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November 6, 2018

VIA ECFS

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

REDACTED – FOR PUBLIC INSPECTION

Re: 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:

T-Mobile US, Inc. ("T-Mobile") hereby submits additional material in connection with the Federal Communication Commission's ("FCC's") Information Request of August 15, 2018.[1] The submission provides additional documentation regarding econometric modeling concerning the effects of the transaction. The attached study prepared by John Asker, Timothy Bresnahan, and Kostis Hatzitaskos of Cornerstone Research was recently submitted to the Department of Justice as part of its review of the proposed transaction. Also being submitted today are the backup data (both the raw data as well as the processed data set and appropriate documentation) and the code underlying the study.

This filing contains information that is "Highly Confidential" pursuant to the Protective Order filed in WT Docket No. 18-197.[2] Accordingly, pursuant to the procedures set forth in the

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[1] Letter from Donald K. Stockdale, Jr., Chief, Wireless Telecommunications Bureau, to Kathleen O'Brien Ham, T-Mobile U.S., Inc., WT Docket No. 18-197 (Aug. 15, 2018) ("Information Request").

[2] Applications of T-Mobile US, Inc., and Sprint Corporation for Consent to Assign Licenses, Protective Order, WT Docket No. 18-197 (June 15, 2018). Pursuant to discussions with Staff, custodial documents and data and materials being provided with this response, unless specifically reviewed and downgraded, have been classified as "Highly Confidential." Notwithstanding that default classification, Applicants are not asserting Highly Confidential status for any documents that have been publicly released (which would be Public) or for third party materials that are copyrighted (which would be considered Confidential).

Protective Order, a copy of the filing, including the attached DVD and drive, is being provided to the Secretary's Office. In addition, two copies of the Highly Confidential Filing, including the DVD and drive, are being delivered to Kathy Harris, Wireless Telecommunications Bureau. A copy of the Redacted Highly Confidential Filing is being filed electronically through the Commission's Electronic Comment Filing System.

Please direct any questions regarding the foregoing to the undersigned.

Respectfully submitted,

DLA Piper LLP (US)

/s/ Nancy Victory

Nancy Victory
Partner

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

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ATTACHMENT A

CORNERSTONE RESEARCH
ECONOMIC AND FINANCIAL CONSULTING AND EXPERT TESTIMONY

ECONOMIC ANALYSIS OF THE PROPOSED T-MOBILE/SPRINT MERGER

By John Asker,* Timothy F. Bresnahan,† and Kostis Hatzitaskos ‡

November 6, 2018

* John Asker is a Professor of Economics at the University of California at Los Angeles, where he holds the Armen A. Alchian Chair in Economic Theory.

† Timothy Bresnahan is a Professor of Economics at Stanford University, where he holds the Landau Professorship in Technology and the Economy.

‡ Kostis Hatzitaskos is a Vice President in the Chicago office of Cornerstone Research.

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1. INTRODUCTION

1. The merging parties' rationale for the proposed merger is to combine complementary T-Mobile and Sprint assets so as to better compete with the two historical leaders, AT&T and Verizon.[1] In particular, the merging parties expect that the New T-Mobile network will provide better performance for more consumers than the T-Mobile and Sprint standalones, with higher network quality and lower marginal costs.[2]

2. We use detailed, present-day data to empirically assess the likely competitive effects of the proposed merger. These data demonstrate that network quality is individualized in that the network quality each consumer experiences depends on where, when, and how they choose to use their phone. This rich variation drives our identification strategy in estimating a flexible model of consumer demand to inform consumer valuation of network quality.

3. Our demand estimation introduces consumer types based on the amount of data they use. Our estimates show that even the consumer type that uses less data than the average values network quality. Our analysis focuses on two dimensions of quality: speed and coverage. We build on these estimates to quantify the likely effect of the proposed merger on pricing incentives for the merged firm and its competitors.

4. We find that the proposed merger is likely to increase competition among wireless carriers. Under a range of assumptions about marginal cost efficiencies and network quality improvements, we find that New T-Mobile will gain subscriber share, consistent with an expansion of output and welfare gains for consumers.

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[1] Public Interest Statement, p. 19 ("On a standalone basis, T-Mobile would be capacity constrained and Sprint lacks coverage. The transaction will solve these issues as New T-Mobile combines each company's complementary spectrum and site assets to mitigate their individual shortcomings and leverage their strengths."); Declaration of John Legere, June 18, 2018, ¶ 24 ("The network synergies resulting from our proposed transaction and the capacity we will have on the New T-Mobile network create an opportunity for us to take market share from the marketplace leaders—but taking advantage of that opportunity requires us to be agile, innovative and aggressive to give consumers great pricing and additional value.").

[2] Public Interest Statement, pp. 17–20 ("The transaction will enable New T-Mobile to build a network with distinct advantages over both the standalone 5G networks planned by T-Mobile and Sprint and will provide a platform for an unrivaled nationwide 5G mobile service."); Declaration of Michael Sievert, June 18, 2018, ¶ 12 ("New T-Mobile will use that capacity [redacted] times the capacity of T-Mobile's current network by 2024] and the resulting lower marginal costs per customer to deliver lower prices and to accommodate increased customer usage at the same or lower prices.").

