DLA Piper LLP (US)
500 Eighth Street, NW
Washington, DC 20004
www.dlapiper.com

Nancy Victory
nancy.victory@dlapiper.com
T 202.799.4216
F 202.799.5616

April 22, 2019
VIA ECFS

Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, DC 20554

REDACTED – FOR PUBLIC INSPECTION

**Re: Notification of Written *Ex Parte* Presentation
Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations; WT Docket No. 18-197**

Dear Ms. Dortch:

Pursuant to Section 1.1206(b) of the Commission's Rules, 47 C.F.R. § 1.1206(b), T-Mobile US, Inc. ("T-Mobile") submits a written *ex parte* presentation in the above-captioned docket. The Commission staff has sought additional detail concerning the modeling of use of millimeter wave ("mmW") spectrum by T-Mobile and Sprint Corporation ("Sprint," and collectively with T-Mobile, "Applicants"), both as standalone companies and as a combined company.[1] In particular, the Commission staff sought to understand if there were a way to estimate mmW spectrum's ability to address congestion in the networks more granularly by taking into account the variations in conditions from site to site. Further, DISH has speculated that the standalone networks might obtain additional mmW spectrum and, on that basis and notwithstanding the limited propagation characteristics of mmW spectrum, alleged that deployment of that additional

[1] The information provided in this filing is intended to be responsive to the FCC staff and does not communicate bids or bidding strategies with respect to the ongoing mmW spectrum auction. *See* 47 C.F.R. § 1.2105(a). Nevertheless, T-Mobile notes that the Protective Order in this proceeding limits access to Highly Confidential Information ("HCI"), such as is being submitted in this filing, only to individuals who have certified that they "are not involved in Competitive Decision-Making." As such, individuals involved in the auction participation of other companies are prohibited from accessing the HCI included herein.

mmW spectrum would increase the capacity of the standalone networks and therefore reduce the marginal cost savings of the transaction.[2]

As described in the attached declarations of Ankur Kapoor, Vice President of Network Technology at T-Mobile, and of Mark Israel, Michael Katz and Bryan Keating, DISH's assertions are without merit:

1. *Deploying mmW spectrum is not, as DISH assumes, free.* There are two components to each network in the engineering model: a baseline network that the company would deploy regardless of the level of traffic (and thus does not contribute to marginal costs), and an incremental set of congestion solutions that is dependent on the level of traffic (and thus does contribute to marginal costs). DISH puts all of its extensive deployments of additional mmW spectrum into standalone T-Mobile's baseline network, and thus treats both the acquisition and deployment of mmW spectrum as free, while purporting to assert that this proves mmW spectrum is an effective solution for congestion as incremental traffic grows. In reality, however—even without considering the costs of acquiring spectrum—[redacted]. Thus, adding mmW to the baseline network, as DISH does, both overstates the places where it will be cost effective enough to use and ignores the marginal cost of deploying it when it is used.

2. *Refining the model to account more realistically for the deployment characteristics of mmW spectrum shows that DISH's hypothesized additional mmW spectrum licenses do not meaningfully change network marginal costs or the consumer benefits from the merger.* Due to the limited use of mmW spectrum in the Applicants' plans, the original engineering model contained [redacted]. DISH now speculates that T-Mobile would have some increased amount of mmW spectrum beyond what it has currently, thus expanding the role that mmW spectrum would play in the network. However, doing so properly requires refining the model's treatment of mmW spectrum to be more precise in two respects. First, as the Commission staff have observed, [redacted]. In response to the

[2] *See e.g.*, *Ex Parte* Presentation of DISH Network Corporation, WT Docket No. 18-197, filed April 16, 2019.

Commission staff's request for more granular treatment of mmW spectrum, T-Mobile measured the actual percentage of traffic addressable by mmW spectrum on a site-specific basis. Second, the assumption that [redacted] These refinements to the engineering model account for the fact that mmW spectrum [redacted][3] Applying these refinements to the model demonstrates that, although adding additional mmW spectrum [redacted], it does not meaningfully change network marginal costs. This is not surprising, given the limited propagation of mmW spectrum and that small cells are typically coverage, not capacity, limited.

3. *A sensitivity analysis that limits capacity included in the assumed baseline networks demonstrates that the Applicants' results—unlike DISH's—are not driven by misleading assumptions regarding the baseline networks.* As noted above, DISH mischaracterizes the baseline network (the set of builds each network would do regardless of traffic levels) to allow the Applicants to serve additional traffic without incurring marginal costs to do so. To demonstrate that the Applicants' results do not suffer similar issues, a sensitivity analysis was conducted that removes from the baselines most of the planned builds for all three networks (standalone T-Mobile, standalone Sprint, and New T-Mobile) and instead allows the engineering model to determine which builds are necessary to serve incremental traffic in each network. This sensitivity analysis demonstrates that the inherent efficiencies of the combination, not assumptions regarding planned baseline networks, are what drive the Applicants' results.

This filing contains information that is "Highly Confidential" pursuant to the Protective Order filed in WT Docket No. 18-197. Accordingly, pursuant to the procedures set forth in the Protective Order, a copy of the filing is being provided to the Secretary's Office, including a DVD containing the enhanced mmW modeling. In addition, two copies of the Highly Confidential Filing are being delivered to Kathy Harris, Wireless Telecommunications Bureau, including the DVD. A copy of the Redacted Highly Confidential Filing is being filed electronically through the Commission's Electronic Comment Filing System.

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[3] This refinement of the engineering model only affects functionality associated with mmW spectrum and has no effect on the underlying functionality of the engineering model for any other spectrum bands.

