VERMONT

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December 3, 2018

The Honorable Peg Flory, Chair
Senate Committee on Institutions

The Honorable Steve, Carr, Chair
House Committee on Energy and Technology

The Honorable Ann Cummings, Chair
Senate Committee on Finance

The Honorable Alice M. Emmons
House Committee on Corrections and Institutions

Re: Report on E-911 Compliant Microcell Service in Vermont

Dear Honorable Senators and Representatives:

I am pleased to submit this report on E-911 Compliant Microcell Service in Vermont, pursuant to Section 233.2 (e) of H.13. that was passed this past year.

If you have any questions or concerns upon reading this report, please do not hesitate to contact myself or Clay Purvis, Director for Telecommunications and Connectivity.

Very Truly Yours,

June E. Tierney
Commissioner

REPORT ON E-911 COMPLIANT MICROCELL SERVICE IN VERMONT

Department of Public Service
December 3, 2018

Submitted to the House Committees on Corrections and Institutions, Energy and Technology; and the Senate committees on Finance, and Institutions

I. INTRODUCTION

Section E.233.2 of H.13 ("the Big Bill") directs the Department of Public Service ("Department") to "submit a report to the Senate Committees on Finance and on Institutions and House Committees on Energy and Technology and on Corrections and Institutions regarding E-911 compliant service in Vermont." In particular, the Commissioner of Public Service is directed to make findings and recommendations related to:

1. the financial viability of operating and maintaining a microcell network in Vermont using existing 2G technology as well as 4G technology.
2. whether changes to the state regulatory policy are needed to facilitate the availability of wireless E-911 service in Vermont.
3. whether the State should subsidize E-911 geolocation service charges incurred by microcell service providers on a permanent basis
4. the costs of completing a statewide propagation coverage analysis and whether such an analysis is needed to inform State policy, planning and investment with respect to wireless service in Vermont
5. the estimated costs of providing microcell service in Vermont including rates and charges related to electric, backhaul, and geolocation services, pole rental fees, backup-power requirements, colocation requirements, and any other costs deemed relevant by the Commissioner, and
6. any other matters deemed relevant by the Commissioner

Vanu CoverageCo was a company founded by the owners of Vanu, Inc., a manufacturer of radio antenna network devices and other wireless equipment. In 2011, the Vermont Telecommunications Authority issued an RFP seeking vendors to provide cell service along state highways that lack cell coverage from at least one provider. Vanu CoverageCo responded with a proposal to serve highways with small-cell technology. The technology consisted of Vanu Inc. manufactured RAN unit and antenna. The devices utilize consumer-grade digital subscriber line service for backhaul, making it less expensive and easier to deploy in rural areas. The devices were limited in coverage area, making it necessary to deploy many units in a daisy-chain formation along rural routes in order to achieve the VTA's coverage goals.

The VTA plan as implemented called for Vanu CoverageCo to lease back from the VTA the radio equipment that the VTA purchased from the company and to install the equipment along road corridors that the VTA identified as unserved. Vanu CoverageCo was also obligated to maintain a spectrum license and roaming agreements with national carriers. The company was also charged with supporting a core network, maintaining the equipment, and responsibility for all other functions of running a wireless network. The company was to pay for all ongoing operational expenses and rely on revenue from other wireless providers to cover these costs and generate a profit. Instead of charging individual subscribers for service like other wireless providers, the company employed a wholesale "roaming" business model where other wireless providers pay a per-minute fee when their subscribers place calls using its network. Callers of the four major retail providers could place a call with their mobile phone and CoverageCo would carry that call on behalf of the caller's carrier. Callers could dial any valid number, including 9-1-1. CoverageCo provided 2G level service capable of transmitting voice and SMS text. This

model entailed significant risk for CoverageCo since subscriber revenue in the unserved areas was unknown.

Vanu CoverageCo commissioned about 160 state-funded micro-cell units out of the 401 it was slated to complete. In the summer of 2018, the Vermont Department of Public Service[1] terminated the master lease agreements with Vanu CoverageCo for the company's ongoing and uncured breaches of those agreements. The microcell network is currently not operating, but 193 sites are installed on poles and could be used by another operator to bring wireless voice service, including access to emergency responders, to the areas previously served by CoverageCo.