1.1. Our merger simulation offers an economically coherent framework, grounded in detailed industry data, for understanding the competitive significance of the proposed merger

5. Our analytical framework follows the academic literature, the Horizontal Merger Guidelines,[3] and simulation methods previously used in merger reviews.[4]

6. We use detailed industry data on consumer behavior, network performance, and brand choice to determine (a) how consumers select a wireless brand given where, when, and how they use their phone ("demand model"), (b) how firms set prices given the prices and offerings of their competitors ("supply model"), and (c) how demand and supply interact to determine market outcomes, namely prices and subscriber shares ("market equilibrium"). We combine the above with a range of estimates of marginal cost efficiencies and network quality improvements to estimate how market outcomes are likely to change as a result of the proposed merger.

7. **Demand model.** We conduct our demand analysis using the Nielsen Mobile Performance ("NMP") dataset. This is the best available dataset about individual consumers who use different cellular service brands of which we are aware.[5] NMP follows [redacted] as they go about their day, recording metadata based on their behavior, e.g., when and where they use their phone to access the internet.[6] The data therefore allow us to closely evaluate the quality of service individual consumers receive from their chosen carrier given their individualized location and usage patterns.

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[3] US Department of Justice and Federal Trade Commission, *Horizontal Merger Guidelines*, August 19, 2010, available at https://www.justice.gov/sites/default/files/atr/legacy/2010/08/19/hmg-2010.pdf, p. 21 ("Guidelines") ("Where sufficient data are available, the Agencies may construct economic models designed to quantify the unilateral price effects resulting from the merger. These models often include independent price responses by non-merging firms. They also can incorporate merger-specific efficiencies. These merger simulation methods need not rely on market definition."). Given the data resources available in this industry, and the complex nature of the trade-offs to be evaluated in this transaction, it is our opinion that merger simulation methods are an appropriate and informative means to deepen our understanding of the likely impact of the transaction on the incentives for competition and the resulting impact on consumers.

[4] For example, Federal Communications Commission, "Memorandum Opinion and Order," *In the Matter of Applications of AT&T Inc. and DirecTV*, July 24, 2015, ¶¶ 82–145 and Appendix C. ¶ 3.

[5] For more details on the NMP data, see Appendix §§ 5.1.1, "The NMP data," and 5.1.2, "NMP geographic coverage."

[6] Nielsen, "Mobile Performance," available at http://www.nielsen.com/us/en/solutions/capabilities/nielsen-mobile-performance.html, accessed October 25, 2018 ("The product employs proprietary metering technology to passively measure a geographically representative opt-in panel of Android U.S. smartphone owners that captures over 400 million data points each month. The passive meter runs 24/7 in the background of the device, continuously capturing data speeds and hundreds of other metrics across different file sizes and applications.").

8. There are several ways to measure quality of experience on a wireless network. We summarize network experience at a geographic and individual level as follows. First, we calculate two measures of network quality for local geographic areas: speed (measured in megabits per second, "Mbps") and coverage (measured as the percentage of time on LTE or 4G).[7] We then construct four measures of network quality for each consumer in the NMP data: average speed and worst speed, and average coverage and worst coverage. The worst speed and coverage measures correspond to the local geographic area where the brand offers the worst speed or coverage the consumer would experience across all of the local areas that the consumer visits.[8]

9. We also allow for consumers to differ in how they choose among brands depending on the characteristics of the consumer. For example, we allow for consumers who download relatively more data to have different sensitivity to download speeds than other consumers. As another example, we allow preferences between brands to differ by income. Our demand model evaluates how consumers may make different brand choices based on these and other observable consumer characteristics.

10. **Supply model.** The supply model we employ is standard in the academic literature and in merger review in industries where products are differentiated. Each firm sets prices to maximize its own profits subject to its marginal costs, consumer demand, the prices set by its competitors, and the network quality of its own product and those of its competitors. The model accounts for carriers that offer multiple brands. In particular, T-Mobile operates its own brand and MetroPCS; Sprint operates its own brand, Boost, and Virgin; and AT&T operates its own brand and Cricket. As explained further below, we do not explicitly model the pricing of MVNOs and regional carriers. Further, due to data limitations, the supply model does not account for the fact that each brand offers multiple plans.[9]

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[7] [redacted]

[8] We describe the "geogrids" that serve as local geographic areas in our analysis, as well as our network quality measures, in more detail below and in Appendix § 5.1.3, "Geogrids."

[9] This is frequently the case in many applications. [redacted]

11. **Market equilibrium.** We combine the demand and supply models to determine the market equilibrium. The market is at equilibrium if no firm can increase its profits by either raising or lowering its prices given the prices that its competitors have set.[10] Our merger simulation then examines how the observed market equilibrium would change if the merger and the network integration efficiencies were to take place today. That is, it provides a view of the change in competitive incentives that the merger would create as benchmarked against the industry as we observe it at present, taking into account the loss of a competitor as well as ranges of marginal cost efficiencies and network quality improvements.

