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Experimental Licensing Branch
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TABLE OF CONTENTS

I.	INTRODUCTION.....	1
II.	UPDATE ON STARRY’S NETWORK DEPLOYMENT.....	2
	A. COVID-19 Response.....	2
	B. Technological Advancements.....	6
	C. Market and Product Expansion & Future Buildout.....	12
	D. Starry Connect Expansion.....	14
III.	CONCLUSION.....	15

I. INTRODUCTION

On January 31, 2020, Starry, Inc. (Starry) filed a fourth Progress Report with the Federal Communications Commission (FCC or Commission) to update the Commission on Starry's progress in developing, deploying, and testing our wideband hybrid fiber licensed fixed wireless broadband network. This fifth Progress Report contains further updates regarding Starry's deployment in the markets in which we hold an experimental test authority license.

Starry's network currently covers millions of households across six states and the District of Columbia with its gigabit, low-latency network. Starry's mission is to connect consumers to better broadband by offering high-speed, low-cost service with exceptional customer care and a strong commitment to consumer privacy. Since 2014, Starry has developed our own advanced fixed wireless equipment and pioneered the deployment of low-cost point-to-multipoint fixed wireless technology using a fixed-only network architecture, cloud control plane, and service model to deliver last-mile gigabit broadband service.

As a result of ongoing access to the market test authority (MTA) granted to Starry, we have continued to refine our technology stack; expanded our experience working with millimeter wave spectrum in a diversity of deployment scenarios; tested several business strategies from selling to large multi-dwelling buildings to direct to consumer, and importantly, targeted communities with affordable programs; and ultimately created a robust, secure, domestic ecosystem for fixed wireless technologies. Since our founding in 2014, Starry has raised approximately \$450 million in capital to finance research and development and commercialization of our technology and business. As described in more detail below, Starry recently launched a sixth market in Columbus, Ohio, and deployed the second generation of our network technology, which improves capacity and range at a lower cost. Starry also continues to expand the reach of our Starry Connect program, an ultra-low-cost, competitive broadband service for consumers in public and affordable housing communities, as we test models for improving digital equity, inclusion, access, and affordability.

Starry's success is a tangible example of how consumers directly benefit from the policies adopted by the Commission, like the market test authority that allows us to continue to deploy, operate, and serve customers as we test, develop, and perfect our technology and business. Starry also has helped to develop varying services and technologies using the Lower 37 GHz band, consistent with the intent of the Commission's test authority. The FCC designated

this swath of spectrum as an opportunity for innovation, and Starry continues to utilize the FCC’s MTA to inspire a more diverse technology ecosystem and a new business model to improve connectivity to millions of homes and small- and medium-sized businesses. With this latest Progress Report, we highlight Starry’s advances in technology development and service models.

II. UPDATE ON STARRY’S NETWORK DEPLOYMENT

On November 24, 2019, the FCC renewed Starry’s MTA for the 37.0 to 38.6 GHz band in 22 markets, with access to the upper 37 GHz conditioned on the conclusion of Auction 103. Since the initial grant and to date, Starry has continued to develop our unique technology, characterize millimeter wave propagation in real-world environments, develop and test business models, and test the service with thousands of consumers in a live environment. Starry continues to develop a technology roadmap and business model variations that we hope will continue to improve the capacity, reduce cost, and prove out new service models, to ultimately create a robust technology ecosystem and competitively aggressive business model. As required by the grant of the market test authority, this fifth Progress Report details Starry’s advancements over the last year.

A. COVID-19 Response

The COVID-19 pandemic forced consumers to find new ways to learn and work, visit their doctors, and connect with family and friends - all from home. As the country continues to recover from the pandemic, the importance of accessible, affordable broadband remains apparent. Broadband is a critical component to fully engaging in daily life, and Starry is proud to have helped consumers remain connected over the duration of the emergency period and to date.

Starry continued to provide an affordable, reliable essential service during COVID-19 in support of the FCC’s “Keep Americans Connected” pledge and through our own initiatives to ensure subscribers affected by the pandemic had access to broadband.¹ Starry was among the first internet service providers to take the FCC’s pledge to suspend termination of service to subscribers as a result of non-payment related to the pandemic and to suspend certain punitive customer practices, such as data caps and additional fees. Starry also was one of a handful of providers to voluntarily extend this pledge commitment through July 31, 2020.²

¹ Starry, “A Letter From Our CEO About Our COVID-19 Response,” (Mar. 27, 2020).

