



STARTM

FCC Progress Report IV

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I. Introduction

On February 15, 2019, Starry, Inc. (“Starry”) filed its third Progress Report with the Federal Communications Commission (“FCC” or “Commission”) to update the Commission on Starry’s progress in developing, deploying, and testing its wideband hybrid fiber wireless (5G fixed wireless) broadband network. This fourth Progress Report contains new updates and lessons learned regarding Starry’s deployment in the markets in which it holds an experimental test authority license.

As the industry finds itself in the midst of a major technological transition to 5G, the Commission has taken numerous steps to foster ubiquitous, affordable broadband services.¹ From the adoption of flexible spectrum policies – including important spectrum sharing opportunities – to addressing obstacles to infrastructure deployment, the FCC continues to provide new entrants the opportunity to successfully compete with well-entrenched incumbents. But even with these important advances, more work remains to connect every consumer to reliable, affordable broadband access. The Commission’s 2019 Broadband Deployment Report found that 21.3 million Americans still lack broadband access,² and nearly half of all consumers lack meaningful choice for their broadband service.³ There is a clear need for expanded broadband in every community across the United States, and Starry is proud to advance the FCC’s efforts to bolster meaningful competition through the deployment of innovative technology and the use of its experimental test authority license.

¹ *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services; Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services*, Third Report and Order, Memorandum Opinion and Order, and Third Further Notice of Proposed Rulemaking, GN Docket No. 14-177, 33 FCC Rcd 5576 (2018); *Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment*, WT Docket 17-79, Second Report and Order, FCC 18-30 (rel. Mar. 22, 2018); *Updating the Commission’s Rules for Over-the-Air Reception Devices*, WT Docket No. 19-71, Notice of Proposed Rulemaking (Apr. 12, 2019); *Improving Competitive Broadband Access to Multiple Tenant Environments*, GN Docket No. 17-142, Notice of Proposed Rulemaking and Declaratory Ruling, (July 10, 2019).

² *Inquiry Concerning Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion*, 2019 Broadband Deployment Report, GN Docket No. 18-238 ¶ 2 (rel. May 29, 2019) (“2019 Broadband Deployment Report”).

³ ArsTechnica, “50 Million U.S. Homes Have Only 25Mbps Internet Provider or None At All,” (last accessed Dec. 1, 2019), available at <https://arstechnica.com/information-technology/2017/06/50-million-us-homes-have-only-one-25mbps-internet-provider-or-none-at-all/>.

The benefits of ubiquitous broadband access are well known.⁴ Broadband access is critical to the nation's economic success - connecting people with employment opportunities, healthcare and education services. Indeed, 80% of middle-skill jobs now require some type of digital skills,⁵ and nearly 70% of teachers assign homework that requires an internet connection.⁶ And for vulnerable communities, such as the elderly or homebound, broadband access is the critical bridge to combatting social isolation.⁷ Broadband users also are more likely to vote and be involved in civic activities in their communities, and a reliable broadband connection helps families and friends maintain relationships with loved ones in an increasingly mobile world. In a consumer survey conducted by Starry in May 2019, more than two-thirds of Starry subscribers said that their internet connection helps them to better connect with families and friends – nearly the same percentage as those who use the internet to perform better at their jobs and to stay up-to-date on current events. As a result of these connections and the knowledge that comes with them, communities with gigabit broadband generate over \$1 billion in additional GDP when it is widely available.⁸

Starry is at the forefront of deploying next-generation technology so that all consumers can realize these benefits of broadband. As a result of continued access to its market test

⁴ See, e.g., *Communications Marketplace Report*, Report, GN Docket No. 18-231 (rel. Dec. 26, 2018); 2019 Broadband Deployment Report; Ajit Pai, "Bridging the Digital Divide" (July 13, 2017), available at <https://www.fcc.gov/news-events/blog/2017/07/13/bridging-digital-divide>.

⁵ Burning Glass Technologies, "The Digital Edge: Middle-Skill Workers and Careers" (2017), available at https://www.burning-glass.com/wp-content/uploads/Digital_Edge_report_2017_final.pdf.