12. This analytical framework allows us to assess competitive product differentiation today and how competition and market outcomes would change if the merged firm were to have a higher quality network and reduced marginal costs. Both of these assessments are rooted in the detailed demand data. This close connection to data provides a reliable foundation for our analysis.[11]

[redacted]

[10] We describe our market equilibrium assumption and supply side model in more detail below, as well as in Appendix § 5.3.2, "Pricing model with Bertrand price competition." Our analysis does not address coordinated effects. The Public Interest Statement, Appendix H and Joint Supplemental Declaration of Professor Steven Salop and Dr. Yianis Sarafidis discuss why coordinated effects are unlikely to arise in this industry. See Joint Supplemental Declaration of Professor Steven C. Salop and Dr. Yianis Sarafidis, September 17, 2018.

[11] Our analysis is complementary to the merger simulation analysis outlined in the Reply Declaration of Mark Israel, Michael Katz, and Bryan Keating, September 17, 2018 ("Israel, Katz, and Keating Declaration"). That analysis has strong foundation in the network engineering work done by the merging parties, while our work is tied to present-day micro data. The Israel, Katz, and Keating Declaration also focuses on the effects of 5G speed improvements, while our work focuses on network quality improvements within the range observed in present-day, LTE-era data.

1.2. Direct empirical evidence suggests and our merger simulation demonstrates that the proposed merger is procompetitive under a wide range of assumptions about marginal cost efficiencies and network quality improvements

13. Our ultimate conclusion is that the proposed merger is likely to increase competition for wireless plans. This is based on the following, summarized here and discussed in more detail in the rest of this white paper and its supporting materials.

14. We first make two observations directly from the data, before any econometric analysis. These observations drive the identification strategy of our demand estimation and suggest opportunities for improved network quality to strengthen competition. Thus they anticipate our merger simulation results and provide a simple explanation of our conclusion that the proposed merger is likely to be procompetitive.

- First, we find that individuals use their phones in different locations and for different tasks. The performance of each network varies across locations, sometimes on a very granular level. As a result, different individuals living in the same city can obtain very different quality of service from a given network.

- Second, we find that consumers who today choose brands on the Sprint or T-Mobile networks tend to be consumers who use their phones in locations where these networks offer quality that is stronger than their average. Similarly, many consumers who today choose AT&T or Verizon would face significant degradation in network quality if they were to switch to the network of one of the two merging parties.

15. We proceed with our econometric analysis of consumer demand, which we then deploy in a merger simulation. This analysis demonstrates that under a wide range of assumptions about marginal cost reductions and network quality improvements, the merged firm will increase output and gain share, an important measure of whether an action is procompetitive when both quality and price are changing.

- First, our demand model shows that the specific measures of individualized network quality we construct using the NMP data are important factors in explaining consumer choice. We find that the different consumer types place significant value on the quality of their network experience. Even the minority of consumers who use substantially less data than the average value incremental network quality. Improvements in network quality will therefore directly benefit consumers and strengthen competition.

- Second, our merger simulation finds that under a wide range of conservative network quality improvements and marginal cost efficiencies, the proposed merger puts competitive pressure on AT&T and Verizon and is likely to be procompetitive.

16. The rest of this white paper proceeds as follows. We first provide direct empirical evidence, without any econometric analysis, on the role of network quality in competitive outcomes today (§ 2). We then present our econometric model of demand and discuss its findings (§ 3). Then we present a wide range of merger simulation scenarios that evaluate the likely competitive effects of the proposed merger (§ 4). Finally, we further describe our data and methodological framework in a detailed appendix (§ 5).

2. DIRECT EMPIRICAL EVIDENCE

17. Competitive conditions among the mobile carriers today can be directly observed in the individual consumer micro data. In this section, we focus on the AT&T, Sprint, T-Mobile, and Verizon brands, and examine their ability to provide service at the times and places individual consumers use their smartphone today.[12] The better the service that a brand provides at an individual's typical places of use (e.g., home, work, commute, main travel locations, and main shopping locations), the greater the competitive advantage that brand will have in winning that individual's business. Historical subscriber shares and third-party network quality rankings are consistent with the merging parties offering substantially lower quality to many consumers than the two leading brands, a pattern we confirm by directly examining the consumer micro data.

18. In this section, we first briefly present some results, namely direct empirical evidence that many consumers would lose substantial network quality if they were to switch from AT&T and Verizon to the merging parties today (§ 2.1). We then step back to provide details on the rich NMP micro data upon which this evidence is based and on the methodology we use to construct individualized measures of the network quality that each brand offers (§ 2.2). In later sections, we use these data to estimate demand (§ 3) and conduct merger simulations under different assumptions about marginal cost efficiencies and network quality improvements for New T-Mobile (§ 4).

2.1. Many consumers today would experience substantially slower speeds were they to use the Sprint or T-Mobile networks

19. Before we describe our data and methodology in detail in the next subsection, we first preview some of the results that follow directly from the data. In particular, we examine the reduction in network quality that many consumers would experience if they were to use the Sprint or T-Mobile brands today. We find that a substantial fraction of consumers would face a large quality penalty, and show that improvements in network quality would allow the Sprint and T-Mobile brands to better compete for these consumers. This result motivates our use of the detailed NMP data, anticipates our merger

[12] For ease of exposition, in this section we focus on the AT&T, Sprint, T-Mobile, and Verizon premium brands. Later, in our demand estimation and merger simulation analysis, we also explicitly model the following non-premium brands: Cricket (owned by AT&T), Boost/Virgin (owned by Sprint), and MetroPCS (owned by T-Mobile).

simulation results, and provides a simple explanation of why our model finds the proposed merger to be procompetitive.