² See “Starry Extends Its Pledge to Keep Americans Connected During the Coronavirus Crisis” (Apr. 30, 2020).

Additionally, Starry created a “Fresh Start” program to wipe away any service debt for subscribers who were unable to pay their broadband subscription fee due to the ongoing impacts of COVID-19.³ Subscribers who opted into the program were able to start with a zero-dollar balance beginning on August 1, 2020. Starry also provided our Starry Connect service - targeted at public and affordable housing communities - free to all existing and new Starry Connect customers until the end of July 2020.⁴ As described in more detail below, Starry Connect is a specialized ultra-low-cost broadband access program that partners directly with public and affordable housing owners to provide high-quality access with no data caps, long-term contracts or complex individual eligibility requirements, for only \$15/month.

Starry also continues to collaborate with unique organizations to further digital equity and digital literacy initiatives. We recently partnered with Microsoft, through its Airband initiative, to accelerate the availability of Starry Connect in public housing communities in Los Angeles and New York City.⁵ The partnership will soon expand to underconnected communities in Detroit, Michigan.⁶ Additionally, in March of this year, Starry launched a new program with PCs for People to enhance digital access and connectivity for public and affordable housing communities in the Denver Metro area,⁷ and donated computers to the Denver Housing Authority.⁸ Starry also partnered with Aurora Public Schools (APS) to make our Connect service available to un- and under-connected APS families living in the Delmar Parkway community in Aurora, Colorado.⁹ Most recently, Starry partnered with Columbus, Ohio-based Huckleberry House to make our Connect program available to residents who are at-risk youth, and also donated and furnished a computer lab for resident use.¹⁰

³ “Starry Announces Its ‘Fresh Start’ Debt Forgiveness Program for Subscribers Adversely Impacted by the COVID-19 Health Crisis” (Aug. 3, 2020).

⁴ “Starry Connect Shares Better Internet With More People,” <https://starry.com/starryconnect>.

⁵ “Starry and Microsoft Team Up to Expand Low-Cost Broadband Access in Public Housing” (Oct. 9, 2020).

⁶ “Starry Announces Plans to Expand Affordable Broadband Access to Detroit with Microsoft” (June 8, 2021).

⁷ “Starry and PCs for People Partner on New Program to Bolster Connectivity in Denver” (Mar. 16, 2021).

⁸ “Starry and Denver Housing Authority Strengthen Partnership to Promote Connectivity for Public and Affordable Housing Residents” (Apr. 7, 2021).

⁹ “Starry and Aurora Public Schools Partner to Expand Affordable Broadband Access to Public School Families” (May 26, 2021).

¹⁰ “Starry Partners With Huckleberry House to Help Bridge the Digital Divide for Central Ohio’s At-Risk Youth,” (Sept. 22, 2021).

Finally, as 2021 progresses, Starry continues to advance efforts to ensure consumers can obtain broadband service through robust participation in targeted FCC proceedings. As noted, the FCC took significant steps to respond to the pandemic with its “Keep Americans Connected” pledge and by implementing innovative programs such as the Emergency Broadband Benefit (EBB) and the Emergency Connectivity Fund. Starry is an active participant in the FCC’s EBB program and qualified to participate in the program through our Connect service.¹¹

Starry believes that the EBB program is critical to address the lingering affordability gap for broadband. As part of our EBB participation, Starry has hosted several “EBB Sign-Up Extravanzas” where we partner with Connect communities to provide information about the EBB and how to enroll. We also implemented an EBB enrollment process that is simple and streamlined, with the goal to remove any unnecessary administrative barriers to sign-up. Because of these efforts, to date, nearly 7% of Starry’s total subscribers participate in the EBB program, which continues to underscore the ongoing need for accessible internet options throughout the country. Thanks in part to Starry’s market test authority, consumers can continue to access more affordable, competitive broadband services even as the country adapts to the aftermath of COVID-19.