⁶ Common Sense, *The Homework Gap: Teacher Perspectives on Closing the Digital Divide*, (2019), available at https://www.common Sense media.org/sites/default/files/uploads/kids_action/homework-gap-report-2019.pdf. What's more, 52% of hospitals in the United States connect to patients over broadband using at least one form of telehealth, and this access is considered a "super determinant" of health." See, The Benton Institute, "Broadband for America's Future: A Vision for the 2020s" at 15 (Oct. 2019), available at https://www.benton.org/sites/default/files/BBA_full_F5_10.30.pdf.

⁷ See Elaine Ryan, "AARP is Fighting for High-Speed Internet for All" (Aug. 21, 2018), available at <https://blog.aarp.org/where-we-stand/aarp-is-fighting-for-high-speed-internet-access-for-all>; Christopher Baker, AARP Public Policy Institute: "A Connection for All Ages: Enabling the Benefits of High-Speed internet Access for Older Adults" (Mar. 2013), https://www.aarp.org/content/dam/aarp/research/public_policy_institute/cons_prot/2013/connection-for-all-ages-insight-AARP-ppi-cons-prot.pdf.

⁸ Analysis Group, "Early Evidence Suggests Gigabit Broadband Drives GDP," (last accessed Nov. 30, 2019), available at https://www.analysisgroup.com/globalassets/content/insights/publishing/gigabit_broadband_sosa.pdf.



authority, Starry has continued to refine its technology stack; launched an ultra-low-cost, competitive broadband product in public and affordable housing; and continued to raise capital to finance its research and development and network expansion. Starry is now deploying its second generation of network technology, enabling gigabits per second service up to 3km in range, and now passes more than three million households in five markets, with plans to expand to additional markets in the coming months. Starry's success is a tangible example of how consumers *today* are directly benefiting from the policies adopted by the Commission, and from our ability to deploy, operate and serve customers in these markets. But even with this forward progress, there is much work still to do to enable this success.⁹ In this fourth Progress Report, we attempt to highlight Starry's recent successes and provide examples of areas that continue to be pressure points to the advancement of advanced fixed wireless service.

II. Company Background & Technological Approach

Starry is an innovative Boston-based technology company and broadband provider that uses millimeter wave spectrum to provide proprietary, wideband hybrid fiber wireless connectivity at a fraction of the cost of other providers.¹⁰ Starry was founded in 2014 by a talented team who created and built a full-stack technology consisting of a network-node ("Starry Beam"), a home receiver ("Starry Point") suitable for single family homes or multiple-dwellings ("MDUs"), and an in-home Wi-Fi access hub ("Starry Station"). To date, Starry has invested more than \$300 million in technology research, network deployment and service, and customer care, and will invest additional significant financial resources over the next year.

⁹ See, e.g., Remarks of FCC Chairman Ajit Pai, Federalist Society 2018 National Lawyers Convention, "The current landscape of telecommunications law," (Nov.16, 2018), <https://docs.fcc.gov/public/attachments/DOC-355136A1.pdf>; FCC 2019 Broadband Deployment Report.

¹⁰ Starry defines its technology as "pre-standard 5G" because Starry does not utilize 3GPP 5G NR radio technology in its base stations and more broadly, believes that for the average consumer the term "5G" represents a wider basket of access technologies that enable high-capacity, low-latency connections. Starry is not utilizing the 3GPP ecosystem, but rather is utilizing the more diverse 802.11 (WiFi) radio ecosystem governed by the IEEE standards body for our baseband technology.

As described in this Progress Report, Starry is a unique, home-grown maker of advanced fixed wireless technology and a competitive force in the fixed broadband marketplace, thanks in large part to its market test authority.

In October 2019, the FCC renewed Starry's experimental market test authority license for the 37.0 to 38.6 GHz band in 22 markets. Since its initial grant and to date, Starry has performed extensive tests to characterize the performance of these bands, including ongoing tests for weather, foliage, and seasonal impacts in both urban and suburban environments. Starry also continues to develop its plans to extend its reach into less dense suburban areas. As required by grant of this license, this fourth Progress Report details advancements and lessons learned from the past year.

Starry's Technological Approach

As described above, Starry's technical architecture includes three key components: Starry Beam, the network-node which communicates using millimeter wave spectrum to Starry Point, the at-premise transceiver, which connects to Starry Station, the in-home Wi-Fi hub.