20. The NMP individual micro data add value to our demand analysis by [redacted] Consumers who would experience lower average quality on a brand tend to avoid it, and instead choose another brand. For example, consumers who choose Sprint tend to be consumers who would experience better than average network quality on Sprint. By contrast, the consumers who choose another brand tend to be consumers who would experience lower than average network quality on Sprint. Relative to AT&T and Verizon, Sprint and T-Mobile have larger differences between the average network quality experienced by their own consumers and the network quality that other consumers would experience on their networks.[13] Given the aggregate subscriber shares, consumers who have not chosen Sprint or T-Mobile are likely to primarily be consumers of AT&T and Verizon.

21. In Exhibit 1 we use the NMP data to examine the reduction in network speed AT&T and Verizon customers would face if they were instead to use Sprint or T-Mobile. We report what fraction of *all* American smartphone users are customers of AT&T or Verizon who would experience a substantial loss of speed if they were to switch to one of the merging firms.[14]

- The lighter bars show the impact of a switch today. [redacted]

[13] See Appendix § 5.1.7, "Calculating measures of actual and counterfactual experiences," and in particular Exhibit 60 and Exhibit 61.

[14] [redacted]

[redacted][15]

- The darker bars show the impact of a switch after a hypothetical increase of today's average speeds of the Sprint and T-Mobile networks by ten percent.[16] [redacted]

[redacted]

[15] [redacted]

[16] As we explain later, in § 4.2.2, "Critical marginal cost efficiencies assuming a ten percent increase in speeds," we understand that a 10 percent increase in speed is likely a conservative estimate of the merger-specific network improvements that are likely to result from the proposed merger.

22. The results in Exhibit 1 demonstrate that, at present, many consumers face considerable quality deficiencies from the Sprint and T-Mobile networks, and that improvements in the quality of the merging parties' networks could position them to better compete for these consumers.

2.2. The NMP micro data allow us to calculate network quality for each individual given where, when, and how they use their phones

23. The NMP data measure [redacted] and are thus particularly well-suited for the purposed of demand analysis. In this subsection we first provide details about the NMP data. We then describe how we use these rich micro data to calculate individualized measures of network quality for each brand that are based on where, when, and how each specific consumer uses his or her phone.

2.2.1. The NMP micro data

24. We use NMP data that cover March through May of 2018 and include information on [redacted][17] When we examine the distribution of demographic characteristics of the NMP sample, we find [redacted][18]

25. The NMP data include [redacted][19] [redacted]

[17] See our workpapers. [redacted]

[18] [redacted]

[19] [redacted]

[redacted][20] [redacted]

26. For each consumer in the sample, the NMP data provide [redacted][21] [redacted][22]

27. In Exhibit 2 we use the example of a single consumer to illustrate the detailed information contained in the NMP data for each consumer. In this map, we show [redacted]

28. Using this information, we can map out [redacted][23] [redacted][24] [redacted]

[redacted]

20 [redacted]

21 [redacted]

22 For more information about the NMP data and sample of consumers, see Appendix § 5.1.1, "The NMP data."

23 [redacted]

24 For more detail on this and other exemplar consumers, see Appendix § 5.1.1, "The NMP data."

[redacted]

[redacted]

[redacted]

[redacted]

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29. [redacted][25] [redacted][26] [redacted]

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[25] [redacted]

[26] See Appendix § 5.1.1, “The NMP data.”

30. In the rest of this section, we use the information recorded in the NMP data to measure the network quality each brand offers from a geographic perspective and from an individual's perspective. We first describe how we aggregate the NMP data over well-defined geographic units to create localized measures of [redacted] We then explain how we leverage the individual usage patterns in the NMP data and the [redacted]

2.2.2. Measuring network quality in local geographic areas

31. To calculate network quality in a local area, we first need to define the unit of geography over which we measure network quality. For this purpose we adopt a system of "geogrids" [redacted] The geogrids are used to measure network quality in local areas significantly more granular than a city, town, or neighborhood. Approximately 200,000 geogrids of varying shape and size cover the entirety of the United States. Smaller geogrids tend to cover areas that are more densely populated or have a denser morphology, such as dense urban areas.[27] Larger geogrids tend to cover less dense, rural areas. [redacted][28]

32. We calculate network quality metrics in each geogrid for each brand. We do this for two dimensions of network quality: speed and coverage.[29]

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[27] The smallest geogrids are approximately 3,500 feet or 0.66 mile wide from one side to an opposing side. See Appendix § 5.1.3, "Geogrids."