These efforts have been critical to both ensuring consumers have access in some circumstances and testing the technology and business case through incredibly unique periods. The COVID-19 pandemic, especially the early days, were a true test for broadband networks and service models: connectivity was essential, which meant that networks needed to perform and service delivery models to be successful, even with significant restrictions on in-person interactions (for example, the ability to install new service connections).

The charts below show the changes in Starry’s network traffic before the pandemic took hold and within the first few weeks thereafter. Daytime downstream traffic on Starry’s network effectively tripled, and no longer experienced valleys - demand was higher and more constant.

¹¹ “Starry Announces Participation in the FCC’s Emergency Broadband Benefit Program” (Apr. 29, 2021).

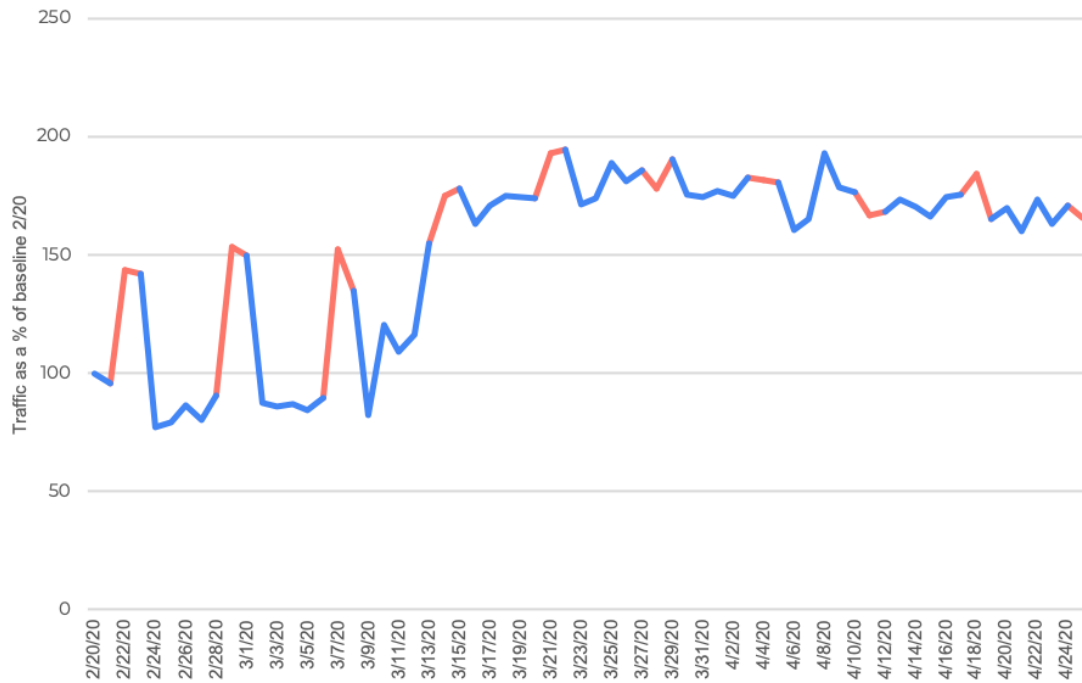


Fig. 1 Downstream daytime traffic; redlines are weekends, blue lines are weekdays

Upstream traffic showed a similarly divergent pattern. This truly highlights the need for robust upstream capacity, as it both increased almost four-fold, and experienced significant new peaks.

