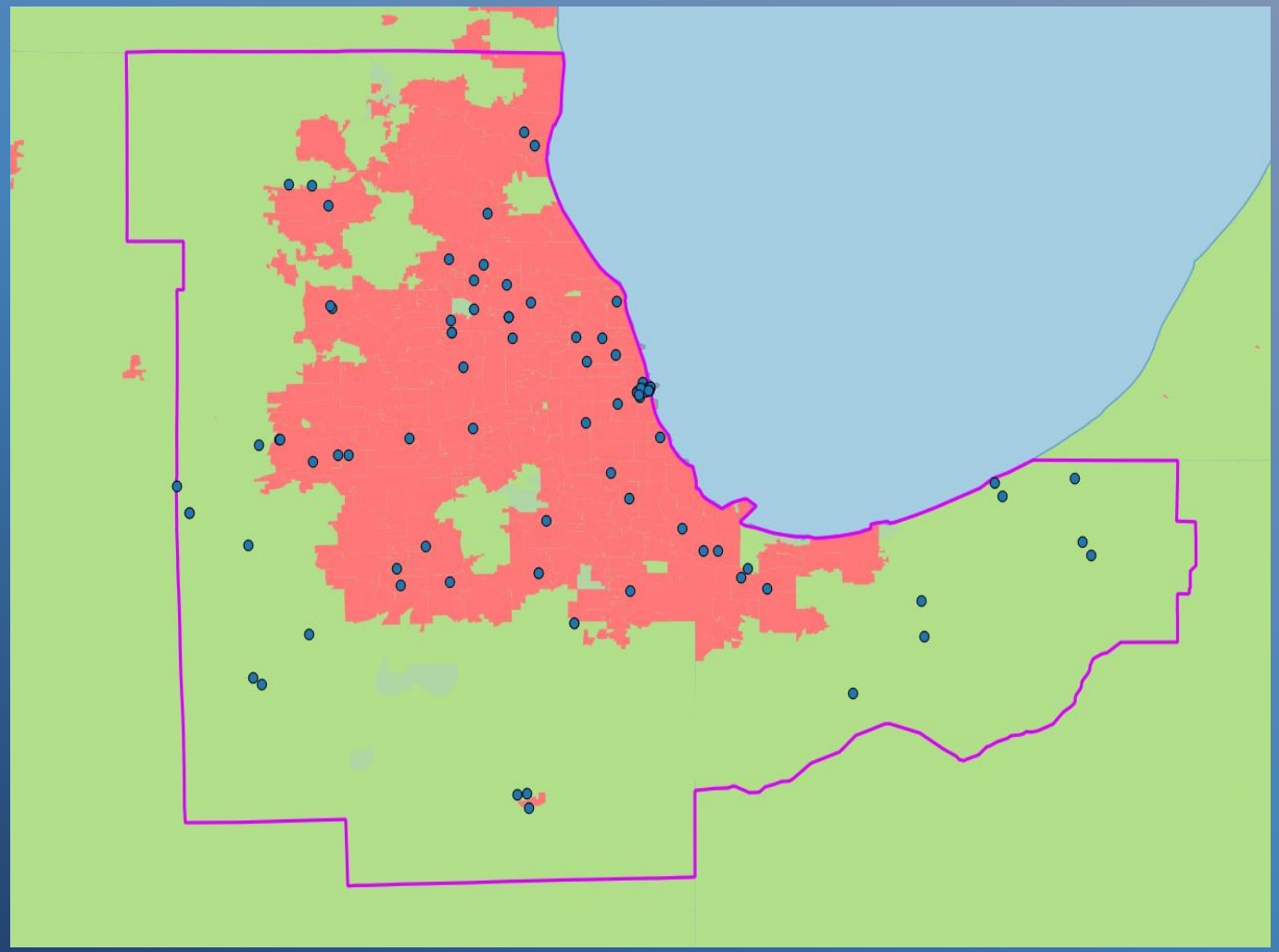
Choose two representative PEAs for in-depth study

1. Urban PEA (Chicago and vicinity)
   - Total 96 SES sites located in ~ 75% Urban and 25% Rural ZCTAs

2. Rural PEA (Altoona, PA)
   - Total 35 SES sites located in ~ 25% Urban and 75% Rural ZCTAs

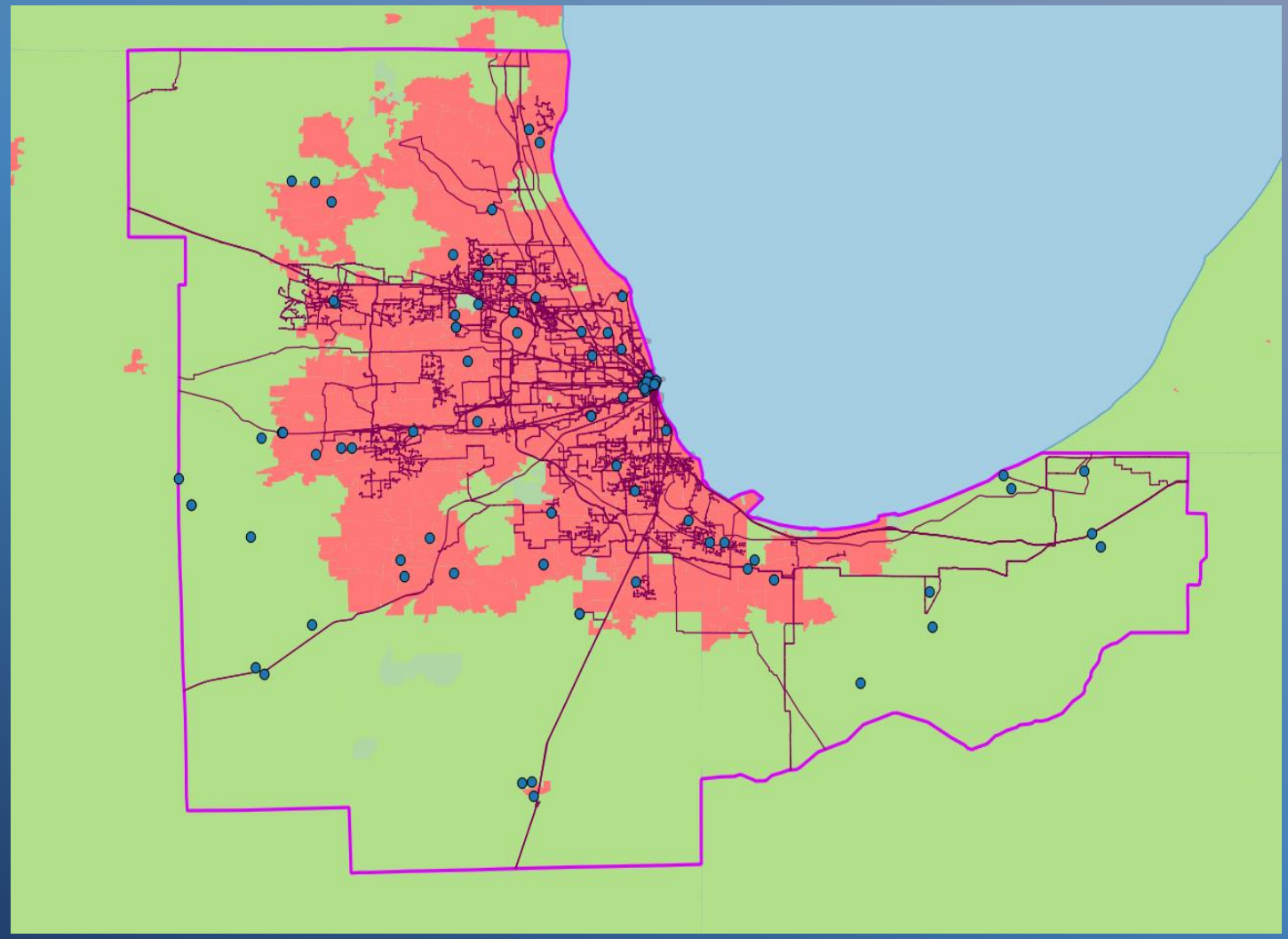
C-Band Sites in PEA 3 (Chicago, IL)

- 96 C-Band sites in PEA 3
  - Current/Pending and Not Accepted (per 3/15/19 IBFS database)
- Urban (pink) and Rural (green) ZCTA areas within each PEA
  - Based on population density <1000 (rural) or ≥ 1000 (urban)
  - About 75% of sites in Urban, 25% in Rural