Please direct any questions regarding the foregoing to the undersigned.

Respectfully submitted,

DLA Piper LLP (US)

/s/ Nancy J. Victory

Nancy J. Victory
Partner

cc: David Lawrence
Kathy Harris
Linda Ray
Catherine Matraves
Jim Bird
David Krech

Attachments

ATTACHMENT A

DECLARATION OF ANKUR KAPOOR
Vice President of Network Technology, T-Mobile US, Inc.

I, Ankur Kapoor, hereby declare the following:

1. My name is Ankur Kapoor. I am Vice President of Network Technology at T-Mobile US, Inc. ("T-Mobile"). In this role, I am responsible for all aspects of network capacity and planning.

I. INTRODUCTION AND SUMMARY

2. To analyze the potential for the LTE and 5G networks, we have developed an engineering model that measures capacity and congestion at the sector level for New T-Mobile (and the two standalone companies). This model is built upon the ordinary course engineering tool that T-Mobile has used since 2011/2012 and has been utilized to guide network investment decisions. This modeling provides a reasonable and accurate representation of how we run our network and how we plan for investments to maintain our network from a capacity perspective.

3. At the time of the development of the engineering model for 5G (2018), use of millimeter wave ("mmW") band spectrum was still in the very early phase of standardization and ongoing testing. Therefore, our engineering model utilized assumptions for the performance of mmW consistent with the mmW spectrum held by T-Mobile as well as the expected propagation capabilities of the band as understood at the time. Specifically, it applied a [redacted] mmW propagation factor to all macro cell sites that were identified to have mmW spectrum deployed. This propagation factor was used to capture the very limited coverage of mmW spectrum, including the small coverage radius around a macro cell site and the inability of mmW spectrum to provide [redacted] coverage.

4. Since the submission of the engineering model, the Commission staff has asked if the engineering model could incorporate site-specific factors to more precisely account for how

mmW spectrum might be used to relieve congestion depending on the conditions at particular sites. In response to this request, we have made minor refinements within the mmW portion of the engineering model to develop site-specific estimates of the ability of mmW spectrum to address congestion. This modeling calculates [redacted].

5. The refinements to the prior modeling apply granular cell site performance of mmW spectrum that is consistent with the measurements that have been reported for operational mmW systems. Importantly, a single [redacted]. Instead, for each cell site in the network, [redacted]. The refinements to the modeling therefore enable a more accurate assessment based on network measurements of mmW spectrum and respond to the Commission staff's desire to have site-specific factors applied for mmW cell sites.

II. THE ORIGINAL ENGINEERING MODEL ESTIMATED MILLIMETER WAVE TRAFFIC USING AN [redacted] APPROACH WITHOUT MEASURED NETWORK TRAFFIC INFORMATION

6. As described in the supplemental information provided to the Federal Communications Commission ("Commission" or "FCC") in Document 18, the engineering model submitted on September 17, 2018 and used to model congestion relied upon a [redacted].[1] The challenge with mmW spectrum

[1] *Ex Parte* Presentation, WT Docket No. 18-197, filed Sept. 17, 2018 (follow-on documentation production and slight revision of the engineering model); Response to August 15, 2018 General Information and Document Request from the Federal Communications Commission, WT Docket No. 18-197, filed Sept. 5, 2018.

is that the propagation at these high frequencies is significantly limited and susceptible to blockage. These limitations dictate that 5G mmW deployments will only be able [redacted] inter-site distances ("ISDs") due to the low coverage area provided by the band and the inability for [redacted] cell sites to support [redacted] mobile customers, given that even obstacles considered permeable in lower frequency spectrum bands (such as glass) result in complete blocking of mmW signals.

7. In developing the original engineering model, we created a method to model the [redacted] that can be expected from a mmW deployment on existing macro cell sites that took into account these limitations. This methodology relied upon estimating the coverage radius and area based on ISD. We calculated ISDs for all existing macro cell sites within the core of every market in T-Mobile's existing network.[2] The average ISD for those macro cell sites was found to be approximately [redacted].[3] Due to the limited propagation characteristics for mmW spectrum and results from vendor testing, we determined that approximately [redacted] would be an aggressive estimate to use for planning purposes for mmW coverage radius.[4]

8. We then derived [redacted] that would be expected with mmW spectrum deployed at a macro cell site, which was [redacted].[5] This [redacted] propagation factor was used in the engineering model, along with an assumption of a

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[2] The core is defined by the first National Launch Polygon used by T-Mobile and aligns with the mmW deployment geography in 2024 as identified in the engineering model. Maps of the National Launch Polygons were provided to the Commission in Document 28 of the supplemental engineering model documentation. *Ex Parte* Presentation, WT Docket No. 18-197, filed Sept. 17, 2018 (follow-on documentation production and slight revision of the engineering model); Response to August 15, 2018 General Information and Document Request from the Federal Communications Commission, WT Docket No. 18-197, filed Sept. 5, 2018.

[3] Document 20 at 1.

[4] *Id*.

[5] Document 20 at 1.

[redacted] of a macro cell site, for modeling mmW spectrum benefits.[6]

9. The [redacted] propagation factor was applied to each macro cell site that had mmW deployed but did not take into account the actual traffic within the coverage area of the cell site. The propagation factor also does not capture fully the limitations of mmW spectrum as it assumes that [redacted]. Therefore, the propagation factor might [redacted].