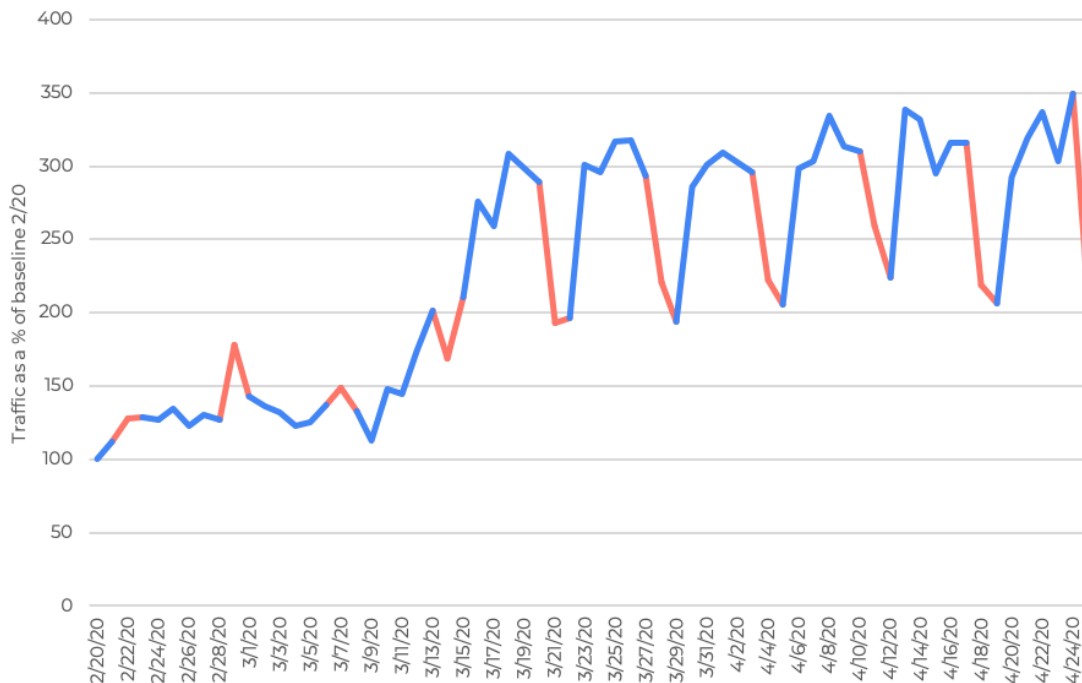


Fig. 2 Upstream daytime traffic; redlines are weekends, blue lines are weekdays

B. Technological Advancements

Since its inception, Starry has set out to solve one of the hardest problems in broadband - how a provider can deploy a new network, at a lower cost, that can scale to cover millions of households. This is driven by Starry's core mission, which is to connect as many Americans as possible to better broadband. Fundamental to this mission is developing a new technology stack for fixed last-mile broadband using licensed millimeter wave spectrum.

When Starry began its initial research and development in 2014, there was not yet an equipment ecosystem that leveraged new modern techniques like MIMO and beamforming to provide high-capacity upstream and downstream connections in licensed millimeter wave spectrum. The same is still true today - Starry's technology is unique as a solution for fixed service using symmetrical two-way communications in licensed millimeter wave spectrum.

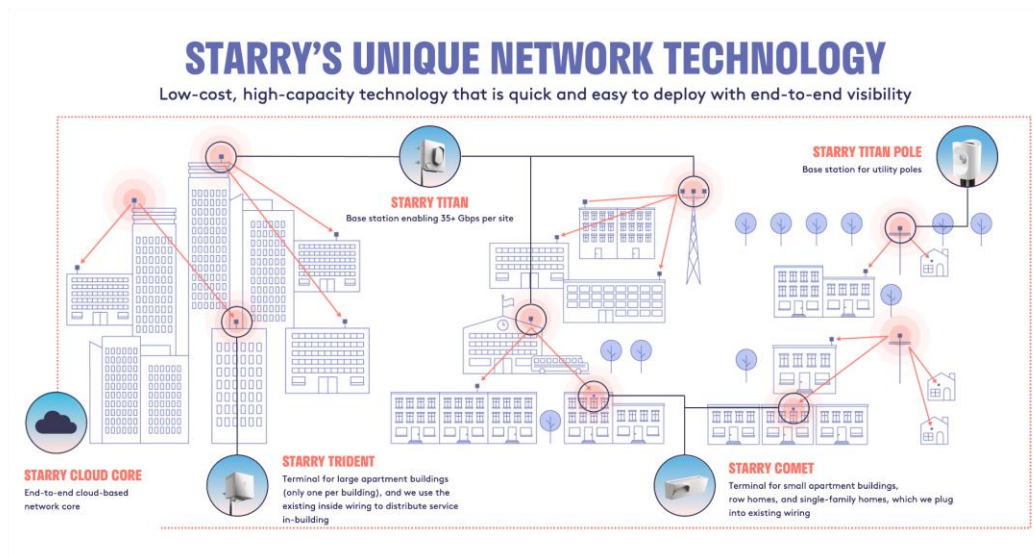
Since Starry's MTA was originally granted, our research and development efforts have focused on three things: 1) improving capacity; 2) reducing cost; and 3) ensuring reliability in increasingly dense deployments and across disparate geographic areas. The MTA is instrumental in our ability to create an entirely new technology from scratch, quickly iterate on it in a real-world consumer environment, and now, to continue to improve capacity, reduce cost, and operate in a dense deployment with single family home deployments.