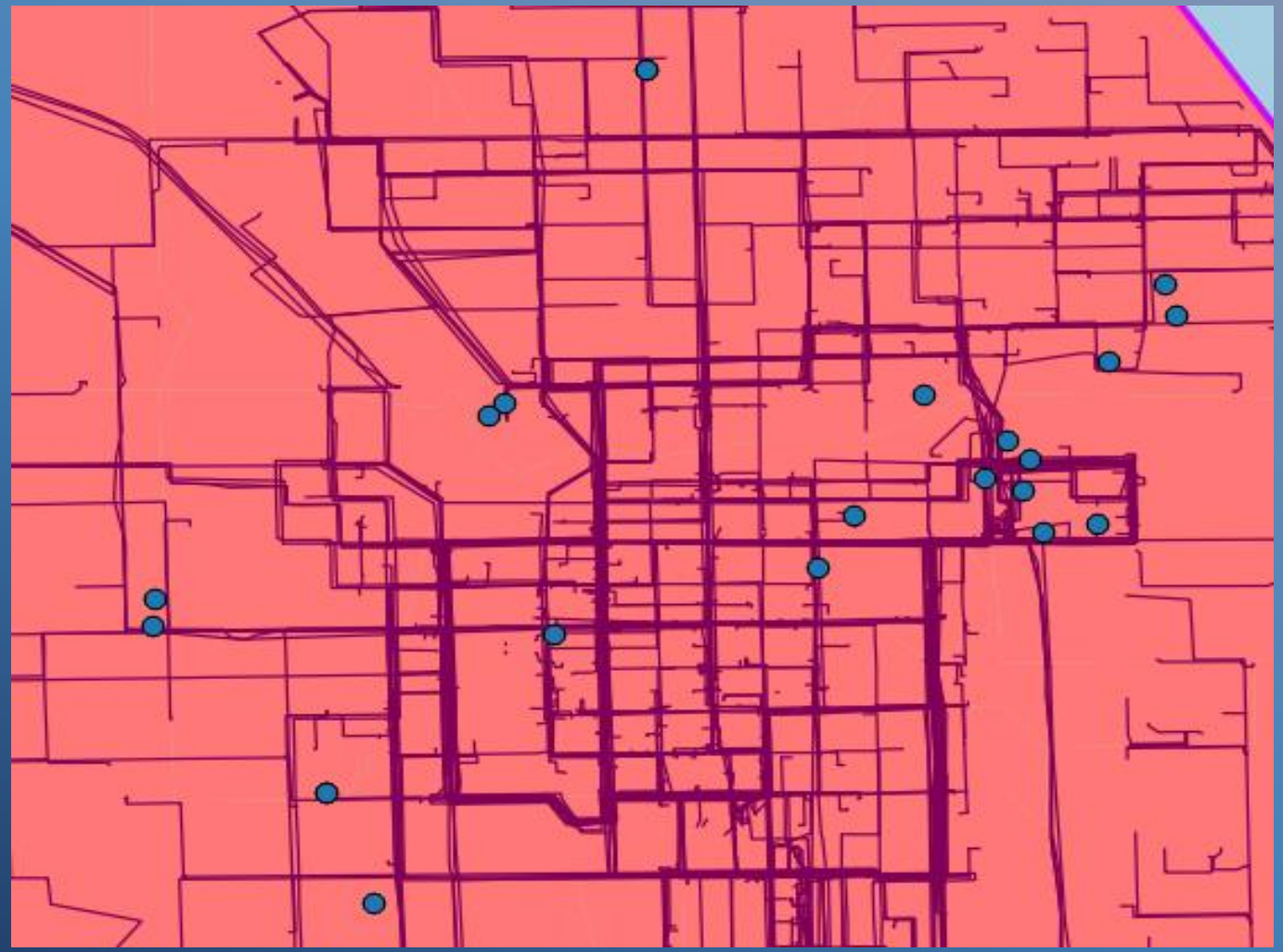
C-Band Sites and Fiber Runs in PEA 3 (Chicago, IL)

- Fiber run maps for 4 providers:
  - Windstream
  - Crown Castle
  - WOW
  - ZAYO
- Limited availability of analyzable fiber maps
  - Plots are based on a subset of all fiber runs that exist
- Example fiber providers in PEA 3 (not mapped):
  - AT&T
  - CenturyLink
  - Unite
  - First
  - Metronet
  - Acme



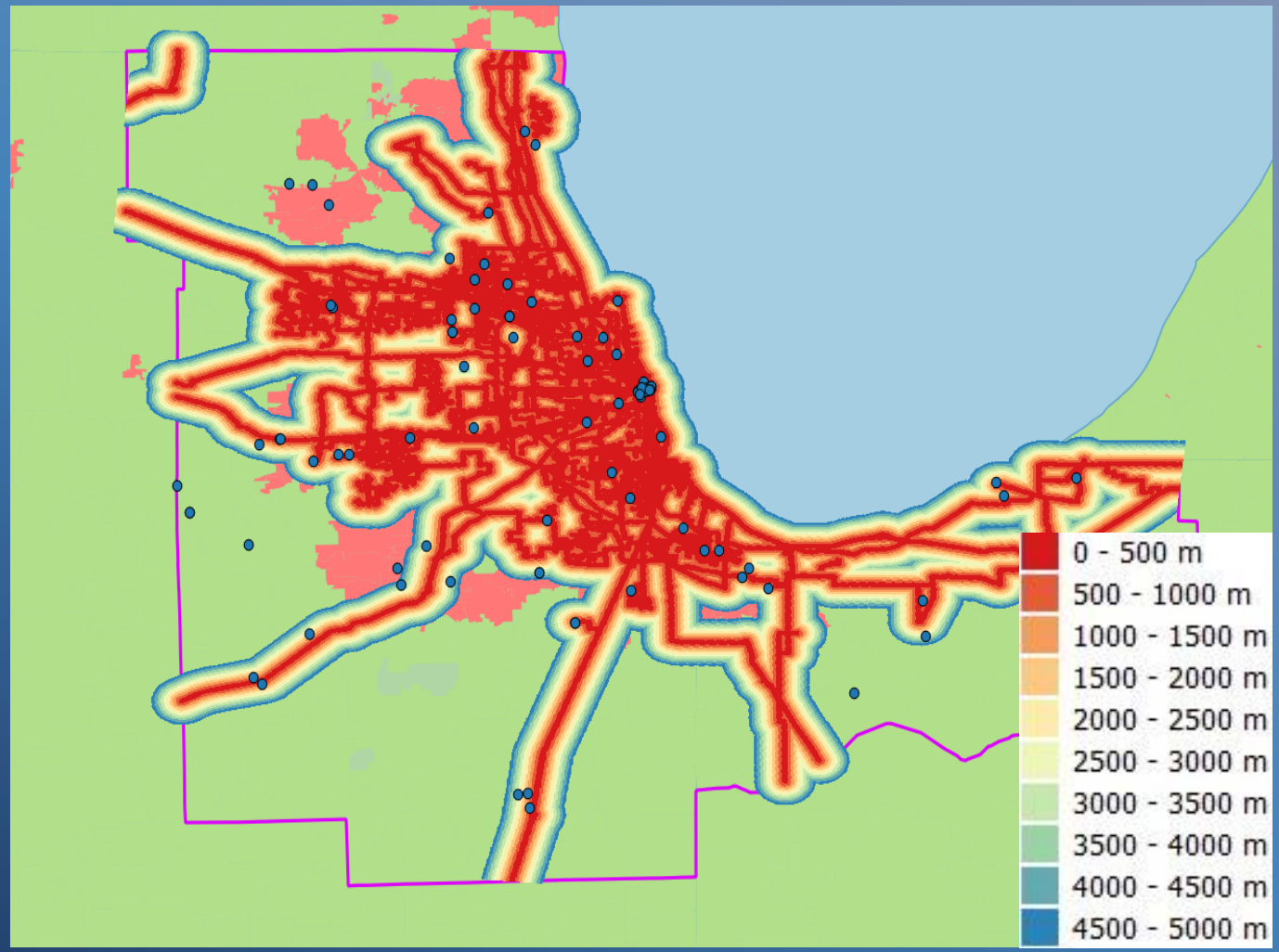
C-Band Sites and Fiber Runs in PEA 3 (Chicago – Detailed)

- Zooming in on Fiber run maps downtown Chicago
  - Dense coverage in inner-city
  - Most sites are in close proximity to fiber runs



Distance Proximity Map for Fiber Runs in PEA 3 (Chicago, IL)

- Color-code distance to nearest fiber run at any point in PEA
  - Used to estimate distance of fiber runs to connect C-Band sites
  - Distance estimates conservative – based on subset of available fiber