III. MODELING OF MMW SPECTRUM EFFECTS HAS BEEN ENHANCED BY UTILIZING MEASURED TRAFFIC TO DETERMINE CAPACITY OFFLOAD

10. To enhance the effectiveness of modeling mmW capacity offload and address the Commission staff's request for a site-specific analysis of the effects of mmW spectrum, we need the ability to determine the amount of traffic that mmW spectrum can serve at each site on the network. To achieve that, we used a third-party tool called [redacted],[7] which we use in the ordinary business course for network optimization and troubleshooting. [redacted] is a real-time, continuous radio access network application that provides timing advance[8] information for all radio connections and is used to assess distance from cell tower. [redacted]

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[6] Document 20 at 2.

[7] [redacted] (last visited April 5, 2019).

[8] Timing advance is a mechanism to ensure that the cell site receives signals from different devices at different distances at the same time. This is done by letting devices at larger distances send their signals earlier; the farther the device, the larger the timing advance (early transmission) the device has to implement.

[redacted], so this bin of data was used for macro cell sites that would be considered as part of mmW spectrum deployment.[9]

11. We reconfirmed that approximately [redacted] would be the appropriate distance from the cell site from recent field measurements of mmW deployments. For example, we have found the average cell radius to be approximately [redacted] in dense urban environments ([redacted]). These field measurements in deployments across a few markets have shown that the probability of receiving mobile 5G mmW signals beyond 150 meters is approximately [redacted] and about [redacted] when the device is up to 100 meters away from the cell site. In addition, this value is greater than what other third-party measurements of mmW spectrum's operating radius have found—a recent MoffettNathanson study of Verizon's operating mmW system in Sacramento, CA found that, on average, each mmW cell site served an effective radius of approximately 700 feet (or less than 214 meters) for a fixed wireless system that would outperform a mobile mmW network.[10] A fixed wireless system has directional antennas that increase the gain which allows better performance than would be expected in a mobile environment where devices have lower gain antennas and are more susceptible to blockages.

12. With all the traffic calculated within [redacted] of macro cell sites, we now had precise information for planning the mmW deployment. Because [redacted] macro cell sites with mmW spectrum do not have the ability to [redacted]

[9] Each [redacted] bin is [redacted]. The next bin of data available would be [redacted], which would greatly exceed the [redacted] expected coverage distance for mmW spectrum.

[10] MoffettNathanson, *Fixed Wireless Broadband: A Peek Behind the Curtain of Verizon's 5G Rollout* (March 20, 2019) at 26. A 250 meter estimate for propagation in the mmW band is well beyond the radius that current testing of operating mmW systems has shown in the field. *See e.g.*, S. Segan, *Trump's FCC Is Auctioning the Wrong 5G Spectrum*, PCMAG (April 15, 2019) (noting that it had found the propagation range for mmW to be 350 to 600 feet (or 107 to 183 meters).

[redacted] from the traffic calculations. T-Mobile has a national database of buildings and structures. This database information was overlaid on top of the total cell site traffic using data from handsets with precise latitude and longitude that is collected by T-Mobile using its proprietary opt-in application, [redacted], to classify the data as [redacted]. This process resulted in an estimate of the percentage of traffic that was [redacted] within approximately [redacted] of each cell site, throughout the network—although still likely overestimating the amount of traffic that could be [redacted] as some [redacted].

13. The percentage of [redacted] traffic (by cell site) was applied to the total traffic (by cell site) within [redacted] of the cell site. Following these calculations, we determined that if mmW could provide at least a [redacted] traffic [redacted] at a macro cell site, then it would be a viable solution for congestion relief. The [redacted] figure was selected as a level that would be cost effective to add mmW compared to the costs and capacity gains of other solutions. We would not implement a congestion solution if the cost did not match the capacity gain associated with the solution. In this case, a [redacted] strikes a balance as compared to other potential solutions—using mmW more aggressively would not provide the capacity gain commensurate with the cost of the solution as compared to other solutions (such as a cell split).

14. This granular approach provides a more detailed and accurate view about the ability of mmW spectrum to provide [redacted]. It is based on actual measurements of traffic distribution in the existing T-Mobile LTE network and takes into consideration whether the traffic is [redacted]. It also applies an [redacted], rather than a [redacted] factor. Finally, it allows for a more precise

determination of whether application of mmW spectrum is a viable solution to mitigate congestion faced in the network.

15. In addition to incorporating site-specific [redacted] factors, the approach used to model the impact of mmW spectrum deployment has been refined. In the previously submitted version of the engineering model, mmW spectrum was treated as effectively equivalent to low-/mid-band spectrum subject to specific adjustments for: limited propagation (as previously discussed, the common [redacted] propagation factor), the split between uplink and downlink, and spectral efficiency.[11] In the refined version of the engineering model, [redacted] This approach more accurately reflects the ability of mmW spectrum to carry traffic that otherwise would have been carried on the macro cell, given the limited propagation characteristics of mmW spectrum.

16. The model then implements additional solutions (small cells, etc.) for the low-/mid-band portion given the reduced traffic level, as needed. No additional solutions are required for the mmW portion, which is assumed to have sufficient capacity to serve the [redacted] traffic—this is because coverage, not capacity, is the binding constraint for the mmW layer.

17. The data gathered is used to create two different calculations. [redacted]

[11] For example, deployment of 200 MHz of mmWave spectrum was treated as being equivalent to the deployment of [redacted].

[redacted]

[redacted]

[redacted]

[redacted] [redacted]

[redacted]

[redacted]

[redacted]

[redacted].

[redacted]

19. I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed on April 22, 2019.

Ankur Kapoor
Vice President of Network Technology
T-Mobile US, Inc.