We have generated an incredible amount of quantitative and qualitative data about our technology over time, which has led to the current generation of Starry's equipment and technology. We have characterized our equipment's operation through extreme heat, record-breaking blizzards, Nor'easters, hurricanes, and other natural events that can impact propagation. We have discovered that, for example, the millimeter wave equipment needs to be passively cooled and with particular care taken around the apertures in terms of shapes and materials to reliably accommodate all weather service. And most importantly, we have been able to conduct this research and development on a production network, in the real world, with real subscribers. We cannot understate how critical this has been, and will continue to be, for our equipment development.

Last September, Starry launched the next-generation of our technology, which has helped to enhance our overall network performance and foster the rapid deployment of our network to

new markets.¹² In particular, these advancements allow Starry to deliver service directly to the consumer and expand our ability to target customers in smaller MTEs and single-family homes.

As a reminder, Starry designs, builds, and deploys three different radios: Titan, our high-capacity base stations; Trident, our customer premises transceivers for larger MDUs; and Comet, our new customer premises transceiver for smaller MDUs and single-family homes. We also develop all of the firmware that runs the equipment, and our own cloud control plane and OSS/BSS for network management. Below, we describe the continued innovation for each piece of equipment over the last two years.



1. Starry Titan and Trident

Starry Titan is our high-capacity base station. Our first-generation base stations were a massive engineering feat - a first-of-its kind device that used 802.11 baseband radios converted into licensed millimeter wave, and using new beamforming and beamsteering techniques to provide a point-to-multipoint fixed service. But it was very much an early device and provided under 1 Gbps capacity. It was also larger, more mechanically complex, and much heavier than our current generation of equipment.

We are now on our third-generation Starry Titan, which boasts significant improvements in cost, capacity, and physical size. Current generation Starry Titans:

- have three times the capacity of the first generation;

¹² “Starry Unveils Powerful Second-Generation Technology to Expand Network Coverage and Improve Network Performance” (Sept. 17, 2020).

- utilize full digital beamforming;
- are triband devices with 37 GHz, 60 GHz, and 5 GHz;
- use 802.11ax chipsets versus 802.11ac;
- are 50% lighter, reduced from 42 kg to 21 kg;
- are 35% smaller in depth (and volume) from 284mm to 189mm;
- reduction of 50% in power consumption;
- are more than 90% less expensive to manufacture

Each generation of Titan includes significant capacity and efficiency gains, as highlighted in the chart below. We were able to develop Gen 2 under the MTA and are in development of Gen 3 today.

Titan Generation	Bandwidth (MHz)	Simultaneous Streams	Effective Bandwidth (MHz)	Peak Aggregate PHY
Gen 2 (Today)	160 TDD	6	960	5.2 Gbps
Gen 3	160 TDD	8	1,280	9.6 Gbps
Gen 4	160 TDD	14	2,240	16.8 Gbps

These significant improvements are a direct result of our ability to test these devices at scale across multiple geographies.

Starry's third-generation customer terminal, Starry Trident, is a smaller and higher performance variation of our first- and second-generation customer terminals. The Starry Trident is deployed on larger MDUs, and is gigabit capable with twice as much capacity as the original version. In addition, the current generation is less than one-third the cost. This is the workhorse in Starry's network today, providing reliable service to thousands of customers. Again, these significant improvements are a direct result of our ability to test these devices at scale across multiple geographies.

2. Starry Comet

Through the full two-year cycle of the FCC's MTA, Starry developed its newest customer terminal, Starry Comet, which represents a step change in capability, cost, and deployability. While the Starry Trident is a highly capable device, its unit cost is too high to

deploy the device on small buildings and single-family homes. For these reasons, we developed a smaller version with the same capability, but in a much smaller form factor, and at a lower price point.