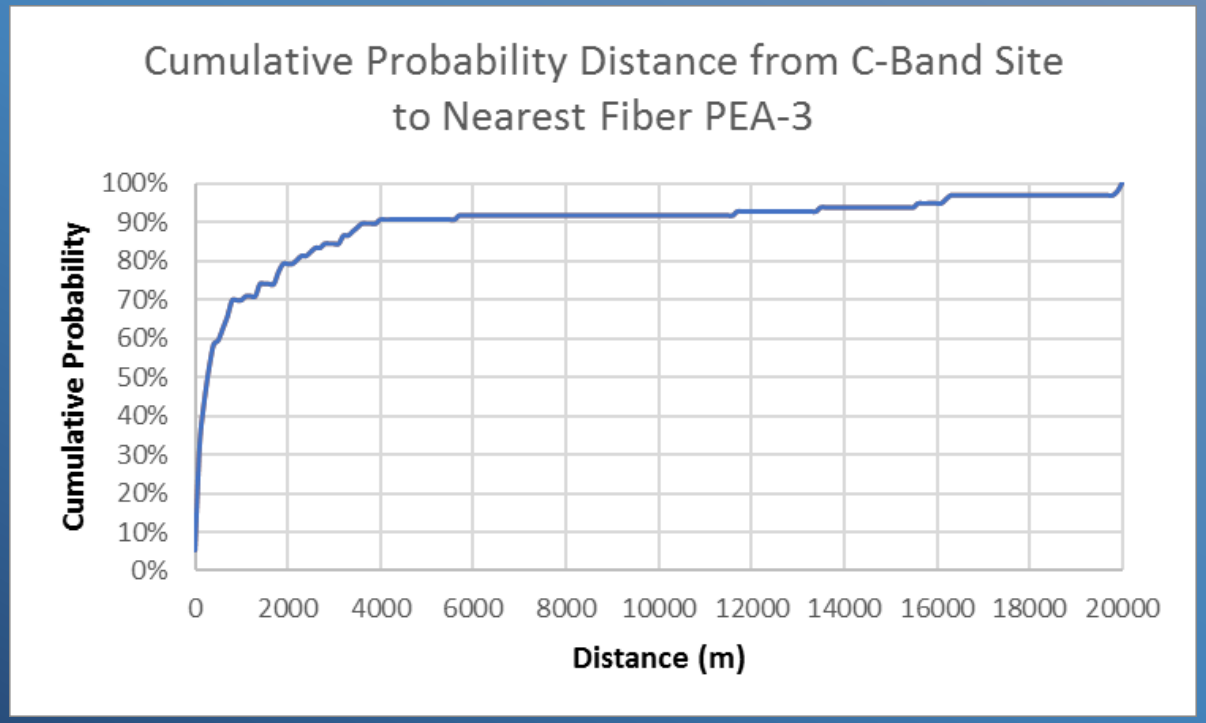


Distances of C-Band Sites to Fiber Runs in PEA 3 (Chicago, IL)

- See that roughly 1/3 of sites within 100 meters of a fiber run
- 70% within 1000 meters
- 90% within 5000 meters

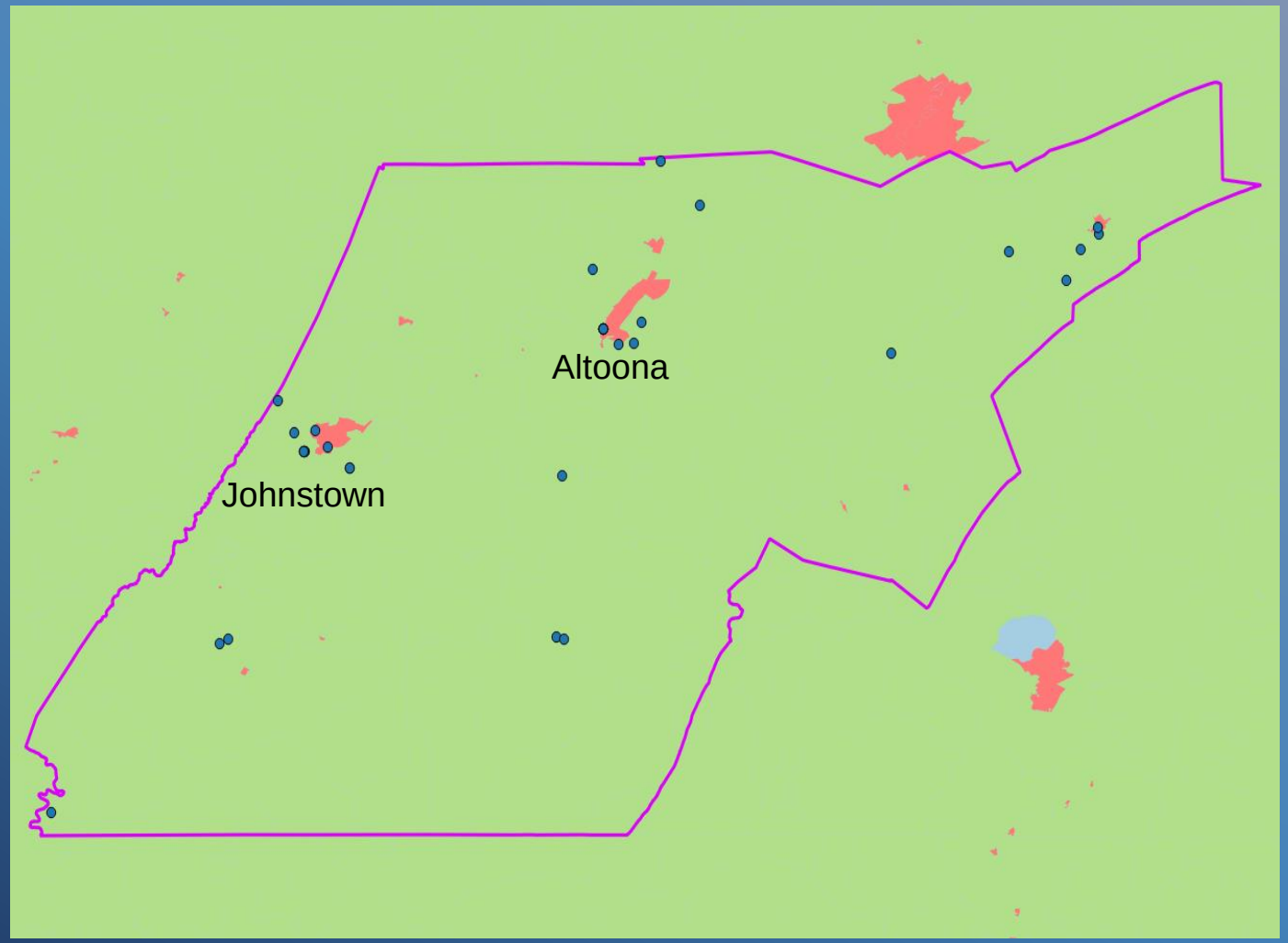
Basic Stats	
Average Distance (m)	2,076
Median Distance (m)	272
Sum Distance (m)	199,264

Distance (m)	No. Sites	Percent	Cumulative
0 - 10	5	5.2%	5.2%
10 - 100	26	27.1%	32.3%
100 - 200	11	11.5%	43.8%
200 - 500	15	15.6%	59.4%
500 - 1000	10	10.4%	69.8%
1000 - 2000	9	9.4%	79.2%
2000 - 5000	11	11.5%	90.6%
5000 - 10,000	1	1.0%	91.7%
10,000 - 20,000	8	8.3%	100.0%
Total	96	100.0%	100.0%