ATTACHMENT B

THE CONCLUSION THAT THE PROPOSED MERGER OF SPRINT AND T-MOBILE WILL INCREASE CONSUMER WELFARE HOLDS EVEN IF THE STANDALONE COMPANIES WOULD OTHERWISE OBTAIN LICENSES TO MMWAVE SPECTRUM

Mark Israel, Michael Katz, and Bryan Keating

April 22, 2019

I. INTRODUCTION

In a series of submissions, DISH and economists that it has retained—Coleman Bazelon, Jeremy Verlinda, and William Zarakas ("BVZ")—have claimed that accounting for the possibility of mmWave spectrum acquisitions by Sprint or T-Mobile as standalone companies would substantially reduce the marginal cost efficiencies that would otherwise be generated by T-Mobile's proposed acquisition of Sprint.[1] Below, we demonstrate that this claim is incorrect even if, for the sake of argument, one accepts BVZ's unfounded assumption that Sprint and T-Mobile (the "Applicants") will definitely acquire licenses to large blocks of mmWave spectrum.

Specifically, we present an analysis that properly models the effects of mmWave spectrum deployment on network congestion and accounts for the actual costs of such deployment, acquiring new mmWave spectrum. That analysis demonstrates that the acquisition of additional licenses for mmWave spectrum would:

- [redacted]
- [redacted]
- [redacted]

We also demonstrate that these findings hold across a broad array of alternative assumptions about diversion ratios and the Applicants' baseline networks with and without the proposed merger.

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[1] See Reply Declaration of Joseph Harrington, Coleman Bazelon, Jeremy Verlinda, and William Zarakas, October 31, 2018, WT Docket No. 18-197, § II.B.2; Declaration of Coleman Bazelon, Jeremy Verlinda, and William Zarakas, WT Docket No. 18-197, February 4, 2019 (hereinafter, *BVZ February 2019 Submission*); Ex Parte Letter from Pantelis Michelopoulos to Marlene Dortch, February 27, 2019, WT Docket No. 18-197, Attachment B (hereinafter, *BVZ February 2019 Ex Parte*), pp. 31-35; Ex Parte Letter from Pantelis Michelopoulos to Marlene Dortch, March 28, 2019, WT Docket No. 18-197, Attachment A (hereinafter, *BVZ March 2019 Ex Parte*), § IV.D; Ex Parte Letter from Pantelis Michelopoulos to Marlene Dortch, April 16, 2019, WT Docket No. 18-197, Attachment B (hereinafter, *BVZ April 2019 Ex Parte*).

II. A Refined Approach to Modeling mmWave Deployment

In response to discussions with Federal Communications Commission staff members, T-Mobile has refined the Network Build Model's treatment of mmWave deployment, so that the model can be used to generate more accurate predictions of network performance—and associated costs and quality—in the presence of additional mmWave spectrum acquisitions.[2] Below, we describe that the relevant features of the original version of the Network Build Model and how they have been refined.

The original version of the Network Build Model took an "overlay" approach that treated deployment of x MHz of mmWave spectrum as equivalent to deployment of $\lambda \times x$ MHz of low/midband spectrum, where λ is an adjustment factor that accounts for differences in propagation, the split between uplink and downlink, and spectral efficiency. For example, deployment of 200 MHz of mmWave spectrum was treated as being equivalent to deployment of 200 MHz × 80% downlink factor × 10% propagation factor × (7.0 / 3.8) spectral efficiency ratio = 29.5 MHz of midband spectrum (downlink).

In the original version of the model, the use of a propagation factor (10% in the example above) served as an approximate means of accounting for the fact that mmWave spectrum propagates over much shorter distances than do either lowband or midband spectrum and, thus, that mmWave spectrum can serve only a small percentage of the area covered by a typical sector. However, this method does not fully capture the limitations of mmWave spectrum; for example, it treats mmWave spectrum as if it can serve the same percentage of traffic anywhere in the footprint of the macro site on which it is deployed when, in fact, mmWave spectrum may be able to serve a substantial portion of the traffic near the macro site and little, or even none, of the traffic toward the site edges.

The refined version of the Network Build Model corrects these shortcomings by taking an "offload" approach to modeling the impact of deploying of mmWave spectrum: Deployment of mmWave spectrum results in a portion of the traffic on the macro site being "offloaded" from the low/midband spectrum to the mmWave spectrum. In effect, this approach bifurcates the traffic into two separate components—traffic served by low/midband spectrum and traffic served by mmWave spectrum—a method that better tracks the propagation differences between different bands of spectrum. By limiting access to mmWave spectrum to a subset of the traffic and leaving the remaining traffic to access the non-mmWave spectrum deployed on the site, this approach more accurately reflects the fact that mmWave spectrum [redacted]

[2] For a detailed description of the earlier model, see, for example, the backup materials to Mark Israel, Michael Katz, and Bryan Keating, "Reply Declaration of Mark Israel, Michael Katz, and Bryan Keating," September 17, 2018, WT Docket No. 18-197 (hereinafter *IKK Declaration*) and Mark Israel, Michael Katz, and Bryan Keating ("IKK"), "Extension of the Israel, Katz, and Keating Analysis to 2019-2020," (Attachment B to Letter from Nancy Victory to Marlene H. Dortch, February 21, 2019, WT Docket No. 18-197) (hereinafter *IKK February 2019 Ex Parte*).

For a description of the model from an engineering perspective, see Reply Declaration of Neville Ray, September 17, 2018, WT Docket No. 18-197 (hereinafter *Ray Reply Declaration*), § II (Mr. Ray refers to the model as the "engineering model").