Starry Beam utilizes an active phased array for Point-to-Multipoint delivery of last-mile fixed broadband to consumer premises. We utilize 802.11ac and 802.11ax baseband technology in our infrastructure to facilitate 4x4 and 8x8 Multi-User MIMO and marry the two technological approaches to create a highly efficient, extremely low-cost, high-capacity internet delivery system. This unique approach to beamforming is especially efficient for use of Starry's millimeter wave spectrum due to the small sizes of the associated antennas. This network construct also allows Starry greater control over the performance of its internet service from end-to-end, which provides an improved, consistently high-quality customer experience.

Throughout 2019, Starry built and deployed its second-generation base station and at-premise transceiver, which dramatically decreased deployment costs while increasing capacity. Starry's second generation base station is a unique multi-band device, designed entirely in-house, that combines the ability to transmit on licensed millimeter wave spectrum and on 5 GHz and 60 GHz, respectively as backup and nearfield channels. As noted in Starry's third Progress Report, the next iteration of our second-generation base station equipment

incorporates 802.11ax technology with OFDMA and additional MU-MIMO functionality, further increasing the capacity and throughput of each base station.

In addition, Starry designed and is preparing to deploy its first single-family home (SFU) transceiver. This advancement will allow Starry to provide a gigabit-capable service to single family homes at a fraction of the cost. These transceivers are small and simple to install, and can split capacity 16 times, allowing, for example, one transceiver to serve a series of row homes.

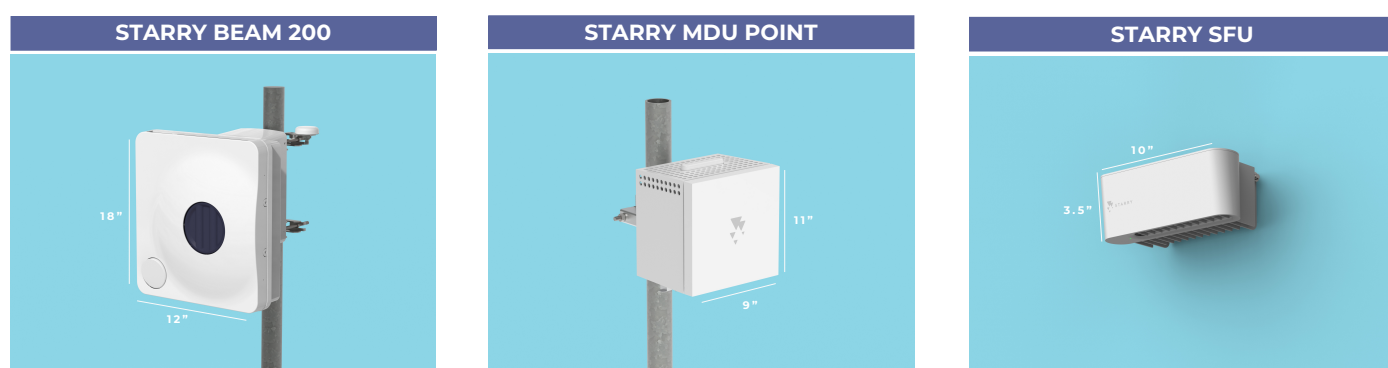


Figure 1. Second-Generation Starry Network Equipment.

Additionally, Starry is preparing to launch its upgraded Starry Station, the in-home Wi-Fi hub. The innovative Starry Station will be upgraded to 8x8 802.11ax configurations and include an interactive screen paired with mobile applications for in-home Wi-Fi management, control over connected devices, parental controls and the ability to conduct speed tests. In line with Starry's "customer first" white-glove philosophy, this second iteration of the Starry Station also will feature integrated chat and text capabilities in the mobile app for enhanced customer support.





Figure 2. Second-Generation Starry Station.

Combined, our technology advantage and the use of millimeter wave spectrum deployed at elevations above the clutter allow us to serve customers at a fraction of the cost of traditional wireline technology. And as a result of the continued ability to advance our technology, our costs continue to fall by ~50% year-over-year. Using current generation technology, we are able to deploy a gigabit-quality service passing a household at under \$10 per home passed.

With the help of the FCC's test authority, we are proud to have these tests realized in a physical network that is connecting consumers across the country to an affordable broadband option that boasts an average network performance of 258 Mbps download speeds with 288 Mbps upload, as measured the last quarter of 2019.

Consistent with Starry's previous Progress Reports, the FCC's experimental market test authority has served exactly as intended: we took an early and significant risk to develop a new technology, deployed stable but early versions for real-world testing, and have tested and deployed a business model in an operational environment.