On August 23, 2018, the Department issued a request for proposals seeking a new network vendor. Responses were due November 2 and the Department received two bids from qualified candidates. The Department is now carefully considering those responses in formulation of an alternative plan to provide coverage in the areas affected by the shuttering of the CoverageCo network.

II. FINANCIAL VIABILITY OF MICROCELL NETWORKS

The Big Bill directs the Department to analyze the financial viability of operating and maintaining 2nd generation (2G) and 4th Generation/LTE (4G) microcell networks in Vermont. There are challenges facing the successful deployment of both types of service.

The International Telecommunications Union Radio Communications Sector (ITU-R) is a trade organization that sets engineering and marketing specifications for wireless telephony and data services. 2G and 4G are sets of specifications established by the ITU-R. 2G was notable for its upgrade from analog wireless voice to digital. For purposes of this analysis the 2G service

[1] The Department of Public Service ("Department") became the successor in interest to the VTA in 2015.

provided by CoverageCo could transmit voice and SMS text using a DSL connection but was unusable for basic broadband functions. With 4G LTE, broadband data rates were increased to allow video streaming, gaming, IP telephony and other data intense applications. 4G technology requires a high-speed connection, such as a fiber optic cable connection, to provide the data rates necessary to meet the standard set by the ITU-R. The lack of access to fiber connections along some of CoverageCo's coverage corridors was an identified problem, but the State's fiber networks do provide access to dark fiber along several of the microcell corridors, namely routes 14, and 113 and 106.[2]

While there are many different small-cell antenna systems on the market, with wide ranges in capability, small-cell technology generally propagates a signal from between ¼ of a mile to ½ mile radius. Small cells are generally deployed in dense urban areas. The value of small cells is not in providing basic coverage, but in enhancing the capacity of existing "macro-cell" networks. Typically, small cells are affixed to the sides of buildings or utility poles. With the complementary coverage that small cell units provide, carriers can increase capacity on their networks, thereby serving the population with higher data rates. In locations where subscribers regularly congregate, such as a shopping mall or city center, small cells can enable the level of connectivity commonly associated with the yet-to-be-defined Fifth Generation ("5G") standard.[3]

Because small cells are deployed as a means of increasing capacity, their application in rural networks is very limited. Where wireless voice and data coverage is available in rural

[2] The term "microcell" refers to a component of wireless antenna networks that provide targeted coverage in small and clearly defined areas, generally for the purpose of increasing capacity. Small cells are differentiated from "macro-cell," which is defined by its high-powered antennas and large coverage area. Macro-cell sites generally consist of a compliment of antenna arrays affixed to a high mast or tower, which typically range from 90-180 feet above ground level. The typical macro-cell site covers a fixed radius of about 1-3 miles.

[3] 5G standards will likely include data transfer rates of up to 1 gigabit per second.

America, it is usually supplied by macro-facilities. Rural environments have lower populations spread over wider areas and are therefore less dense. To meet coverage objectives, carriers favor technology that can propagate a signal over a large territory.

Cell sites need electricity and backhaul service.[4] Additionally all carriers are required to comply with the requirements of the FCC's E-911 location rules. As discussed further in this report, the costs of operating a micro-cell site can range from $113-$147 per month, as cited by Vanu Coverageco in the past. Vanu CoverageCo estimated its average total per-site cost at $339 per site, per month.[5]

Roaming agreements are agreements between carriers to share voice and data traffic. Companies negotiate with facility owning companies for the right to roam on the network. Customers of the roaming company can use the facilities to place calls and access the internet. The facilities-based carrier carries and transfers the traffic to the roaming carrier. Roaming agreements are an important way for carriers to extend service to new areas without building infrastructure, and they provide for efficient investment in wireless infrastructure. Wholesale providers generate revenues by charging a few cents per minute for voice traffic and a few cents per megabyte for data traffic. Vanu CoverageCo had similar arrangements with all of the major carriers, including AT&T.