[redacted].

Following the deployment of mmWave spectrum as an incremental solution, the model then implements additional solutions (*e.g.*, small cells) as needed [redacted] by applying the standard congestion criteria [redacted][3]

Finally, the model calculates user-experience throughput separately for traffic served using mmWave spectrum and traffic served using low/midband spectrum. For each type of spectrum, the model uses the same approach to calculating user-experience throughput as did the prior version of the model.[4]

III. As was the Case with the Original Model, Application of the Refined Model Demonstrates The Proposed Merger Will Benefit Consumers and Strengthen Competition

Using the refined Network Build Model, we continue to find that the proposed merger will strengthen competition and benefit consumers because the projected merger efficiencies will outweigh any adverse competitive effects from the loss of a competitor.[5]

Table 1 below reports the projected effects that the proposed merger will have on consumer surplus, expressed on a per-subscriber, per-month basis for each year from 2019-2024, using the original and refined versions of the Network Build Model *applied to current mmWave holdings*.[6]

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3 [redacted].

4 The results reported below for Sprint were generated by applying the Network Build Model using the original treatment of mmWave deployments. For the sake of argument, we also adopted BVZ's assumption regarding where mmWave could be deployed in the standalone Sprint network. We took this approach because the anti-collusion rules of the ongoing mmWave auction limited our ability to obtain information from Sprint and thus inhibited our ability to model in additional detail how Sprint would deploy mmWave spectrum in its standalone network. To test the robustness of our results, we ran a sensitivity analysis applying the refined mmWave logic using a 10% offload factor for all sites to the standalone Sprint network and found that such an approach would yield even larger projections of both network marginal cost savings and consumer welfare gains from the proposed merger. (See backup materials for details.)

5 We reached substantively similar conclusions based on the original Network Build Model. (See generally *IKK Declaration*; *IKK February 2019 Ex Parte*.)

6 We focus our NPV calculations on the "Maintain" case, which generates a flat marginal cost curve and therefore avoids any issues related to the fact that non-linear cost curves would tend to mitigate the effects of the merger (in either direction) on equilibrium outcomes. (*IKK Declaration*, § IV.A.2(a).) As described in the *IKK Declaration,* a finding that the merger

We find that the merger will benefit consumers in each year for the foreseeable future with both the original and refined model. Due to the timing of the realization of efficiencies, the proposed merger will generally become increasingly beneficial for consumers over time. As we have done in previous submissions, we calculate the net present value (NPV) of annual consumer welfare effects on a per-subscriber basis in order to provide a single, summary measure of the overall consumer welfare benefits of the merger.[7] The NPVs reported in Table 1 all are positive, which shows that the merger is welfare enhancing in our baseline case and all sensitivity cases using the refined Network Build Model. And the fact that the NPVs using the refined model are higher than with the corresponding NPVs using the original model demonstrates that the original approach was conservative.

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enhances welfare in the "Maintain" case is a sufficient basis on which to conclude that the merger enhances welfare overall. (*IKK Declaration*, ¶ 109.)

7 In Table 1 and below, we present a conservative net present value (NPV) calculation that assumes a discount rate of two percent (the upper bound of the discount rate recommended by the Council of Economic Advisors for studies of intertemporal consumption) and assume no welfare increases after 2024. (*IKK February 2019 Ex Parte,* n. 41 (citing Council of Economic Advisors, "Discounting for Public Policy: Theory and Recent Evidence on the Merits of Updating the Discount Rate," Issue Brief, January 2017, p. 3.).)

Although this conservative case is less conservative than our old conservative case, which used an unrealistically high discount rate of 10 percent, the assumptions remain quite conservative because it uses the high end of the range of recommended discount rates—thus putting greater weight on smaller benefits in the early years—and because it conservatively assumes zero merger benefits after 2024 even though the consumer benefits of the merger are positive in 2024 and are likely to persist, or even grow, thereafter. (For a discussion of the likely growth, see *IKK Declaration,* ¶ 151.)

Table 1
The Proposed Merger's Effect on Consumer Surplus with Current mmWave Holdings

Sensitivity Case	Consumer Surplus Change by Year ($/Sub/Month) 2019	2020	2021	2022	2023	2024	Total Welfare Change NPV ($ Billion) Baseline (2% DR; Ongoing CS at 2024 Level)	Intermediate (2% DR; 2025-2029 CS at 2024 Level)	Conservative (2% DR; No CS Beyond 2024)
ABH Diversion Ratios									
Original Treatment of mmWave	[redacted]								
Refined Treatment of mmWave									
ABH Nested Logit Diversion Ratios									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Harris Mobile Insight Based Diversion Ra[redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Sprint Brand IQ Survey Based Diversion [redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
T-Mobile SoGA and SoDA Estimates Base[redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Subscriber Share Based Diversion Ratios ([redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Adjusted Facebook Data Based Diversion [redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Conservative Industry Elasticity (-0.1)									
Original Treatment of mmWave									
Refined Treatment of mmWave									

Notes: Results are for the adjusted Nevo model in the Maintain Case using the site-specific scaling approach to calculating LTE throughput. The model assumes -0.3 industry elasticity, 75% wholesale pass-through rate, and vGUPPI without input substitution. It applies near-term retail and wholesale price constraints. A positive number indicates that the merger is procompetitive.