[28] [redacted]

[29] These metrics are frequently measured by third party data vendors. For example, the first two metrics that OpenSignal reports are 4G/LTE availability and download speeds. See Andrea Toth, "Understanding mobile network experience: What do OpenSignal's metrics mean?," *OpenSignal*, April 5, 2018, available at https://opensignal.com/blog/2018/04/05/understanding-mobile-network-experience-what-do-opensignals-metrics-mean/, accessed October 25, 2018. In addition, companies routinely discuss speed and LTE availability in their marketing and other announcements. For example, see Colin Gibbs, "Sprint CFO: Customers now on LTE 90% of the time," *Fierce Wireless*, December 4, 2015, available at https://www.fiercewireless.com/wireless/sprint-cfo-customers-now-lte-90-time, accessed October 25, 2018; and *T-Mobile*, "The results are in. We're still on top," available at https://www.t-mobile.com/coverage/4g-lte-network, accessed October 25, 2018 ("The results are in. We've got the fastest LTE network. Billions of real-world consumer tests prove it. See the Ookla and OpenSignal data for yourself. We tripled our LTE coverage.").

33. **Average standardized speed for each geogrid.** To measure speed for each brand in each geogrid, we do not simply average the raw speeds [redacted][30] To account for these factors, we construct a measure we refer to as standardized speed. Speed standardization makes speed measurements taken [redacted] which is to evaluate network performance in a particular geogrid. The result is a measure of speed that isolates the effect of the network quality on download speeds and allows for an apples-to-apples comparison of different experiences.[31]

34. Once we have standardized download speeds, we calculate the brand's network quality in a given geogrid in terms of speed by [redacted]

35. In Exhibit 3, we present [redacted][32] [redacted][33] In the next subsection,

[30] [redacted]

[31] See Appendix § 5.1.4, "Calculating standardized speeds."

[32] [redacted]

[33] [redacted]

we explain how we use this intuition and the network quality metrics to construct individualized measures of network quality.

[redacted]

36. **LTE coverage for each geogrid.** We use the NMP data to [redacted][34] As described above, [redacted][35]

37. [redacted]

[34] See Appendix § 5.1.5 "Calculating geogrid-level measures of network quality."

[35] [redacted]

38. Using these measures we can directly compare the quality of coverage offered by each brand in specific locations. [redacted][36]

39. **Imputing network quality for non-premium brands.** In many geogrids [redacted]

40. Since they operate on the same networks, we may expect premium and non-premium brands offered by the same firm to offer the same network quality.[37] This is not always the case. Policies such as deprioritization mean that non-premium brands may receive slower speeds than premium brands, for example during congestion.[38] [redacted]

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[36] See Exhibit 61 in Appendix § 5.1.7, "Calculating measures of actual and counterfactual experiences."

[37] The one potential exception is Sprint and its non-premium brands, Boost and Virgin. We understand that while Sprint-branded phones have been allowed to roam on other networks when outside of Sprint's coverage footprint, Boost phones historically do not offer data roaming and only limited voice roaming, in an effort to save on roaming costs. See Adam Fendelman, "Prepaid Wireless: Roaming Policy at Boost Mobile," August 28, 2018, available at https://www.lifewire.com/wireless-roaming-policy-at-boost-mobile-579088, accessed October 30, 2018. Assuming that the relationship we observe between the premium and non-premium brands holds in geogrids where we do not observe both will likely overstate the quality of Boost and Virgin in these geogrids. This is likely conservative. We understand that New T-Mobile will not face the same coverage challenges, and hence Boost and Virgin will experience the same coverage and speeds as MetroPCS. By overstating the network quality of the standalone Boost and Virgin, our merger simulation thus understates the expected quality increases. Moreover, to the extent that the network quality we include in our demand estimation is not entirely accurate, we would expect this measurement error to attenuate our estimates and for it to suggest that consumers care less about network quality than they do in practice.

[38] For example, see Phillip Michaels, "MetroPCS vs. T-Mobile: Which is Best for You?" October 11, 2017 available at https://www.tomsguide.com/us/metro-pcs-vs-tmobile,review-4537.html, accessed October 28, 2018 ("But there can be limitations on just how much MetroPCS customers benefit from T-Mobile's network. T-Mobile does reserve the right to prioritize traffic for its own subscribers when there's heavy demand on its network: In other words, MetroPCS customers may face slower speeds if there are lot of other users tapped into T-Mobile's network at any given time. Still, when we did our own LTE speed testing, we noticed minimal difference between T-Mobile and MetroPCS. T-Mobile had an average download speed of 23.5 Mbps nationally, compared with 22.1 Mbps for MetroPCS. In some of the testing spots around the country, in fact, MetroPCS even outperformed its parent company. That's not to say that MetroPCS customers won't find themselves deprioritized at some point, but in our experience, the speed gap isn't as noticeable as it is with other Big Four carriers and the mobile virtual network operators that piggyback on their service.").

[redacted][40] [redacted]

2.2.3. Measuring individualized network quality

41. The second step in examining the current state of network competition today is to measure the counterfactual network quality each consumer would experience from each brand if they were to choose that brand. This is also a step toward our econometric model of the role of network quality in the choice of brands. Ideally, we would observe seven consumers, each using their phones in the exact same places, at the exact same times, for the exact same purposes, with each consumer using one of the seven brands. Realistically, this is impossible. [redacted]

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[39] [redacted] See Exhibit 57 and Appendix § 5.1.7, "Calculating measures of actual and counterfactual experiences."