Microcells affixed to a string of poles along a highway only generate low revenues, due to the lack of traffic passing through rural highway sites. In order to generate revenue, the wholesale provider must earn many minutes. For instance, a 50-minute call at 4 cents per minute

[4] Backhaul service is best understood as a dedicated data circuit from the site to the carrier's network
[5] This figure includes the hosted core network expenses, site operating expenses and G&A/overhead for the company to operate 188 sites as reported in the plan it submitted to the Department on June 30, 2018. CoverageCo's average site specific costs were $147 per month per site.

would generate $2.00 for the microcell provider. In a situation where eight microcell sites are daisy chained along a highway, and the majority of each site's traffic comes from a moving vehicle, it is infeasible to expect that roaming traffic alone would support revenue sufficient to cover the ongoing costs of provisioning revenue.

To make any cell site economically viable a wireless carrier needs to generate revenue with the site. For the national retail carriers, this means increasing subscription rates in the area served by the facility. For a wholesale provider, such as Vanu CoverageCo, this means generating revenue from roaming agreements. CoverageCo estimated its average per-site revenue at $234 per site per month. The financial viability of a 2G or 4G microcell site depends just as much on revenue as it does cost. Any future deployments of microcell technology should take into account the expected traffic on the site, the expected revenues generated from the site, and the methodology used to calculate those numbers.[6]

III. WHETHER THE STATE SHOULD SUBSIDIZE "GEOLOCATION SERVICES"

The term "geolocation service refers to services provided by third party database providers authorized to supply Automatic Location Information (ALI) to the E-911 network, which, in the case of a wireless call, consists of longitude and latitude coordinates of caller. This data can be used by 911 call takers to dispatch emergency services to the callers exact location. The ability of the public to reach E-9-1-1 in an emergency is very important and is the greatest benefit to having the microcell network fully deployed and operational.

All wireless providers are required to comply with the FCC's E-911 rules. In order to comply, most, if not all, wireless carriers rely on a third-party vendor to manage and deliver E-

[6] Temporary test sites could be placed in possible locations to measure cell phone activity. Auto traffic data and population density could also be measured to determine an estimate of potential cell traffic at a proposed site.

911 ALI data to the E911 Public Safety Answering Point (PSAP). It should be noted that the FCC does not mandate how ALI data is delivered to the PSAP, but places the burden on the carriers to comply with the rules. There are two major providers of this service: West Corporation and ComTech Telecommunications Corp.

The Department believes that a subsidy forgeolocation services on a permanent basis would be problematic for three reasons. First, the relationship between third party database providers and carriers is purely contractual. The State has no authority or visibility into the rates charged by these companies or other terms and conditions of service. A public subsidy could place upward pressure on prices for these services without any ability of the State to control the final prices charged by the third-party vendor. Second, with the expected proliferation of small cell technology, any commitment to subsidize geolocation services could become cost prohibitive as more carriers build out small cell infrastructure. Lastly, while CoverageCo raised the issue of geolocation costs, other providers have not. As Vermont considers ways to encourage wireless development in rural Vermont, the State should broaden its focus to include the totality of costs incurred by wireless carriers of all types as they deploy in rural Vermont. Consideration should be given to these concerns before the State implements a program to subsidize the cost of complying with Phase II E-9-1-1 service

IV. PROPOSED CHANGES TO STATE REGULATORY POLICY

This section summarizes possible changes to state regulatory policy that state regulators and the Legislature may want to consider in order to enhance the availability of wireless infrastructure in rural Vermont. First, the State should consider whether the Vermont's wireless siting law should be made permanent. Second, this report recommends considering a permitting process that fast-tracks small cell development and protects other uses of the State's rights-of-

way. Third, the department makes recommendations related to electric tariffs for small cell operators.

The Telecommunications Act of 1996 expressly preempts states from exercising regulatory authority over many aspects of the provision of mobile wireless telecommunications service.[7] This express prohibition, coupled with the FCC's exclusive jurisdiction over the use of radio spectrum, and oversight of local zoning laws pertaining to the placement of wireless facilities, has greatly restrained the ability of the states to plan and direct the deployment of mobile wireless services. As a result of this comprehensive federal regulatory framework, Vermont is left with little legal authority to enact policies for increasing wireless coverage in rural Vermont.

Vermont has a land-use siting law under 30 V.S.A. § 248a for telecommunications installations designed to streamline government review of wireless facilities. The law is temporary and is slated to sunset in 2021. The sunset provision is an important opportunity for the Legislative and Executive branches to reassess the value of Section 248a to Vermont and consider changes. Nevertheless, with nearly ten years of success behind the law, it may be time to make this successful statutory process permanent. Providing a permanent permitting structure will enable cell providers to make long-term plans regarding new cell deployments.