IV. THE CONCLUSION THAT THE PROPOSED MERGER WILL BENEFIT CONSUMERS WOULD HOLDS EVEN IF THE APPLICANTS WERE ASSUMED TO ACQUIRE ADDITIONAL LICENSES TO MMWAVE SPECTRUM

BVZ purport to show a "significant reduction in merger benefits if the companies added modest amounts of millimeter wave spectrum to their networks."[8] Specifically, BVZ consider a scenario in which each standalone entity acquires rights to 200 MHz of mmWave spectrum and New T-Mobile acquires rights to 400 MHz of mmWave spectrum.[9]

In addition to relying on a version of the Network Build Model that makes conservative (from the perspective of merger review) assumptions about the treatment of mmWave deployment, DISH and BVZ's claims regarding the effect of mmWave license acquisitions on marginal costs savings from the proposed merger rest on two fundamental errors.

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8 *BVZ February 2019 Submission,* p. 3.

9 *BVZ February 2019 Submission,* § II.

BVZ also considers a scenario in which each standalone network acquires 100 MHz of mmWave spectrum and New T-Mobile acquires 200 MHz of mmWave spectrum and a scenario in which each standalone network acquires 500 MHz of mmWave spectrum and New T-Mobile acquires 1000 MHz of mmWave spectrum.

First, BVZ effectively—and incorrectly—assume that mmWave spectrum can be deployed for free. More precisely, BVZ assume that, if any company acquires additional mmWave spectrum, then that spectrum will be deployed as part of that company's *baseline* network at all sites that are suitable for mmWave spectrum. By including mmWave deployments in the baseline networks, BVZ ignore any costs associated with that deployment (e.g., the costs of additional radios, power, and truck rolls) when (incorrectly) calculating marginal costs. By contrast, a proper calculation of marginal cost in the presence of any mmWave spectrum acquisition requires that mmWave deployments be added to the set of available solutions in the Network Build Model and that the costs of additional solutions triggered by serving additional traffic be taken into account.

BVZ's second error is more subtle, but also damaging to their claims. BVZ computes marginal cost savings at the usage levels in the "Maintain" Case from our *IKK Declaration*.[10] BVZ do so without recognizing that the usage levels for standalone T-Mobile are derived from [redacted][11] As a result, BVZ's approach is internally inconsistent: [redacted][12]

In the remainder of this section, we show that correcting these errors in BVZ's analysis leads to the conclusion that the proposed merger is procompetitive even accepting *arguendo* BVZ's assumptions regarding the acquisition of mmWave spectrum by the standalone and combined entities, as well as BVZ's assumptions regarding the sites that are suitable for mmWave spectrum. We conduct this analysis in three steps. First, we show that correcting BVZ's fundamental errors [redacted]. Second, we show that deployment of mmWave spectrum would tend to [redacted] Third, we show that, after correcting these fundamental errors and running the resulting network marginal costs and network performance estimates through our economic model, our conclusion that the proposed merger will increase consumer welfare and strengthen competition continues to hold.

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10 *BVZ February 2019 Submission,* Tables 1-3 and n. 22. For a description of the Maintain case, see *IKK Declaration*, ¶ 83.

11 *IKK Declaration,* ¶ 80 (citing Reply Declaration of Peter Ewens, September 17, 2018 (hereinafter *Ewens Reply Declaration*), ¶ 33.)

12 Elsewhere, BVZ criticize us for adjusting standalone T-Mobile's projected demand in our analysis of the effects of the merger on 2019 and 2020. (*BVZ March 2019 Ex Parte*, ¶ IV.B.2.)

This criticism misrepresents our analysis. In fact, we have consistently applied the effects of the financial constraints that standalone T-Mobile faces on the projected traffic that the standalone network could handle. As network marginal cost estimates vary across different sets of assumptions, the magnitude of the effect of these financial constraints also varies.

A. The Effects of mmWave Spectrum Acquisition on Estimated Network Marginal Costs

We calculate network marginal cost savings, correcting the two fundamental errors in BVZ's analysis identified above and making use of the refined Network Build Model.[13]

First, rather than including mmWave deployment at all possible sites (as estimated by BVZ) in each network's 2021 baseline plan, we "endogenize" mmWave deployments by allowing the Network Build Model to choose such deployments as one of the potential solutions to congestion. We also account for the associated costs of such incremental deployments (using the same approach that we apply to other potential solutions). In this way, we appropriately account for the effects of mmWave solutions on marginal costs—rather than repeating BVZ's mistake of effectively treating mmWave deployments as having no costs.

Second, we also account for the effects that the associated changes in operating expenditures will have on the financial constraints T-Mobile faces.[14] As described in the *IKK Declaration*, [redacted][15] It is important to recognize that the binding constraint on the amount of traffic that the standalone T-Mobile network can accommodate [redacted].[16] Consequently, changes to the Network Build Model that affect incremental OpEx [redacted]. Said differently, changes to the Network Build Model, [redacted].[17] In the analysis described

[13] We follow BVZ in assuming that acquisition of new mmWave spectrum licenses would have no impact on our projections of marginal costs for 2019 and 2020. This assumption is reasonable because 2019 projections are based entirely on LTE, for which mmWave overlays would not be implemented. Similarly, marginal costs for 2020 are a weighted average of approximately 80 percent LTE and 20 percent 5G and there is relatively little 5G congestion, so any effect of mmWave acquisitions would be small even if it were possible to obtain the licenses and deploy the necessary network equipment and handsets in that timeframe.

See backup materials for further details.

[14] *IKK Declaration,* ¶ 80.

[15] *IKK Declaration,* ¶ 80; *Ewens Reply Declaration*, ¶¶ 33-34.

[16] *Ewens Reply Declaration*, ¶¶ 32-33.