The Comet is small, measuring only 4" (H) x 10" (W) x 3.5" (D), but capable of delivering symmetrical gigabit speeds. It uses an 802.11ax chipset with Starry's own technology to upconvert the signal to licensed millimeter wave, and it performs digital beamforming in the vertical dimension, which ultimately simplifies the deployment.



By design, the Starry Comet is easy to install. It is powered over coax and does not require a separate power source. A Starry technician uses a custom-built application for the installation process that allows them to provision the device, which they then mount to the home, and run only a single coax into a ground block at the premises. From there, we use the existing inside wiring to provide service in the home through Starry's provided Wi-Fi router.



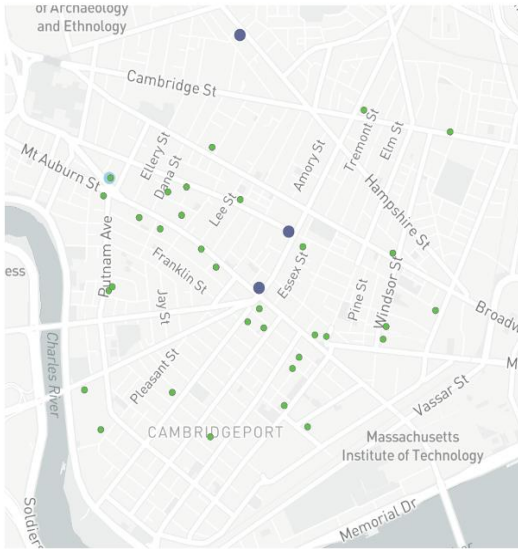
COMET INSTALLATION: SIMPLE APP-ENABLED RADIO INSTALLATION



This terminal changes the entire business model. To date, we have deployed and tested service in only larger MDUs. With the Starry Comet, we can now target service to every household that is within coverage of a base station site. This also brings a significant shift from a business-to-business sales model to a new direct-to-consumer sales model.

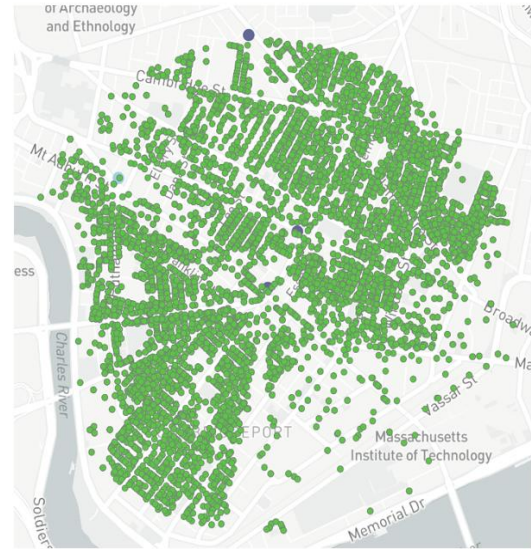
EXAMPLE: SITE PRE-COMET

Only large apartment buildings targeted;
3,989 units with effective serviceability of 18%



EXAMPLE: SITE POST-COMET

All serviceable households targeted;
17,547 units with effective serviceability of 79%



We are still in the early stages of deploying the Starry Comet on our network and are currently rolling it out in every live market, and we still have a lot to learn. The MTA will allow us to test the network performance with a more significant density of customer sites, to better characterize multipath events, to better validate our modeled coverage and serviceability across a much larger number of target customer locations, and to test out this new direct-to-consumer sales model.

3. Primetime

In addition to hardware innovations and the development of our own software stack, we have initiated a project to make modifications to the media access control layer of the 802.11 standard baseband radios. We are doing this because we believe that we can make some modifications that are specific to our use case that will improve capacity to up to 2 Gbps in a single 160-megahertz channel. Specifically, we are modifying the protocol to a TDD/TDMA/multi-user fixed wireless access protocol, which will also allow us to execute carrier aggregation between licensed millimeter wave spectrum and unlicensed bands. This is a unique software stack unlike any other in the unlicensed space. We are modeling this new MAC layer now and intend to begin to implement it in the first quarter of 2022.