Small cell deployments raise issues of siting, safety, and land use specific to small cell technology and network design. Yet, Vermont has no small cell siting law. Installations placed at under 50 feet above ground level do not trigger the requirements of Act 250. Section 248a is an optional siting law designed to provide a streamlined siting process outside the confines of Act

[7] 47 U.S.C. § 332(c)(3)(A)

250. Other than Section 1111 permits issued by the Agency of Transportation for work in the rights-of-way, the state has no official process for monitoring the deployment of small cell installations. A small cell siting law, such as the one passed by Rhode Island or the FCC model rule, would provide the state with valuable insight as to where small cells were being placed and how they are being used.

Another policy option would be to require the State's electric utilities to develop a tariff for small cell providers that charge a reduced cost for electric service. Under this policy the tariff would obviate the need for a meter and potentially eliminate or reduce the subscriber charge at each micro-cell site. While this is certainly a possible avenue for reducing the operations costs of small cell sites, it may not produce significant cost savings. Vanu CoverageCo was the only operator in Vermont asking for such a policy accommodation, which suggests that most, if not all, other carriers do not see electricity costs as a significant burden on the provision of wireless service. Furthermore, there are other ways under existing law that would allow an operator such as CoverageCo to receive a special rate for its equipment. Vermont law allows electric utilities, with prior PUC approval, to enter into special contracts with customers, in which the utility can offer rates that fall outside the utility's tariff. Nevertheless, changes in electricity rate policy should be explored if wireless carriers see such changes as beneficial to the ongoing support and expansion of wireless service in Vermont.

V. COSTS OF COMPLETING A STATEWIDE PROPAGATION ANALYSIS

This report includes findings and recommendations related to the costs of completing a statewide propagation coverage analysis and whether such an analysis is needed to inform State policy, planning, and investment with respect to wireless service in Vermont.

In 2010 and again in 2013, the Vermont Telecommunications Authority ("VTA") conducted studies that produced detailed wireless coverage information. Specifically, the studies delivered separate maps depicting the projected availability of voice and data services for each facilities-based wireless operator. The contractor employed a coverage simulation model that, based on tower site information, projected the likely extent of service. The VTA sought tower site information from the cellular operators and when it was unable to obtain the information, provided the contractor with tower site information gathered from 248a petitions. The contractor conducted drive tests to verify coverage and to refine the assumptions used in the model. It was unwieldy to interpret so many maps, so for the purposes of statewide analysis and statistics formulation, coverage from all carriers was aggregated into a single map. The aggregated map depicted the presence or absence of service from any of the six carriers without indicating which one served a specific area. Consumers' experience often differed from the information depicted on the map. Consumers also found it confusing that the map depicted information from multiple carriers.

In addition, 30 V.S.A. § 202e(e)(4) directs the PSD to annually identify "the areas served and the areas not served by wireless communications service". In the past, instead of developing independent analysis the PSD relied upon the publicly available coverage information submitted by providers to the FCC on Form 477 for this submission. It is the Department's understanding that consumers' experience sometimes differs from the information published by the FCC on from the Form 477 data.

Request for Information

On October 22, 2018, the Department issued a Request for Information (RFI) to gather input and obtain information and cost estimates to determine the costs of completing a statewide

propagation coverage analysis. The RFI stated that the information was sought in the context of consideration of the future of the state-funded microcell network. The key objectives of the RFI were to provide information to assist the state in determining:

- the appropriate deliverables for a "statewide propagation coverage analysis";
- whether such an analysis requires estimated modeling, empirical drive testing, or both;
- whether the information required by contractors to perform the task is publicly available, or can reasonably be acquired;
- whether this information can be suitable for the annual, ongoing reporting requirements;
- the a.) precision, and b.) accuracy of any such report, and the cost/benefit ratio of improving accuracy and precision;
- if identified requirements can be met in a cost-effective manner;
- if identified requirements can be met by available software/hardware COTS (Commercial off the Shelf) alternatives, or with publicly available information.