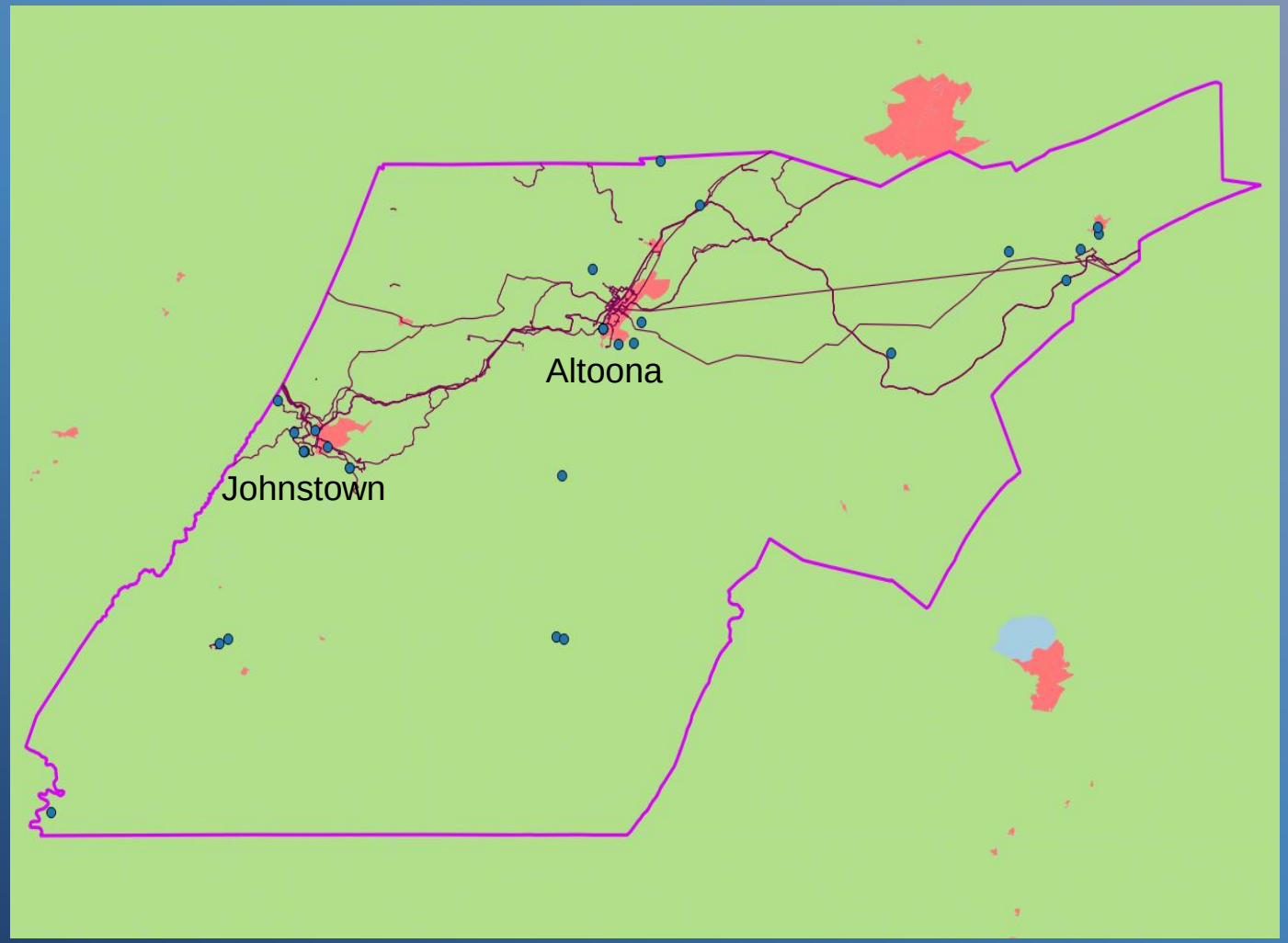
C-Band Sites in PEA 121 (Altoona, PA)

- 35 C-Band sites in PEA 121
  - Current/Pending and Not Accepted (per 3/15/19 IBFS database)
- Urban (pink) and Rural (green) ZCTA areas within each PEA
  - Based on population density <1000 (rural) or ≥ 1000 (urban)
  - About 25% of sites in Urban, 75% in Rural



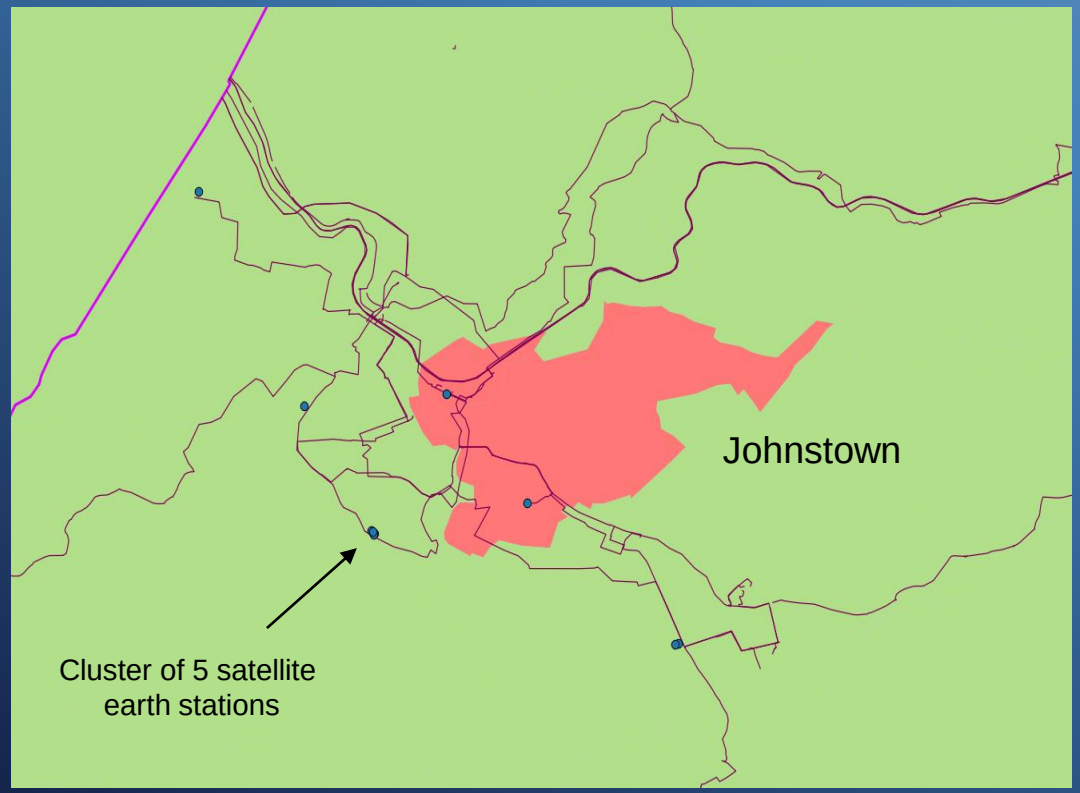
C-Band Sites and Fiber Runs in PEA 121 (Altoona, PA)

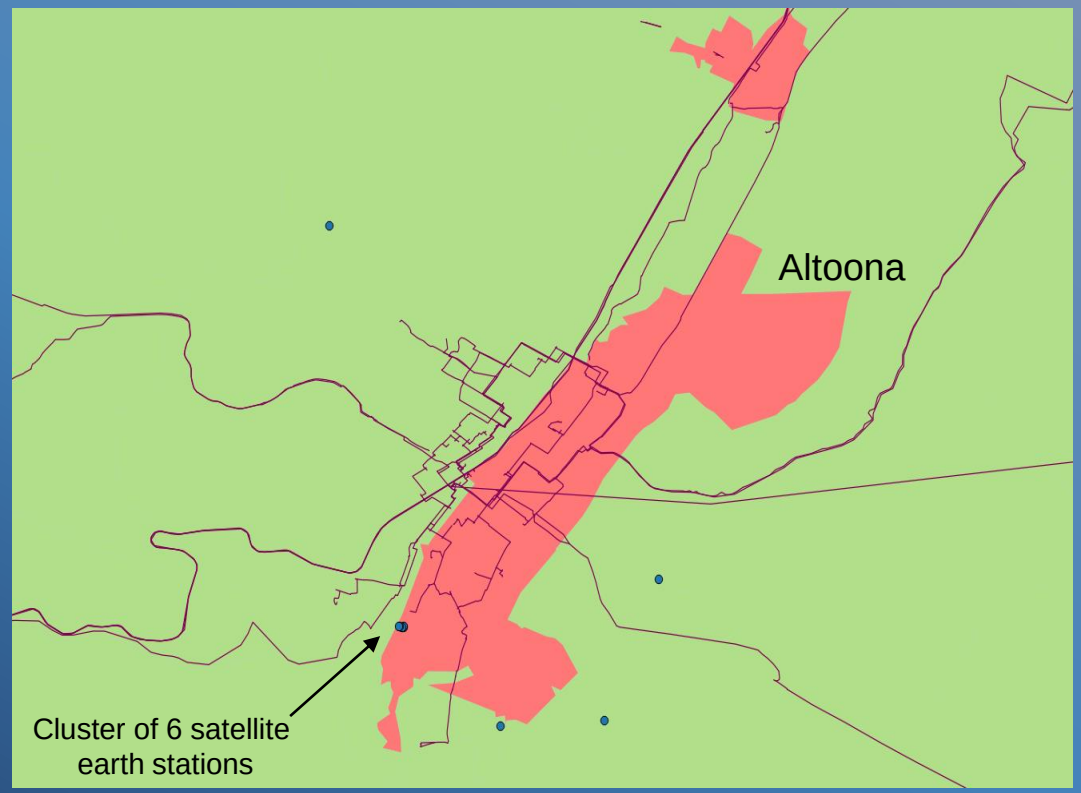
- Fiber run maps for 3 providers
  - Windstream
  - ZAYO
  - Pennsylvania Research and Education Network
- Limited availability of analyzable fiber maps
  - Plots are based on a subset of all fiber runs that exist
- Example fiber providers in PEA 121 (not mapped):
  - Atlantic Broadband
  - Nittany Media
  - CenturyLink
  - Armstrong
  - Crown Castle