4. Domestic Assembly

Starry has always used a diverse group of suppliers and manufacturers, and historically assembled its equipment in Asia. This was cost efficient, but because our technical stack was developed entirely in house and because we used diverse suppliers, it required in-person Starry oversight to ensure the equipment assembly was accomplished in the highest quality manner, that testing was correctly executed, and that only finished and operational devices were shipped. But when COVID-19 hit, we lost the ability to participate in this process in person.

So, like Starry's technology stack, we decided to do it ourselves. Beginning in the spring of 2020, we began assembling some of our equipment in our Boston headquarters. After several months of experience, we expanded the operation into our warehouse, and set up a true assembly line for our Starry Titan, Trident, and Comet products. This has been a tremendously successful strategy, allowing us to both assemble products more quickly and with fewer issues, and also to iterate on products in a tight loop between the network technicians, the assembly team, the hardware team, and the software team.

This process has been so successful that we are expanding into a 50,000 square foot space outside of Boston, and plan to hire a full-time manufacturing team. Through 2022, we expect most of our final assemblies to be completed in the United States.

C. Market and Product Expansion & Future Buildout

Starry is an incredibly unique vertically integrated company, combining new wireless technology development, network deployment, network operations, and service delivery. Since Starry's inception, we have tested each of these aspects of the business in various ways, including by scaling across multiple markets, in different geographies, simultaneously. We are in parallel developing and testing new technology, developing new methods and plans for rapidly deploying our network, and testing different kinds of products and services. We have made significant strides in each over the term of the MTA and continue to build from our learnings to evolve the technology and service delivery models.

In 2021, we launched our sixth market, Columbus, Ohio. Studies suggest that an estimated one million Ohio consumers lack broadband access at home, including nearly 100,000 households in the Columbus metropolitan area.¹³ As part of the market launch, Starry offered an

¹³ Policy Matters Ohio, "COVID-19 Makes Tearing Down Nation's Digital Barriers More Urgent" (Apr. 30, 2020), <https://www.policymattersohio.org/blog/2020/04/03/covid-19-makes-tearing-down-nations-digital->

“early adopter” plan for those who signed up before August 15, 2021, which included \$25/month for life until the customer moves or cancels with no data caps, contracts, or cancellation fees. After August 15, 2021, Starry offered the standard \$50/month plan which includes 200 Mbps service, as well as our \$15/month Connect plan for residents in public and affordable housing communities. As with all of Starry’s service options, installation and equipment are provided at no additional charge, with no long-term contracts or data caps.

Importantly, the FCC’s MTA enables Starry to continue to test different business models and our expansion into the Columbus market is a prime example of how we can do that to continue to serve consumers. As noted, the MTA has helped us to simultaneously test across various environments including less dense topographies like suburban and exurban areas, and through varying weather conditions. Additionally, the Columbus market bridges the gap between our MTA and our 24 GHz upper flexible use license markets - we are relying on the MTA to build out early parts of the network as we finish the certification of our 24 GHz equipment. This has been critical to our ability to scale the network and transition into the 24 GHz band in the markets in which we hold these licenses.

Starry is proud to help bridge the digital gap that persists in Ohio, and our ability to expand to a sixth market is in part a product of the MTA provided to us for the Columbus and Cleveland markets. Starry’s network is built to cover the 360,000 households in the Columbus metropolitan area and is the first city-wide network to be built prior to launch. To facilitate this expansion, Starry also collaborated with scaling construction partners to help expand coverage across the state of Ohio and throughout the country. Starry’s market expansion is a real-world example of the consumer benefits derived from the FCC’s market test authority.

In addition, as discussed in the context of the Starry Comet, in 2021 we began offering service direct-to-consumers in smaller MTEs and single-family homes. Prior to the introduction of Comet, our business focused on selling larger apartment building owners and managers to allow us to install our service in their buildings, after which we would sell the service to their residents. This was a business-to-business-to-consumer sales model, which is necessary in larger MDUs, but that ultimately limits the reach of our service to only a small subset of consumers in a

barriers-more-urgent/; WOSU NPR News, “Ohio’s Digital Divide Deepens Inequalities,” (Mar. 3, 2020) <https://news.wosu.org/news/2020-03-03/ohios-digital-divide-deepens-inequalities/>.

market under coverage. As explained, we executed this strategy because it was economically efficient based on the cost of our customer terminal, Starry Trident.