We also gathered critical technical data on how millimeter wave bands behave in a variety of real-world conditions and collected valuable insight from consumers to better understand the market appetite for new products, and the barriers to their adoption. We look forward to continuing to apply this data to create a robust and competitive broadband marketplace for all Americans.

III. Starry's Network Deployment

a. Opportunities & Obstacles

In Starry's previous Progress Reports, we detailed our extensive efforts to plan for and reduce barriers to deployment. From continuing to shrink the size of our base stations to designing a diverse array of CPE to be compact and responsive to challenging deployment areas, Starry continues to apply a progressive approach to swift connectivity. However, even with significant investment of time and resources, deployment barriers continue to challenge Starry's growing footprint.

Starry understands that minimizing equipment size and increasing efficiency are primary factors to expeditious deployment. As noted, Starry typically deploys its base stations on vertical assets: specifically, managed rooftops or towers that are at least 100 feet in elevation. Because of the propagation characteristics of millimeter wave spectrum deployed at elevation above clutter, Starry only needs to deploy tens of sites to provide citywide coverage – as compared to other providers in the midst of deploying hundreds or thousands of small cells to meet a similar footprint.

Starry also purpose-built our base stations to be more compact to reduce siting barriers that often plague larger equipment installations. As a result, Starry's network design allows us to take advantage of FCC rules to expedite infrastructure deployment, such as meeting the requirements for the Commission's Over-the-Air-Reception-Devices ("OTARD") rules and policies governing deployments on and within MDUs.¹¹ The design of our hardware is critical to a rapid and scalable deployment strategy. We will continue to innovate on these designs to utilize every regulatory streamlining tool available to us.

¹¹ 47 C.F.R. § 1.4000.



While the Commission has made significant strides to increase infrastructure deployment since Starry's last Progress Report,¹² there is more work to be done by both policymakers and providers hoping to close the digital divide. For example, in many municipalities, the permitting process can still take up to 90 days or more to complete.¹³ Many municipalities also lack the personnel to deal with the sheer volume of applications, and others are not up to speed on new regulations or how to permit new, unfamiliar technologies that are smaller in footprint than traditional cellular installations. As discussed in more detail below, obstacles likewise remain as related to deployments on MDUs when exclusivity arrangements are in effect. Tailored policies can address these barriers and further advance next-generation technology throughout the country. We therefore welcome the Commission's ongoing efforts to modernize existing rules, such as the OTARD rules and updates to deployments on and within MDUs.

b. Market Deployment Status

In late summer 2016, Starry launched its initial beta service in the Boston area and targeted areas where the population density was a minimum of 1,000 homes per square mile. Since that time, Starry's network has been stress-tested against a variety of factors like inclement weather and foliage, and our network remains resilient even in these difficult conditions. We deliver high-quality, affordable broadband that focuses on the customer first – meaning no bundles, no data caps, no long-term commitments, no additional equipment or installation fees, strict privacy protections, and an adherence to net neutrality. Based on these principles, today, Starry is serving customers in the Boston, Los Angeles, New York City, Washington, DC, and Denver markets.

Consumers in all markets are offered a monthly, no contract, no installation fee, no data cap plan of 200 Mbps down/up for a flat rate of \$50 per month, inclusive of all equipment, and installation. With standalone broadband service costs at over \$80 on average – Starry serves as

¹² See *supra*, note 1.

¹³ While Starry's base stations are afforded a 60-day review period, local governments will simply deny the application within the period or request alterations to an application, and we are then required to re-start from square one.



an alternative for consumers who seek an affordable, reliable broadband-only connection.¹⁴ And as described in greater detail below, Starry is committed to connecting customers in affordable housing through our Starry Connect program, which provides a 30 Mbps symmetrical service for only \$15 per month with no individual pre-qualification or complicated eligibility requirements.

Starry also continues to prioritize the customer experience as part of its market test. Starry takes a white-glove approach to installations and customer care, with the aim of reducing customer frustration and increasing customer satisfaction. Today, Starry has a 4.95-Star Rating (out of 5 highest possible) for all installations and our overall Net Promoter Score hovers around 70.¹⁵ Starry continues to refine its customer service processes with a goal of maintaining 100% customer satisfaction.