C-Band Sites and Fiber Runs in PEA 121 (Zoom)

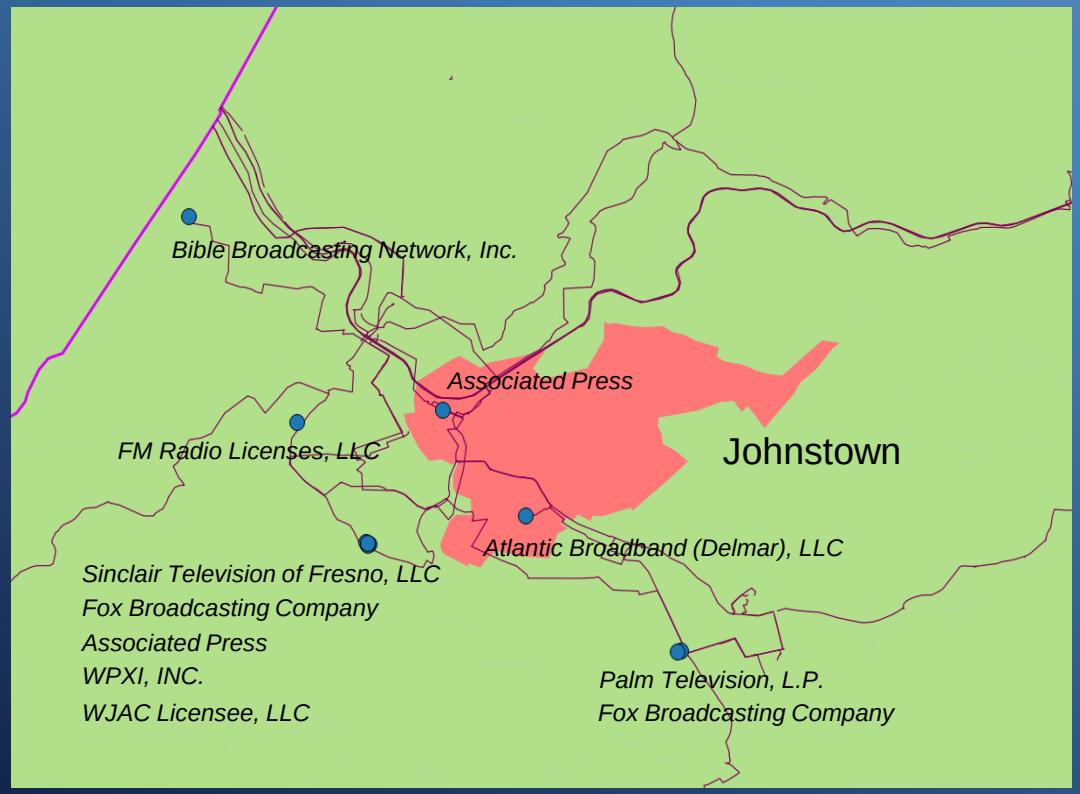
- Zoom in on Fiber run maps downtown Altoona and Johnstown
  - Main population centers of PEA

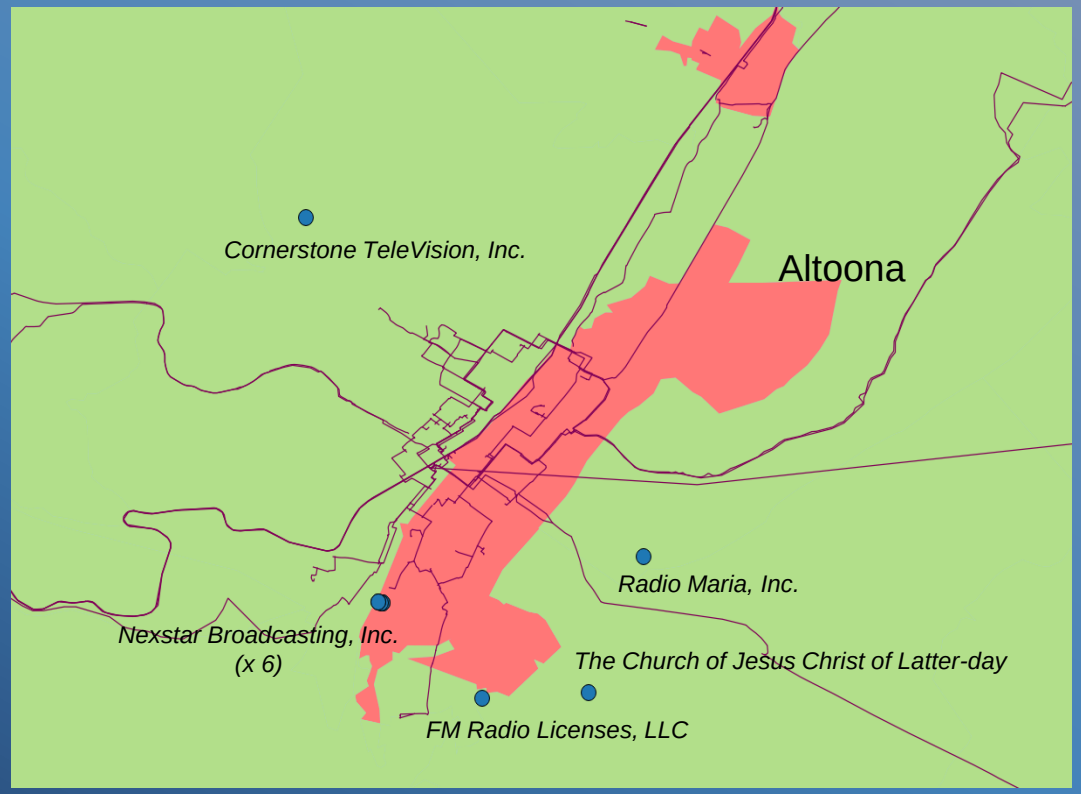




C-Band Sites and Fiber Runs in PEA 121 (Zoom)

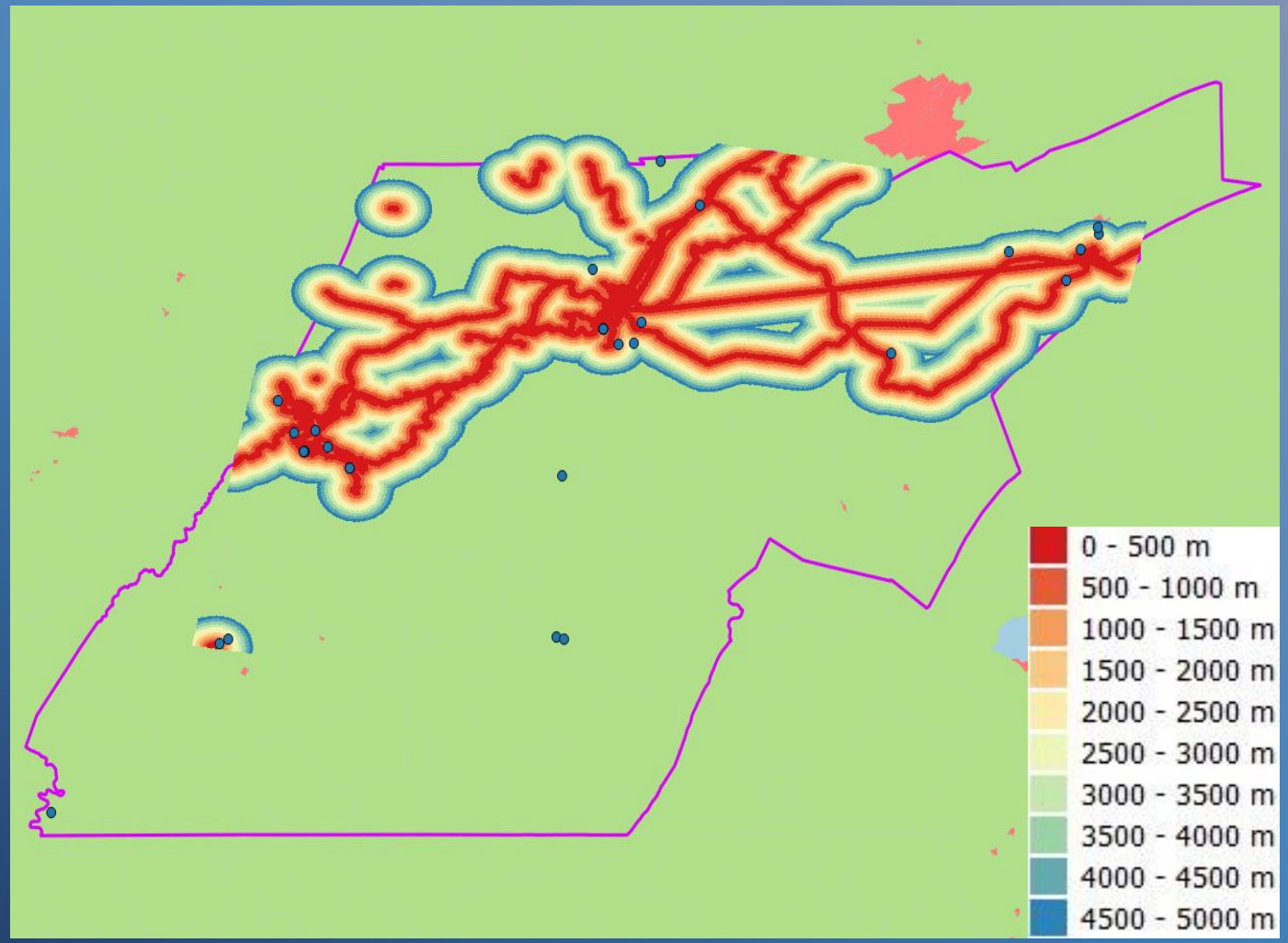
- Zoom in on Fiber run maps downtown Altoona and Johnstown
  - Main population centers of PEA
  - Applicant names shown