However, with Starry Comet, which is one-fourth the cost of Starry Trident, we can now scale the business to target consumers in homes of any size that are within coverage of our existing footprint, and all homes under coverage as we expand. This is a fundamentally different model that relies on targeting direct-to-consumer services. And importantly, it means that we can provide our service to even more people, resulting in essential connectivity.

D. Starry Connect Expansion

Thanks in part to Starry's ability to scale the network under the MTA, Starry Connect similarly experienced tremendous growth over the past year. As noted, Starry Connect is our digital equity program that provides 30 Mbps symmetrical speeds for \$15/month. Starry Connect does not require credit checks, other individual eligibility criteria nor qualification in federal subsidy programs to participate. The FCC's MTA enables Starry to continue to test different business models and our Connect program is another prime example of how we can do that to serve unconnected and underconnected low-income households.

Throughout 2020, Starry expanded our Starry Connect program to nearly 29,000 units of public and affordable housing across the country,¹⁴ including a partnership with Harlem Congregations for Community Improvement to extend the program to more than 600 households in Harlem.¹⁵ During the emergency period, Starry also provided free Connect service through the end of the year and donated 21 Chromebooks to residents living at Mar Vista Gardens, a Housing Authority of the City of Los Angeles public housing community, to support distance learning for LAUSD students.¹⁶

The reach of Starry Connect continues to expand throughout 2021. Recently, we launched service in three New York City Housing Authority communities as part of a connectivity pilot program under New York City's Internet Master Plan for Universal

¹⁴ "Starry Connect - A Digital Equity Program Focused on Broadband Connectivity in Public and Affordable Housing - Grows to Reach More Than 29,000 Units" (Dec. 29, 2020).

¹⁵ "Starry Expands Access to Its Ultra-Low-Cost Broadband Program, Partnering with HCCI to Expand Affordable Broadband Access Across Harlem" (Mar. 13, 2020).

¹⁶ See, e.g., "Starry Announces Free Starry Connect Access Until the End of 2020 for Residents at HACLA's Mar Vista Gardens" (Aug. 24, 2020); "Starry Computer Donation Helps Bridge Digital Divide for HACLA Families" (Aug. 15, 2020).

Broadband,¹⁷ and initiated a partnership with the Huckleberry House in Los Angeles to provide the Connect service to its residents.¹⁸ Starry also expanded its Connect service to the Columbus market and committed to providing six months of free Starry Connect service to residents of new affordable housing partners that join the Connect program before the end of 2021. As of the end of Q3 2021, Starry counted more than 40,000 units of public and affordable housing in the Connect program, exceeding our pace of program growth in 2020.

Starry Connect continues to be eagerly received by tenants and property owners alike, and we intend to expand this program across every market where Starry has a presence. We are appreciative of the ongoing ability to utilize the MTA to connect underserved consumers to affordable and reliable broadband services through innovative, home-grown technologies.

III. CONCLUSION

As a result of ongoing access to the FCC’s market test authority, Starry has continued to refine our technology and equipment stack, pursued testing in less dense environments and direct-to-consumer sales models, established collaborative scaling partnerships, and continued to launch an ultra-low-cost, competitive broadband product in new metropolitan and suburban markets. The Commission has made great strides to facilitate innovative deployments, including through the use of its experimental grants. Consistent with Starry’s previous Progress Reports, the FCC’s market test authority has served exactly as intended: we took a preliminary risk to develop a unique technology and have continued to deploy and expand an innovative service to consumers using the operational authority provided to us by the experimental license. We thank the Commission for the ongoing ability to leverage this market test authority to better connect consumers in our markets to affordable, reliable broadband service.

Respectfully submitted,

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¹⁷ “Starry Launches Affordable Broadband Service in Three New York City Housing Authority Communities” (Sept. 3, 2021).

¹⁸ “Starry Partners with Huckleberry House to Help Bridge the Digital Divide for Central Ohio’s At-Risk Youth” (Sept. 16, 2021).