[40] This analysis does not identify the mechanisms that cause the reduced network quality experienced by consumers on non-premium brands relative to the premium brand. Our understanding is that beyond deprioritization, this likely includes prepaid plans having lower data caps and network management causing slower speeds after usage exceeds those caps. Note that standardization of speed accounts for differences within a geogrid in the mix of file types and sizes, as well as differences in usage patterns throughout the day. Thus, to the extent that non-premium consumers within a geogrid use their phones differently than premium consumers along these two dimensions, such differences are not driving the estimated relationships between non-premium and premium average standardized speed. Our goal in inferring speeds for non-premium brands, however, is not to precisely identify the cause of the differences in quality between the premium and non-premium brands. Rather, it is to infer what the quality of the network experience would be for non-premium consumers in areas for which we do not have any data. The simple average relationship is well-suited for this purpose.

42. [redacted] We do not focus only on the average experience of each consumer. [redacted][41] Thus, we capture two dimensions of the quality of the experience on the network for each consumer: average experience and "worst" experience.

43. For example, [redacted][42] [redacted][43]

44. We calculate each of these network quality metrics in the same way for the brand the consumer chose and the brands the consumer did not choose. This results in similar measures of individualized network quality for each brand.

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41 [redacted] See Delta Partners, "Managing Network Quality of Experience (QoE) from a Commercial Perspective," September 8, 2017, p.13.

42 [redacted]

43 [redacted]

45. [redacted][44]

[redacted]

44 [redacted]

46. [redacted]

47. In this section, [redacted]

3. ECONOMETRIC MODEL OF DEMAND

48. Up to this point, our discussion has been informed by a direct examination of the NMP and other available data. In this section, we describe how we use the rich NMP micro data to estimate an econometric model of the relationship between brand choice and network quality (§ 3.1). We then present the results of our demand estimation, including our estimates of the values consumers place on the quality of their network experience (§ 3.2). In the next section, we use these demand estimates in various merger simulation exercises to investigate the likely competitive effects of the proposed merger (§ 4).

3.1. Our demand estimation framework incorporates individualized network quality reflecting where, when, and how each consumer uses their phone, allowing for heterogeneous preferences over network quality

49. We use the NMP micro data to estimate an econometric model of the relationship between brand choice and network quality. As described above, the micro data allow us to construct [redacted]

50. We estimate a standard conditional logit model of brand choice, where each consumer ranks each available brand on the basis of a utility score and then chooses their top-ranked option. The utility score assigned to each carrier varies across individuals and is comprised of three components: (a) network quality given a person's individualized usage patterns, (b) preferences reflecting how much they value different brand characteristics, including quality, which are parameters to be estimated and may depend on how intensely an individual uses their phone, demographics, and other consumer characteristics,[45] and (c) a stochastic term that accounts for the fact that people with identical experiences for each brand might nevertheless make different choices for reasons we cannot measure, e.g., advertising exposure or proximity to a particular brand's retail store.

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[45] Note that because we only have one national price for each carrier, the price coefficient cannot be separately identified from brand fixed effects in the conditional logit regression. We describe how we back out the price coefficient in §§ 3.2.2, "Our demand model produces estimates of diversion ratios that are founded in estimates of consumer responsiveness to price and network quality" and 5.3.2, "Pricing model with Bertrand price competition."

51. Formally, each person indexed by i of data use intensity type t living in location l assigns a utility level u_{itlb} to brand b.[46] The utility level is specified as follows:

$$u_{itlb} = \alpha_{lb} + \alpha_{tb} + \beta_t x_{ib} + \gamma_b C_i + \epsilon_{ib}$$

where x_{ib} is a list of the network quality metrics, subscripted by i and b to reflect that an individual i's experienced quality for brand b depends on where and when they use their phone; α_{lb} and α_{tb} capture brand preferences that may depend on the individual's location of residence and whether they are a light, medium, or heavy data use type; γ_b capture brand preferences that may depend on consumer demographics given by C_i; ε_{ib} is a stochastic term distributed type-I extreme value reflecting determinates of choice not included in our model; and β_t are preference coefficients that govern how much individuals of data use type t value each network quality product characteristic. We allow the parameter β_t to vary by whether individual i is a light, medium, or heavy data user, as explained further below. We estimate α_{lb}, α_{tb}, β_t, and γ_b to match observed consumer brand choices. We use the NMP data to measure x_{ib}, and both census and NMP data to measure C_i.[47]

52. In summary, we allow consumers to differ in how they experience network quality and in how much they value network quality. We also allow consumers in different cities, or with different demographics and other characteristics, to differ in their preferences among the different brands.

53. **Brands modeled and the outside option.** In our demand model consumers choose from one of seven brands and an outside option. The seven brands that we model directly, including measuring the network quality they offer, are AT&T, Sprint, T-Mobile, Verizon, Cricket, Boost/Virgin, and MetroPCS. The outside option in our model, whose network quality we do not measure, represents options such as US Cellular, Tracfone, Xfinity, Google, and other MVNOs. This is a narrow definition of the outside option that likely understates the likely procompetitive effects of the proposed merger.[48]

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[46] The locations we use in our modeling are KPMG/Sprint "market areas." For more detail, see Appendix § 5.2.1, "Shares."