Distance Proximity Map for Fiber Runs in PEA 121 (Altoona, PA)

- Color-code distance to nearest fiber run at any point in PEA
  - Used to estimate distance of fiber runs to connect C-Band sites
  - Distance estimates conservative – based on subset of available fiber

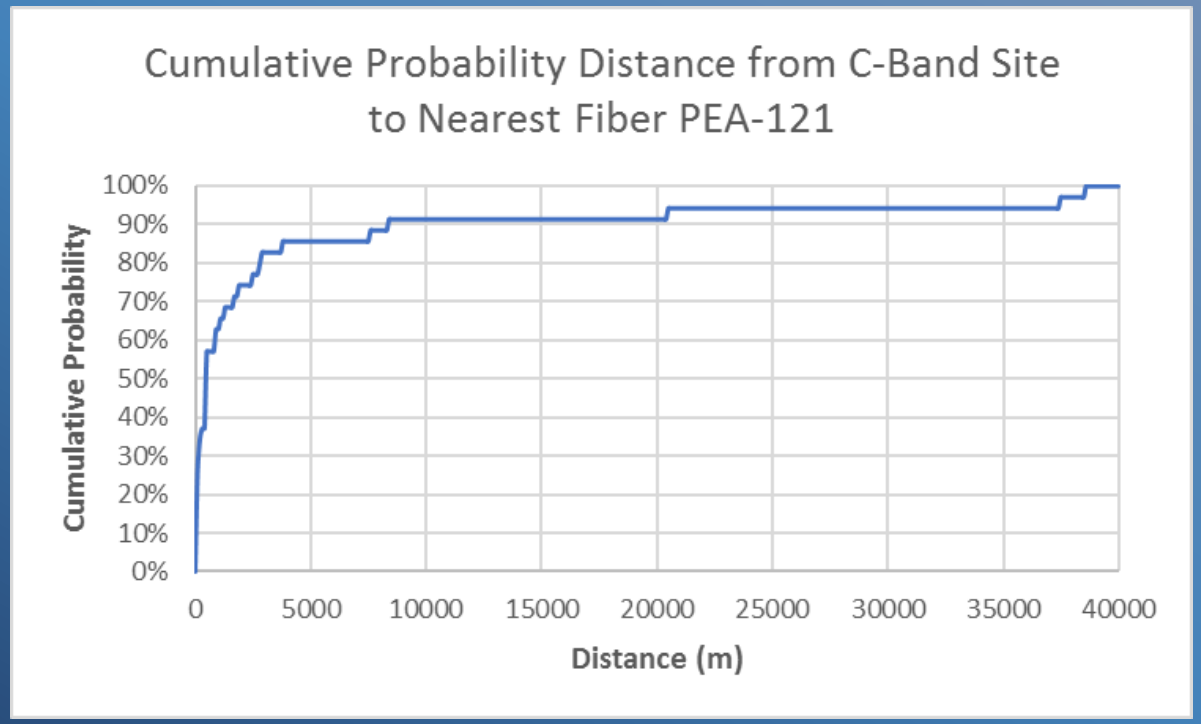


Distances of C-Band Sites to Fiber Runs in PEA 121 (Altoona, PA)

- See that roughly 1/4 of sites within 100 meters of a fiber run
- 63% within 1000 meters
- 86% within 5000 meters

Basic Stats	
Average Distance (m)	3,889
Median Distance (m)	465
Sum Distance (m)	136,120

Distance (m)	No. Sites	Percent	Cumulative
0 - 10	0	0.0%	0.0%
10 - 100	9	25.7%	25.7%
100 - 200	3	8.6%	34.3%
200 - 500	8	22.9%	57.1%
500 - 1000	2	5.7%	62.9%
1000 - 2000	4	11.4%	74.3%
2000 - 5000	4	11.4%	85.7%
5000 - 10,000	2	5.7%	91.4%
10,000 - 20,000	0	0.0%	91.4%
20,000 - 40,000	3	8.6%	100.0%
Total	35	100.0%	100.0%



C-Band Sites in PEAs - Statistics

	Current and Pending Sites	All Filed Sites
No. Urban and Rural C-Band Sites*	6,403	13,437
Avg. No. Sites per PEA	15.5	32.5
No. Urban C-Band Sites	2,708	5,189
Avg. Urban Sites per PEA	6.5	12.5
No. Rural C-Band Sites	3,695	8,248
Avg. Rural Sites per PEA	8.9	19.9

The two columns (**Current and Pending Sites** as well as **All Filed Sites**) are used to establish lower and upper bounds on estimating costs of fiber replacement

* Sites outside of defined urban or rural areas not included

Cost Models for Urban and Rural Sites (Nationwide replacement, All 415 PEAs – current and pending)

Current and Pending sites, Nationwide replacement in all PEAs analysis			
# of Satellite C-Band Receivers in urban sites	2,708	# of Satellite C-Band Receivers in rural sites	3,695
Average # of blocks to fiber access	1	Average # of blocks to fiber access	20
Length of city block = 660 x 330 feet	495	Length of a block = 660 feet	660
Average length of fiber (feet)	495	Average length of fiber (feet)	13,200
Cost per foot of fiber wire ($ per foot)	110	Cost per foot of fiber wire ($ per foot)	10
Probability 1 Gbps available (%)	90	Probability 1 Gbps available (%)	70
Cost of wiring urban site with fiber (including laying fiber, fiber termination costs)	56,450	Cost of wiring rural site with fiber (including laying fiber, pole attachment and fiber termination costs	137,500
Cost of replacig satellite w/ fiber for all existing urban sites	15,286,660	Cost of replacing satellite w/ fiber for all existing rural sites	152,418,750