Market Status

Updated January 1, 2020

Market	Status
Boston, MA	Customer operations. Continuing to expand network footprint across the metro area.
Los Angeles, CA	Customer operations. Continuing to expand network footprint across metro area.
Washington, DC	Customer operations. Continuing to expand network footprint across metro area.
New York Metro	Customer operations. Continuing to expand network footprint across metro area.
Denver, CO	Customer operations. Continuing to expand network footprint across metro area.
San Francisco, CA	Customer operations. Market is in beta stage. Base station construction pending permitting.
Chicago, IL	Rooftop leases executed. Awaiting final permitting. Construction pending.
Cleveland, OH	Base station site construction complete.
Houston, TX	Base station site construction complete.
Dallas, TX	Base station site construction complete.
Seattle, WA	Base station site construction complete.
Atlanta, GA	Base station site construction complete.
Philadelphia, PA	Base station site construction complete.
Indianapolis	Base station site construction complete.
Seattle, WA	Base station site construction complete.

¹⁴ AllConnect, "Are You Paying Too Much for Internet" (May 10, 2019), available at <https://www.allconnect.com/blog/cost-of-high-speed-internet>.

¹⁵ Net Promoter Score is a measure on a scale -100 to 100 of customers' willingness to recommend a product or service. One of the largest publicly available sources puts the Net Promoter Score for ISPs on average at 0. See <https://npsbenchmarks.com/industry/telecommunications/internet-service-provider>.



Market	Status
Minneapolis, MN	Base station site construction complete.
Memphis, TN	Base station site leased, pending construction.
Phoenix, AZ	Base station site leased, pending construction.
Sioux Falls, SD	Base station site leased, pending construction.
Detroit, MI	Base station site leased, pending construction.
Portland, OR	Base station site leased, pending construction.
Miami, FL	Base station site leased, pending construction.
Manchester, NH	Base station site lease under negotiation.

c. Starry Connect

Starry understands that closing the digital divide – especially for low-income consumers – remains one of the Commission’s top priorities.¹⁶ While the FCC has advanced smart policies to meet this goal over the last year, digital inequities remain, and often are exacerbated by incumbents’ affordable access plans that do not offer speeds that qualify as broadband,¹⁷ or that contain qualification thresholds that are often impossibly high for most families to meet.

Starry Connect takes a different approach. Launched in August 2018, Starry Connect provides free and low-cost internet access solutions through direct partnerships with public and affordable housing owners. For \$15/month, Starry Connect participants gain access to a 30 Mbps symmetrical plan, with no data caps, no long-term contracts, no extra equipment or installation fees and the same white-glove service that is a hallmark of Starry’s internet service. Importantly, the 30 Mbps symmetrical speed represents a floor – not a maximum plan speed for participants. Starry also does not require credit checks or individual eligibility requirements to participate. Rather, Starry ties the eligibility to participate in Starry Connect to the apartment community, not the individual, so regardless of who lives in ‘Apartment 3A,’ if the unit is a part of the Starry Connect program, the resident will always have access to the ultra-low-cost plan. Starry’s goal is to reduce barriers to adoption and relieving the consumer of the burden to ‘prove eligibility’ is a key component that distinguishes Starry’s Connect program from incumbents.

¹⁶ See 2019 Broadband Deployment Report.

¹⁷ EveryoneOn, *Low-Cost Internet Service and Devices*, available at <https://www.everyoneon.org/lowcost-offers>.

To date, Starry has partnered with Related Companies, the nation's largest private owner of affordable housing and a number of other affordable housing owners to connect, as of January 2020, more than 5,000 affordable housing units to the program. Starry has also launched partnerships with public housing owners including the Boston Housing Authority and the Denver Housing Authority and is in talks to expand its presence in public housing communities across the country.

In the fall of 2019, Starry had the distinction of being designated as an official ConnectHomeUSA Stakeholder, a program of the U.S. Department of Housing and Urban Development that aims to increase broadband expansion and adoption in federally subsidized housing. As an official ConnectHomeUSA stakeholder, Starry can accelerate the expansion of its ultra-low-cost broadband access to more public and affordable housing communities across the United States.