[17] As noted above, if one does not account for the financial constraints and instead uses T-Mobile's projection of unconstrained demand for mobile broadband services, then the merger would be

below, [redacted]

Table 2 below reports the effect of making these two corrections and using T-Mobile's refined Network Build Model to calculate the proposed merger's marginal cost savings. As the table shows, correcting these errors [redacted] For example, in BVZ's 200/400 acquisition scenario, we find that Sprint's marginal cost savings [redacted] by approximately [redacted]/subscriber/month in 2024 and T-Mobile's marginal cost savings [redacted] by approximately [redacted]/subscriber/month in 2024. Although the finding that [redacted]. For example, in 2024, standalone T-Mobile's usage [redacted] from [redacted] GB/subscriber/month in the baseline case to [redacted] GB/subscriber/month with the acquisition of mmWave spectrum.

Table 2
Comparison of Network Marginal Cost Savings Estimates

	T-Mobile						Sprint					
Sensitivity Case	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Network Marginal Cost Savings ($/Sub/Month)												
Original Treatment of mmWave	[redacted]											
Refined Treatment of mmWave												
Brattle 100/200												
Brattle 200/400												
Brattle 500/1000												
5G Usage (GB/Sub/Month)												
Original Treatment of mmWave												
Refined Treatment of mmWave												
Brattle 100/200												
Brattle 200/400												
Brattle 500/1000												

Notes: Results are for the Maintain Case.

In summary, we have shown above that correcting two of the fundamental errors in BVZ's analysis [redacted].

projected to generate even greater marginal cost savings and consumer benefits than indicated by our analysis.

B. The Effects of mmWave Spectrum Acquisition on Network Performance

In order to project the proposed merger's effects on consumer welfare, we also need to model the effects of mmWave deployments on user-experience throughput. Table 3 below reports the effects of different levels of hypothesized mmWave spectrum license acquisition on average user-experience throughput. As can be seen by comparing the first and second panels in the table, taking mmWave holdings at their current levels, the refined Network Build Model predicts [redacted] for standalone T-Mobile and New T-Mobile than does the original version of the model.[18] Acquisition of additional mmWave spectrum licenses would [redacted].

Table 3
Average User-Experience Throughput

Sensitivity Case	2019	2020	2021	2022	2023	2024
Original Treatment of mmWave						
T-Mobile Standalone	[redacted]					
Sprint Standalone						
New T-Mobile (T-Mobile Subs)						
New T-Mobile (Sprint Subs)						
Refined Treatment of mmWave						
T-Mobile Standalone						
Sprint Standalone						
New T-Mobile (T-Mobile Subs)						
New T-Mobile (Sprint Subs)						
Brattle 100/200						
T-Mobile Standalone						
Sprint Standalone						
New T-Mobile (T-Mobile Subs)						
New T-Mobile (Sprint Subs)						
Brattle 200/400						
T-Mobile Standalone						
Sprint Standalone						
New T-Mobile (T-Mobile Subs)						
New T-Mobile (Sprint Subs)						
Brattle 500/1000						
T-Mobile Standalone						
Sprint Standalone						
New T-Mobile (T-Mobile Subs)						
New T-Mobile (Sprint Subs)						

Notes: Results are for the Maintain Case using the site-specific scaling approach to calculating LTE throughput.

C. Consumer Surplus Changes for 2019-2024

We now demonstrate how the marginal-cost and network-performance effects of mmWave license acquisitions described above translate into effects on consumer benefits. Table 4 below

[18] It has no effect on the performance of the standalone Sprint network because at present Sprint has no mmWave spectrum licenses.

reports the projected effects that the proposed merger will have on consumer surplus in each year from 2019-2024 using the refined Network Build Model as well as the net present value of the change in consumer welfare. In all of the BVZ mmWave acquisition scenarios, the merger increases consumer welfare in all years and in all sensitivity runs.

Table 4
Projected Consumer Benefits under Alternative Spectrum-Acquisition Scenarios

	Consumer Surplus Change by Year ($/Sub/Month)						Total Welfare Change NPV ($ Billion)		
Sensitivity Case	2019	2020	2021	2022	2023	2024	Baseline (2% DR; Ongoing CS at 2024 Level)	Intermediate (2% DR; 2025-2029 CS at 2024 Level)	Conservative (2% DR; No CS Beyond 2024)
ABH Diversion Ratios	[redacted]								
Original Treatment of mmWave									
Refined Treatment of mmWave									
Brattle 100/200									
Brattle 200/400									
Brattle 500/1000									
ABH Nested Logit Diversion Ratios									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Brattle 100/200									
Brattle 200/400									
Brattle 500/1000									
Harris Mobile Insight Based Diversion Rati									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Brattle 100/200									
Brattle 200/400									
Brattle 500/1000									
Sprint Brand IQ Survey Based Diversion R									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Brattle 100/200									
Brattle 200/400									
Brattle 500/1000									
T-Mobile SoGA and SoDA Estimates Based									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Brattle 100/200									
Brattle 200/400									
Brattle 500/1000									
Subscriber Share Based Diversion Ratios (S									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Brattle 100/200									
Brattle 200/400									
Brattle 500/1000									
Adjusted Facebook Data Based Diversion R									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Brattle 100/200									
Brattle 200/400									
Brattle 500/1000									
Conservative Industry Elasticity (-0.1)									
Original Treatment of mmWave									
Refined Treatment of mmWave									
Brattle 100/200									
Brattle 200/400									
Brattle 500/1000									

Notes: Results are for the adjusted Nevo model in the Maintain Case using the site-specific scaling approach to calculating LTE throughput. The model assumes -0.3 industry elasticity, 75% wholesale pass-through rate, and vGUPPI without input substitution. It applies near-term retail and wholesale price constraints. A positive number indicates that the merger is procompetitive.