Total Estimated Cost (All 415 PEAs) ~ $ 167.7 Million

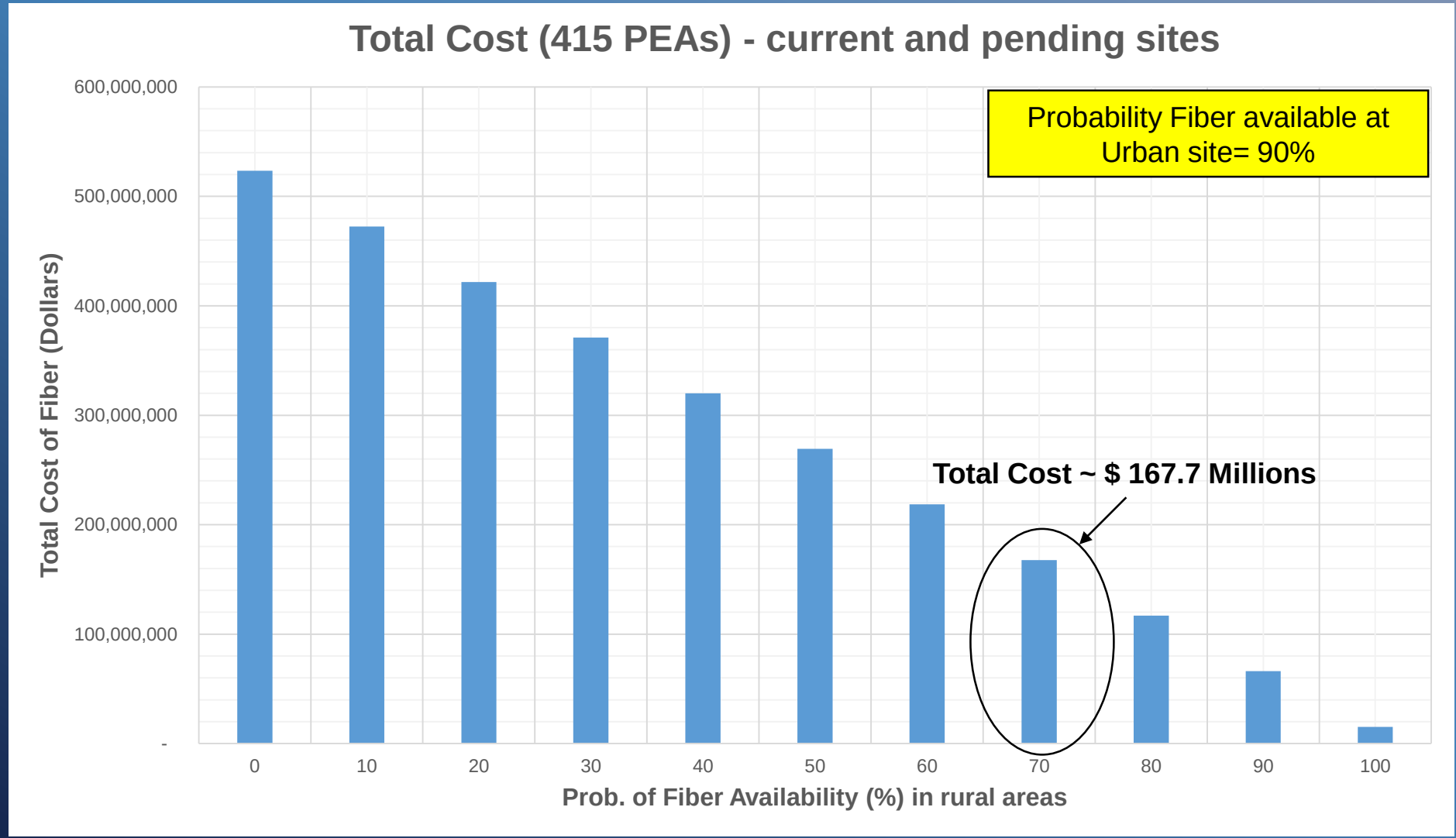
Note: In our model, the cost of wiring a rural site is $ 137,500. This is more conservative than estimated cost of $ 127,500 for providing 10 miles of aerial fiber under the assumptions of the American Cable Association. It is also comparable to the cost of providing 2.5 miles of underground fiber in remote rural areas. Note that regulatory or rights-of-way fees could further impact costs. See page 17 in Comments of the American Cable Association, GN Docket No. 17-183, October 2, 2017.

Cost Models for Urban and Rural Sites
(Nationwide replacement, All 415 PEAs – All filed records)

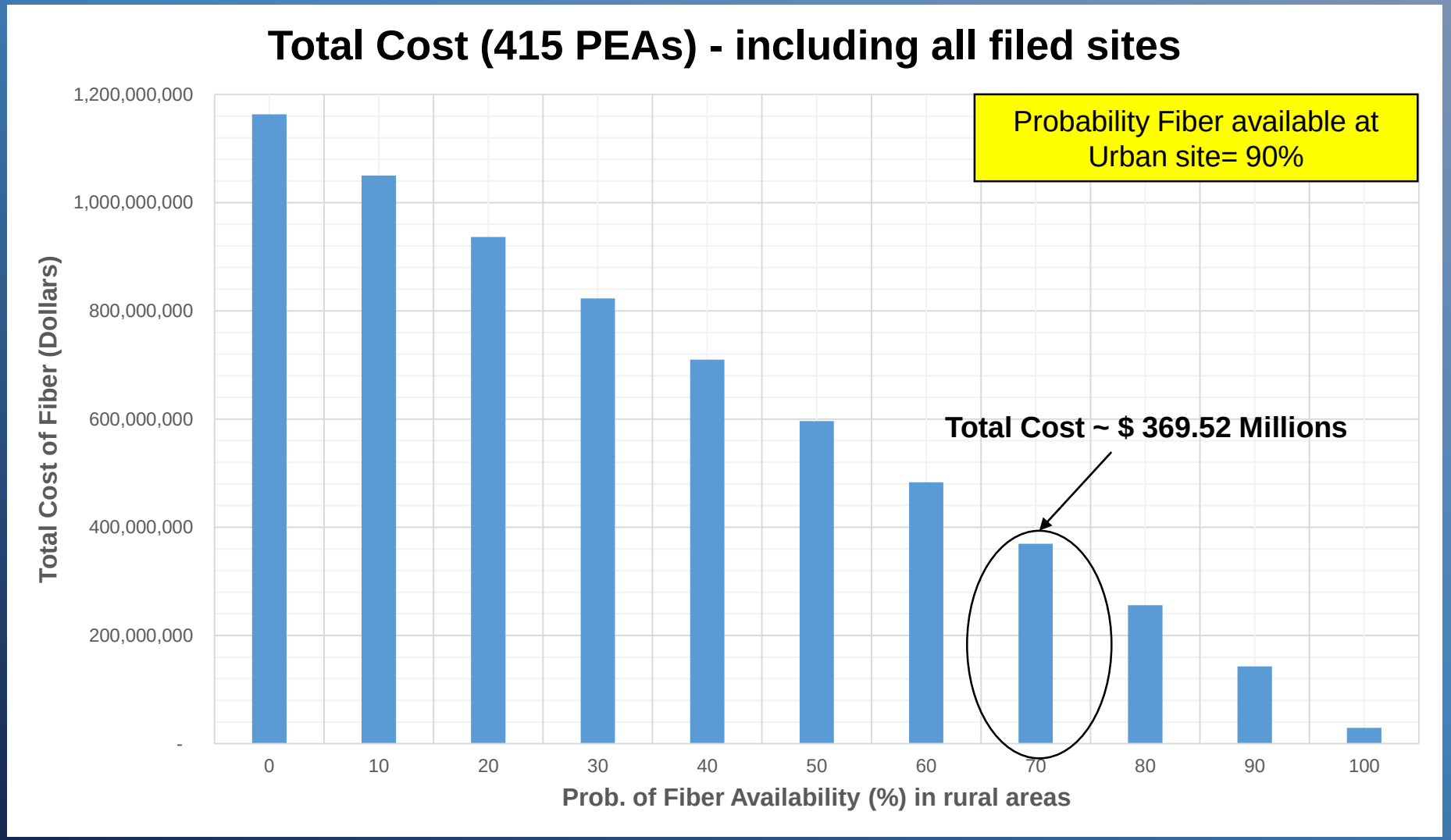
All Filed , Nationwide Replacement in all PEAs Analysis			
# of Satellite C-Band Receivers in urban sites	5,189	# of Satellite C-Band Receivers in rural sites	8,248
Average # of blocks to fiber access	1	Average # of blocks to fiber access	20
Length of city block = 660 x 330 feet	495	Length of a block = 660 feet	660
Average length of fiber (feet)	495	Average length of fiber (feet)	13,200
Cost per foot of fiber wire ($ per foot)	110	Cost per foot of fiber wire ($ per foot)	10
Probability 1 Gbps available (%)	90	Probability 1 Gbps available (%)	70
Cost of wiring urban site with fiber (including laying fiber, fiber termination costs)	56,450	Cost of wiring rural site with fiber (including laying fiber, pole attachment and fiber termination costs	137,500
Cost of replacig satellite w/ fiber for all existing urban sites	29,291,905	Cost of replacing satellite w/ fiber for all existing rural sites	340,230,000