[47] We estimate this choice model directly using maximum likelihood. For more detail, see Appendix § 5.3.1, "Demand estimation framework."

[48] In particular, our formulation of the outside option assumes the market size is fixed at the current number of connected devices. To the extent that this makes demand somewhat more inelastic at the extensive margin than might be the case if market size were larger (e.g., allowing for the possibility that lower prices or higher quality

54. **Network quality.** Our specification allows consumer demand to depend on a list of network quality variables, measured for each individual across the geogrids they visit and in which they use their phones, x_{ib}. These include:

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

55. We also interact each of the network quality metrics with a variable that identifies [redacted][49] Including these interaction terms allows for the possibility that consumers with different levels of data usage differently value each of the above four aspects of network quality.[50]

56. **Consumer characteristics.** Consumer choice and substitution patterns may differ across demographic groups. For example, it is possible that individuals who use larger amounts of data are relatively more sensitive to download speeds. These individuals may, all else equal, choose higher speed brands and switch to relatively higher speed brands given a price increase. Another possibility is that preferences differ by income. For example, lower-

could lead consumers to connect more devices to a network), our framework is more inclined toward findings adverse to the proposed merger.

[49] [redacted] Many brands offer limited plans that charge users on a per GB basis, or that have limits as low as 1 GB, e.g., AT&T, Xfinity Mobile, and Project Fi. Verizon, Cricket, T-Mobile, MetroPCS, and Sprint all offer limited 2, 3, or 4 GB plans. For example, see Xfinity Mobile, "The Xfinity Mobile Plan: Designed to save you money," 2018, available at https://www.xfinity.com/mobile/plan; and Google Project Fi, "Bill Protection makes saving twice as sweet," 2018, available at https://fi.google.com/about/plan/, accessed October 25, 2018.

[50] Consumers are using substantially more data over time, so we would also expect the share of heavy data users to increase further over time, and for heavy data users to increase their average usage over time. For example, from 2014 to 2016, the average mobile data usage per smartphone subscriber increased from 1.36 to 3.90 GB. See Federal Communications Commission, "Twentieth Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services," September 27, 2017, Appendix I: Chart 2 on p. 72. Consistent with this pattern, the share of consumers with unlimited data plans has increased in recent years. For Sprint, from January, 2016 to June 2018, subscribers on unlimited plans [redacted] See Exhibit 86 in Appendix § 5.3.1, "Demand estimation framework."

income individuals may be more likely to choose a lower-priced, non-premium brand.

57. In order to allow for these possibilities, we allow preferences to vary across observably different consumers. Specifically, we allow for heterogeneity across consumers by interacting key demographic variables with an indicator for each brand. These interaction terms allow for preferences and thus choices to differ for consumers with different demographics, even if they live in the same city and face identical network qualities for each brand. Specifically, we include interactions between brand and:

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

58. [redacted][51]

[51] See Appendix § 5.1.9, "Weighting NMP consumers to align with subscriber shares."

3.2. Our demand estimation results demonstrate that consumers place significant value on the quality of their network experience

59. In this section we discuss the results of our demand model, including the interpretation of the coefficients for the network quality variables, the ability of our model to capture brand choice for different types of consumers, and the diversion ratios based on our demand estimates.

60. In Exhibit 5 we present estimates from our demand model. In the top panel, we report the estimates for each of our four measures of network quality for each of the three data use types. [redacted][52]

61. [redacted][53]

62. The coefficients we estimate in the demand model reflect the relative marginal utility that consumers receive, [redacted] Since utility is not directly observed, the coefficients may not be intuitive to many readers.

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[52] [redacted]

[53] [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

63. To make the estimates more intuitive, we also calculate and present economic results based on the estimates of our demand model. For each consumer type ([redacted]) in Exhibit 6 we present the willingness to pay for an incremental unit of each of the four measures of network quality we include in our demand model.[54] [redacted][55] [redacted][56] [redacted]

[redacted]

64. Overall, consumers who use more data value speed more than consumers who do not. All consumers value coverage, in the form of the percentage of time they are on LTE, but consumers who use more data value it more.

[54] The utility specification used to estimate demand (see prior section) did not include price. Instead, the effect of price enters through the location-specific brand fixed effects, α_{lb}. When calibrating the price coefficient using the supply side model and profit maximizing assumptions, we disaggregate the location-specific brand fixed effects into a price effect, δp_b, and the remaining location-brand fixed effect, ξ_{lb}: $u_{itlb} = \xi_{lb} + \delta p_b + \alpha_{tb} + \beta_t x_{ib} + \gamma_b C_i + \varepsilon_{ib}$.

[55] [redacted]

[56] See Exhibit 54 in Appendix § 5.1.4. "Calculating standardized speeds."