Starry Connect has been eagerly received by tenants and owners alike, and we intend to expand this program across every market where Starry has a presence.

d. Lessons Learned

In Starry's previous Progress Reports, we detailed several critical data points about the Starry subscriber, and expand upon these lessons for this current Progress Report:

- 1. Consumers continue to exhibit an insatiable demand for data.** Industry is welcoming a new era of technology and as innovation continues to flourish, consumers' data consumption outpaces even our own expectations. The average Starry customer consumes more than 350 GB/month; the top 5% consumes more than 750 GB/month; and the top 1% consume more than 1.3TB/month. These numbers continue to grow, and our customers benefit from our un-capped service.
- 2. Symmetry and latency are increasingly important to consumers.** A recent survey of our customers revealed that 95% use the internet for streaming video content, and *more than two-thirds* of those customers work from home for at least a significant portion of their work week. What's more, nearly 50% of Starry's customers use the internet specifically for career development, and as noted, 60-70% of teachers now assign

homework that requires an internet connection.¹⁸ Symmetrical, low-latency connections are therefore critically important to support seamless video conferencing, generate or transmit complex files, and support other applications that require robust download and upload capacity. We expect each of these trends to increase in importance as the overall workforce and education system evolves towards more flexible arrangements.

3. **Privacy protections are important to our users.** Consumer privacy has arisen as a key concern of modern consumers and policymakers alike. Starry has taken a proactive and aggressive approach to privacy throughout the last year. In October 2019, Starry updated its privacy policy to provide consumers with greater control over their personal information. We also underscored several foundational principles for Starry’s handling of consumer information: we do not sell data about our users to any third-party; we do not perform deep packet inspection, nor do we look at or keep user browsing data; and we only collect the data necessary to provide our customers with excellent service. These simple tenets have strong resonance with our customer base.
4. **Broadband remains financially out of reach for many, but real estate partners and cities are eager to help close the digital gap.** Starry continues to develop creative relationships with public and private owners of affordable housing properties willing to help provide low-cost broadband access through the Starry Connect program. Starry has agreements in place with housing authorities in Boston and Denver, and partnerships with private affordable housing owners to provide free or low-cost service to their residents. Importantly, this service is available without complicated eligibility hurdles – any resident living in a participating community can subscribe.
5. **Supply chain security is at the forefront of consumers’ and policymaker’s priorities.** The issue of 5G technology security has grown ever more important since Starry’s last Progress Report. Policymakers and consumers are becoming more and more educated regarding network construction and vulnerabilities. Starry has made critical manufacturing and supply chain decisions, all with an eye to protecting not just our

¹⁸ See *supra*, note 6.

intellectual property, but the security and integrity of our telecommunications stack. Specifically, Starry maintains the commitments set forth in its third Progress Report: Starry does not use software from Chinese sources as a matter of policy, and we utilize multiple overseas vendors (that do not share ownership) to manufacture the components of our system.

6. **The MDU market presents unique opportunities and challenges.** As noted, consumers and property owners continue to crave broadband choice in a market dominated by incumbents. But in many instances, Starry's and other providers' ability to effectively offer a competitive choice is impeded by historic exclusive agreements, including for inside wiring and service terms, that distort the MDU market to the incumbents' benefit. What's more, many building managers do not understand that these types of exclusive service agreements are prohibited by the FCC. The mere threat of litigation is an effective deterrent against pursuing in-building broadband alternatives. Starry is therefore pleased that the FCC recently released its Notice of Proposed Rulemaking to improve competition and clarity in MDUs. While the Commission studies this issue, Starry will maintain partnerships with national real estate owners who understand the value of pursuing alternatives for competitive broadband. We welcome the FCC's adoption of modern policies to overcome these challenges, and to ultimately avoid a scenario where a building – and its residents – go unserved.

IV. Looking Ahead: 2020 and 2021

Starry's work to develop next-generation wireless technologies has been groundbreaking to date, and we look forward to continued research and development over the next two years, using our market test authority license.

In 2020, Starry will focus on expanding coverage to single family homes, testing and deploying its next-generation equipment, and providing coverage away from the urban core and deeper into suburban environments in the markets where its test authority license is active. Through these additional deployments, Starry will continue to advance its innovative technology research and development, while also providing additional connectivity to consumers across the country.

V. Conclusion

The Commission has made great strides to clear the path for swift and efficient deployments, including through its market test authority grants. Flexible access policies for millimeter wave spectrum are critical to innovation and the deployment of ubiquitous broadband networks. Starry continues to prove, through its unique approach and ability to launch a working network, the great promise of these bands. We thank the Commission for the ongoing ability to utilize a market test authority to realize our mutual agendas to connect Americans, through innovative technologies, to affordable and reliable broadband services.