Total Estimated Cost (All 415 PEAs) ~ $ 369.52 Million

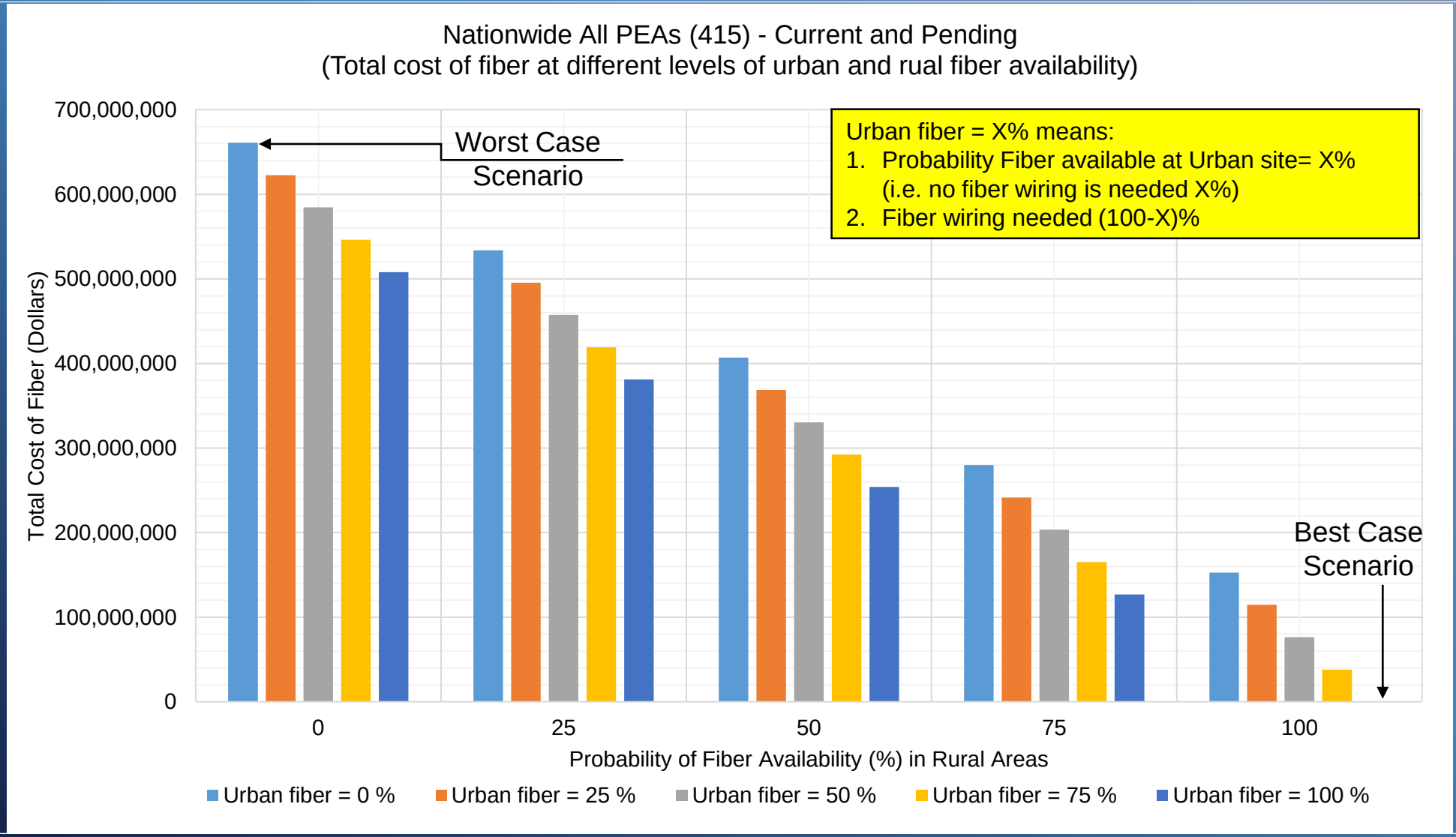
Total Cost (415 PEAs) - current and pending sites



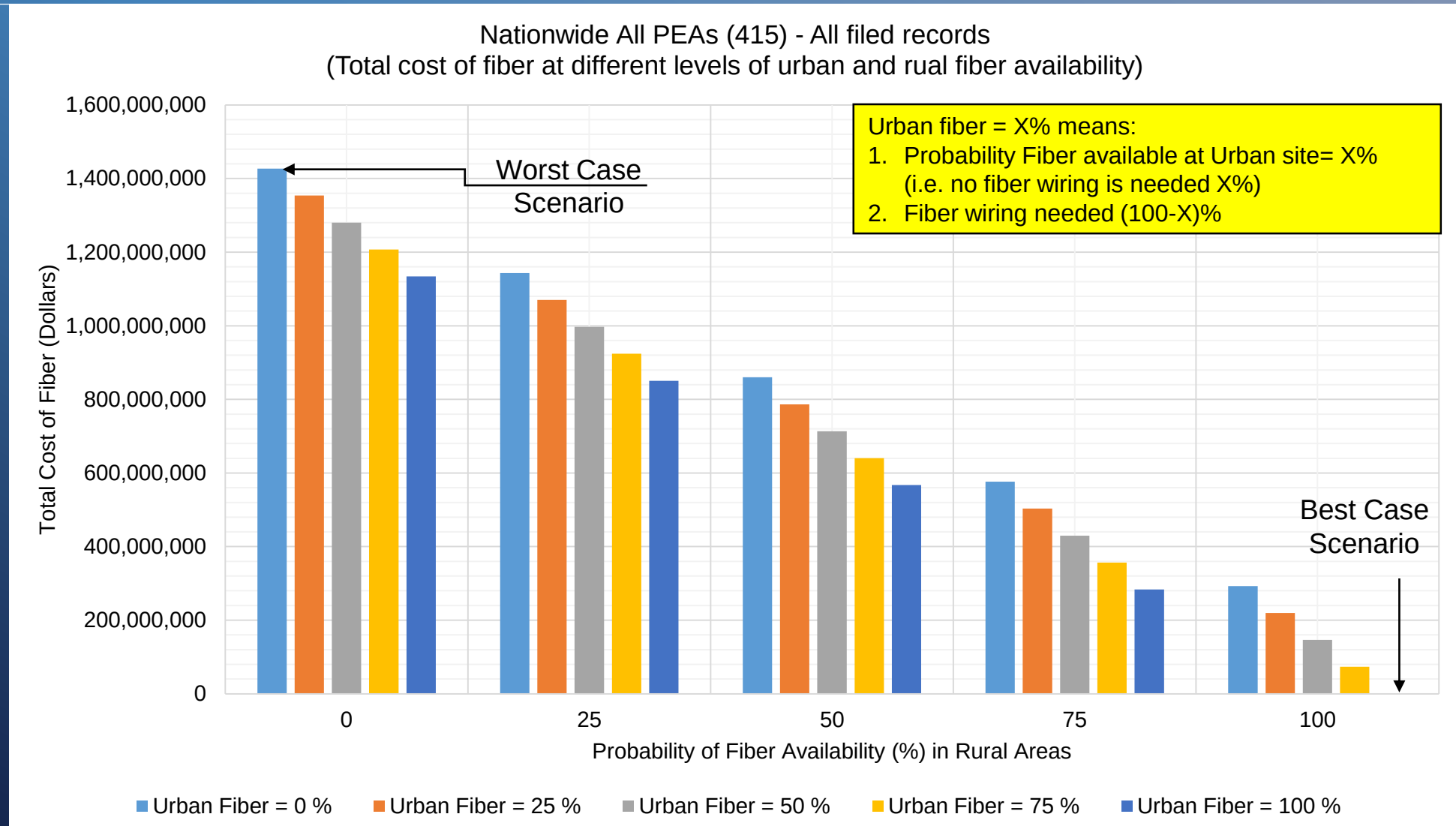
Total Cost (415 PEAs) - including all filed sites



Nationwide All PEAs (415) - Current and Pending



Nationwide All PEAs (415) – All filed records



Conclusions

- On a nationwide basis, satellite earth stations are located such that:
  - ~ 40 percent are in Urban areas/60 percent are in Rural areas
- Sample “urban” and “rural” PEAs help demonstrate our quantitative analysis of the fiber-replacement cost for all registered earth stations
  - In the Chicago, IL PEA:
    - 33% of all C Band sites are within 100 meters of a fiber run
    - 70% of all C band sites are within 1000 meters of a fiber run
    - 90% of all C Band sites are within 5000 meters of a fiber run
  - In Altoona, PA PEA:
    - 25% of all C Band sites are within 100 meters of a fiber run
    - 63% of all C band sites are within 1000 meters of a fiber run
    - 86% of all C Band sites are within 5000 meters of a fiber run
  - Median distance to fiber in representative urban PEA is 272 meters and 465 meters in rural PEA
- Based on current/pending and all filed records in IBFS:
  - Nominal cost to run fiber to every satellite earth station ranges between $167.70 - $ 369.52 Million
  - Worst case sensitivity case to run fiber to every satellite earth station ranges between $660.92 Million - $1.42 Billion
  - Regulatory or rights-of-way fees could further impact costs
- Estimates are very conservative with no attempt at optimization in this study. Cost of fiber can be further reduced with:
  - Consideration of additional fiber runs that exist but were not considered in this study
  - Optimization of fiber topology to cost efficiently connect clusters of sites