The RFI stated: "Respondents should prepare cost estimates for a project that would include separate analyses for voice and data services for each of the six facilities-based providers of CMRS in Vermont: AT&T, Verizon, US Cellular, T-Mobile, Sprint, and VTel Wireless. In addition, for voice and data respondents should prepare a single aggregated dataset indicating the presence and absence of service from any provider."

RFI Responses

The PSD received two responses to the RFI. One company recommended departing from the VTA approach. Instead of relying on modeled, estimated, or predicted coverage, this company recommend using actual data, explaining that "[p]redicted analysis may also be used,

but it is only valuable for calculating the maximum potential coverage area, not actual coverage. The only way to get true coverage data is to collect it." This company recommends a methodology that combines collecting actual data, and also collecting crowd sourced data. The company estimated that the cost to provide the analysis sought was approximately $335,000.

Another company recommended an approach similar to the one employed by the VTA. Specifically, the company recommended a process that involved both propagation modeling and drive testing. The company stated that like the VTA analysis, the propagation model would require tower site information. This information could be sought from the providers. Providers are obligated by the FCC to share tower site information with E-911 authorities, but this information is subject to confidentiality agreements. It may be possible for the Vermont E-911 Board to share this information with a propagation consultant, but unlikely without carrier support. Another option would be to use the tower site information from public records in 248a proceedings. While this information would not be complete, the analysis could use assumptions to fill in missing information. The company estimated that the project would cost approximately $130,000, including drive testing roughly in line with that done in the previous VTA analyses.

FCC Mobility Phase II Challenge

The FCC will make up to $4.5 billion in support available over 10 years to primarily rural areas that lack unsubsidized 4G LTE service through a program called Mobility Phase II. The FCC developed a process to ensure that funding is directed to unserved areas. Specifically, the FCC required cellular wireless service providers to submit maps, on a confidential basis, that depict availability of 4G LTE service, defined as offering consumers access to service at 5 Mbps. The FCC invited states to challenge this asserted wireless coverage if they believe that it does not accurately reflect actual availability. The FCC developed sophisticated rules and specifications

for the challenge process that require multiple download speed tests within a 1-kilometer square "cell" for each carrier that asserted service in that cell.

PSD staff obtained and reviewed the confidential filings by the companies and found that they do not accurately represent availability of service. In order to ensure that more territory in Vermont will be eligible for the forthcoming grants, the Department decided to mount a challenge. The FCC cut the state into 25,438-one square-kilometer cells. There are more than 15,000 miles of roads (class 4 and above) in the state, and 25% of the cells contain no roads. Given these facts, and the lack of an available budget and the short time frame, it was impossible to mount a challenge to all cells. The PSD developed a methodology that involved driving the state and federal highways, and also additional tests in the designated downtown and village center areas. PSD staff identified an Android smartphone application that performed the required download tests while in motion. From October 2, 2018, through November 20, 2018, PSD staff drove the approximately 7,000 miles, all the while collecting 187,507 download speed tests.

The PSD submitted the challenge on November 26. According to the FCC automated process, the challenge included 6065 cells across the state. Of these, 789 cells met the challenge requirements. An additional 3,397 cells showed download speeds from all reported carriers below the 5 Mbps threshold but lacked sufficient tests in the cell. Another 1,879 cells were tested, but the challenge was rejected, either because no tests with speeds below the 5 Mbps threshold were presented, or because the test were not in the asserted coverage area of a provider.

The challenge did not require outside contractors and thus had limited costs. The project required approximately 3 months of staff time or about $11,250. PSD staff employed state fleet

cars for the driving, which generally costs $0.40 per mile, or about $3,000. The project required the purchase of six handsets and service for three months at a cost of about $3,000.

Forthcoming Analysis

While the 2018 drive test was primarily conducted for the FCC Mobility Phase II challenge, the data will serve other purposes as well. Specifically, the handsets recorded download speeds at intervals of approximately 300 meters along the traveled routes. The PSD will provide analysis, statistics and maps in the forthcoming Connectivity Division annual report. It is important to note that while this data includes 187,507 data test points, it only addresses 6,065 of the 25,438 cells in the state. Moreover, there is a diversity of service within each cell. To be clear, the results themselves address only the actual download tests, also only along major roads and village centers and do not include any propagation estimates. Importantly, the analysis will include a review of the wireless service at the 421 current and planned CoverageCo microcell sites to determine whether service at these locations is still necessary. A preliminary review of the data shows that of the 193 installed CoverageCo sites, 121 have cell coverage of some kind by at least one of the six national retail carriers.[8] Members of the public with a compatible handset should have access to emergency services at 121 microcell sites through other providers. The following chart breaks down service at installed sites by carrier.