In considering the points above, two additional aspects of mmWave acquisition are important:

- First, it is uncertain whether either standalone firm will be successful in acquiring mmWave spectrum in upcoming auctions. Hence, if any modification is applied to our marginal cost savings, it should be discounted by the probability that one or both parties would be unsuccessful in obtaining mmWave spectrum licenses through auctions or secondary market transactions.
- Second, although we have correctly added the *deployment* costs associated with mmWave spectrum to the cost estimates, we, like BVZ, treat the *acquisition cost of the spectrum itself* as sunk, even though it has not yet been acquired. However, if an economically rational firm is motivated to purchase additional mmWave licenses in order to expand its capacity to serve additional traffic, then the firm will consider the costs of acquiring that spectrum to be a component of the cost of serving that incremental traffic. In other words, the firms will treat some or all of those costs as marginal costs, reducing the profitability of serving the incremental traffic. By creating greater capacity, and thus reducing congestion at any given traffic level without using mmWave spectrum, the merger would reduce this cost and thereby increase incentives to cut prices and expand output, all else equal.

V. THE CONCLUSION THAT THE PROPOSED MERGER WILL BENEFIT CONSUMERS IS NOT AN ARTIFACT OF THE PLANNED BASELINE NETWORK

In our prior modeling, we conservatively used the planned baseline networks in each year through 2024 for standalone Sprint and T-Mobile as our starting points and used the Network Build Model to determine incremental builds necessary beyond those networks.[19] For New T-Mobile, we used the planned baseline network in each year from 2019 through 2021 as the starting point and conservatively used the planned 2021 network as the starting point for our analysis of 2022 through 2024.[20]

As described in our original declaration, we used New T-Mobile's planned 2021 network as a starting point because it is the product of considerations that the Network Build Model—which is a model of capacity solutions—is not designed to capture: namely, the requirements associated with integrating the Sprint and T-Mobile networks, motivated by the desire to achieve decommissioning synergies, as well as the expansion of coverage.[21] By contrast, the BVZ analysis of potential mmWave spectrum acquisitions inappropriately includes mmWave deployments in the baseline networks even though—given their extremely limited coverage—mmWave deployments are fundamentally capacity solutions.

To demonstrate that our conclusions are not sensitive to our assumptions about the baseline networks, we conduct a sensitivity analysis using hypothetical baseline networks that are limited

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19 *IKK Declaration,* ¶ 59.

20 *IKK Declaration,* ¶ 59; *IKK February 2019 Ex Parte,* p. 2.

21 *IKK Declaration,* ¶¶ 56, 59; *Ray Reply Declaration,* ¶ 15.

relative to the actually planned baseline networks.[22] We then use the Network Build Model to determine incremental builds beyond these limited-baseline networks. This approach is analogous to our earlier modeling approach for New T-Mobile in 2022-2024, but now we apply it to all three networks.[23]

Table 5 below reports the projected effects that the proposed merger will have on consumer surplus in each year from 2019-2024 using the refined Network Build Model, as well as the NPV, under the limited-baseline network scenarios. As the table shows, the proposed merger will benefit consumers even if one considers baseline networks that are quite limited relative to the planned baseline networks for 2019-2024.

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22 Specifically, we assume New T-Mobile would: [redacted]

For standalone T-Mobile, we assume that it would: [redacted]

For standalone Sprint, we assume that it would [redacted]

23 *IKK Declaration,* ¶ 59.

Table 5
Projected Consumer Benefits under Alternative Spectrum-Acquisition Scenarios: Limited- Baseline-Network Sensitivity

Sensitivity Case	Consumer Surplus Change by Year ($/Sub/Month) 2019	2020	2021	2022	2023	2024	Total Welfare Change NPV ($ Billion) Baseline (2% DR; Ongoing CS at 2024 Level)	Intermediate (2% DR; 2025-2029 CS at 2024 Level)	Conservative (2% DR; No CS Beyond 2024)
ABH Diversion Ratios	[redacted]								
Original Treatment of mmWave									
Refined Treatment of mmWave									
LBN									
LBN - Brattle 200/400									
ABH Nested Logit Diversion Ratios									
Original Treatment of mmWave									
Refined Treatment of mmWave									
LBN									
LBN - Brattle 200/400									
Harris Mobile Insight Based Diversion Rat[redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
LBN									
LBN - Brattle 200/400									
Sprint Brand IQ Survey Based Diversion R[redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
LBN									
LBN - Brattle 200/400									
T-Mobile SoGA and SoDA Estimates Based[redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
LBN									
LBN - Brattle 200/400									
Subscriber Share Based Diversion Ratios ([redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
LBN									
LBN - Brattle 200/400									
Adjusted Facebook Data Based Diversion[redacted]									
Original Treatment of mmWave									
Refined Treatment of mmWave									
LBN									
LBN - Brattle 200/400									
Conservative Industry Elasticity (-0.1)									
Original Treatment of mmWave									
Refined Treatment of mmWave									
LBN									
LBN - Brattle 200/400									

Notes: Results are for the adjusted Nevo model in the Maintain Case using the site-specific scaling approach to calculating LTE throughput. The model assumes -0.3 industry elasticity, 75% wholesale pass-through rate, and vGUPPI without input substitution. It applies near-term retail and wholesale price constraints. A positive number indicates that the merger is procompetitive.

ATTACHMENT C

REDACTED IN FULL