Download speeds recorded within 400m of installed microcell sites (191)

Service (Mbps)	Any Carrier	Verizon	AT&T	VTel	US Cellular	Sprint	T-Mobile
0	70	163	144	119	164	118	152
> 0 < 0.254	15	9	7	5	21	11	22
> 0.255 < 4.9	46	12	20	37	5	45	7
> 5.0	60	7	20	30	1	17	10
Total, > 0	121	28	47	72	27	73	39

[8]The Department measured service at the 193 installed sites. Many of these sites have coverage from multiple carriers. The 193 sites includes sites both commissioned by CoverageCo and installed but not commissioned.

VI. ESTIMATED COSTS OF PROVIDING MICROCELL SERVICE IN VERMONT

The operational costs of provisioning mobile wireless service with small cell technology is likely the same or similar in Vermont to any other state. Costs for the microcell network can be split into two types of costs: site-specific expenses and core expenses. Site-specific expenses include electricity, backhaul, 911 location service, and pole attachment fees. Core expenses include network and switching costs, overhead and maintenance.

A carrier needs radio spectrum over which it can propagate a radio signal. Exclusive use of spectrum can be purchased through an FCC auction or leased on the secondary market. Spectrum leases are lightly regulated by the FCC and are the generally held to a reasonableness test. Spectrum can be leased in two ways and are accomplished either as a *de facto* lease or obtained through the FCC's Spectrum Manager.[9] The Department does not have cost data for spectrum leasing but notes that leasing of spectrum was not an identified cost barrier for CoverageCo.

The site-specific costs were $147 per site, per month. The VTA had contracted for 401 sites. At this rate the per site cost is $58,947 per month to run the sites or $707,364 per year. According to CoverageCo, hosted core expenses and G&A/Overhead would total $583,680 per year.[10] The total cost to run 401 state funded sites would be $1,291,044 under this analysis.

[9] For more information on spectrum licensing visit the FCC's website at https://www.fcc.gov/wireless/bureau-divisions/technologies-systems-and-innovation-division/spectrum-leasing

[10] CoverageCo, *Preliminary Plan*, June 30, 2018. CoverageCo estimated this cost for 454 sites – not 401

CoverageCo did not provide a breakdown of costs in its June 30 Plan, it is not possible for the Department to accurately assess CoverageCo's assumptions about the cost of each discrete service. In 2017, however, CoverageCo supplied information to the Vermont Legislature asserting that the per site cost was $113 per site, per month.[11] With 401 sites the annual per-site cost of operating the network would be $543,756. Using the same network and overhead expenses listed above the total cost of operating 401 state-funded sites under this analysis would be $1,127,436.

CoverageCo estimated it earned an average $234 per site per month in revenue, split between voice ($172) and data ($62). CoverageCo provided no traffic history analysis to support this figure. Nevertheless, using this figure, the micro-cell network could expect $1,126,008 with 401 deployed sites. This figure suggests an annual losses of between $1,428 and $165,036 under CoverageCo's June 30 revenue predictions.

VII. ADDITIONAL CONSIDERATIONS

The Capital Bill appropriated $900,000 in funding to the Department to support and expand the microcell network. As previously noted, the Department exercised its rights under the Master Lease Agreements with CoverageCo to terminate the agreements for CoverageCo's continuous and uncured breach of those agreements. The Department is in the process of selecting a new vendor to provide coverage in the areas that are unserved by CoverageCo today. While the Department is unable to discuss the details of the responses, it should be noted that no respondent offered the same business model as CoverageCo. One Respondent suggested using CoverageCo's equipment as a stop-gap while investments in new technology can be made, while the second

[11] See *Creating a Sustainable Path to 911 and Cell Service Expansion*, Matt Dunne, House Energy & Commerce, April 18, 2017. This analysis included a breakdown of site specific charges.

proposed using completely different technology to support the same coverage goals established by the State in 2011.