65. In addition to valuing the average network quality they experience, consumers also tend to value networks where their worst quality experiences would be less bad. The value placed on improving their worst experiences is less than the value of a corresponding increase in average experience. [redacted]

66. As an example of what these estimates might mean for consumer choice, consider the example of a consumer choosing a brand. [redacted]

57 [redacted]

[redacted]

67. The results of the demand model show that network quality is a quantitatively important determinant of consumer demand. The speed and coverage that each consumer would experience with a given brand matters to consumers when they are choosing a brand. This confirms that, everything else equal, a merger that leads to greater network quality improvements would enhance competition.

3.2.1. Our demand model does well in predicting brand choices for different types of consumers

68. We now present analyses that confirm that our demand model fits the data well. [redacted]

69. [redacted]

[redacted]

[redacted]

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70. [redacted][58]

[58] [redacted] See Appendix § 5.1.9, "Weighting NMP consumers to align with subscriber shares" for more details on how these weights are constructed.

71. [redacted]

[redacted]

72. [redacted][59]

[59] The census measures race and ethnicity separately. Survey responders may report multiple races, of which African American is one option. Ethnicity determines whether a person is of Hispanic origin or not, but Hispanics may report as any race. See U.S. Census, “Race & Ethnicity,” undated, available at https://www.census.gov/mso/www/training/pdf/race-ethnicity-onepager.pdf, accessed October 25, 2018. We add both measures at the zip code level. See Appendix § 5.1.8, “Assigning demographics to NMP consumers” for more details.

[redacted]

73. [redacted]

[redacted]

3.2.2. Our demand model produces estimates of diversion ratios that are founded in estimates of consumer responsiveness to price and network quality

74. Demand models can often be used to directly estimate consumer responsiveness to price. We cannot do this as part of our demand model. Ideally, we would have data where different consumers faced different prices either across locations or over time. This would allow us to estimate how choices vary with prices. However, in this case each brand sets prices nationally and we lack sufficient intertemporal variation in prices to directly estimate price sensitivity within our demand model.

75. Instead we combine our demand framework with the supply side of the model and a standard equilibrium assumption, which we discuss in more detail in the next section, to back out the price coefficient.[60] Due to common data limitations, we follow the literature and regulatory practice and summarize price using a single measure,[61] in our case average revenue per user ("ARPU"). We then calculate a price coefficient using price data for each brand and margin data for one brand.[62] Specifically, we use T-Mobile estimated margins of [redacted], corresponding to 2018 estimates.[63] We also use the first-order condition to calculate implied margins and marginal costs for other brands.

76. We calculate diversion ratios based on our estimates of consumer responsiveness to network quality from our demand model and the calculation of price sensitivity we described above.[64] [redacted]

[60] The utility specification used to estimate demand (see prior section) did not include price. Instead, the effect of price enters through the location-specific brand fixed effects, α_{lb}. When calibrating the price coefficient using the supply side model and profit maximizing assumptions, we disaggregate the location-specific brand fixed effects into a price effect, δp_b, and the remaining location-brand fixed effect, ξ_{lb}: $u_{itlb} = \xi_{lb} + \delta p_b + \alpha_{tb} + \beta_t x_{ib} + \gamma_b C_i + \varepsilon_{ib}$.

[61] For example, see Berry, Levinsohn, and Pakes, "Automobile Prices in Market Equilibrium", *Econometrica*, Vol. 63, No. 4, July 1995; Yurukoglu et al., "The Welfare Effects of Vertical Integration In Multichannel Television Markets," Econometrica, Vol. 86, No. 3, March 2018; and Federal Communications Commission, "Memorandum Opinion and Order," *In the Matter of Applications of AT&T Inc. and DirecTV*, July 24, 2015, ¶¶ 332–334.

[62] See Appendix § 5.3.2, "Pricing model with Bertrand price competition."

[63] See Appendix § 5.2.2, "Margins."

[64] The diversion ratios typically calculated and used in antitrust analysis summarize diversion resulting from changes in price. We can also calculate diversion ratios corresponding to changes in network quality directly from our demand estimation model, without relying on assumptions regarding the supply side, but we focus here on price-based diversion.

[redacted]

77. These diversion ratios, which are based on our demand estimates and consumer price sensitivity, generally differ from what we would expect if diversion was proportional to subscriber shares. This is true both for specific individuals (as seen in Exhibit 8 through Exhibit 11) as well as in the aggregate, consistent with our demand model capturing ways in which consumer brand choice patterns vary across different consumer types and brands.

78. Our model generally shows diversion among the brands owned by the merging parties above that predicted by shares alone. For instance, share-based diversion from the Sprint brand to the T-Mobile brand would be [redacted] whereas our model estimates diversion of [redacted][65] We also find that diversion between the brands owned by the two market leaders and the brands owned by the merging parties are lower than would be expected based on shares alone. For instance, diversion from Verizon to T-Mobile if based only on shares would be [redacted] whereas our model estimates diversion of [redacted][66]

65 [redacted] We report the subscriber shares for each brand in Appendix § 5.2.1, "Shares."

66 [redacted] We report the subscriber shares for each brand in Appendix § 5.2.1, "Shares."

79. The diversion ratios that our rich demand model generates are closer to the lower end of the range reported in the Israel, Katz, and Keating Declaration. For Israel, Katz, and Keating, diversion ratios are an input to which they calibrate their model, not an output. Using two different inputs, they report total diversion from all Sprint brands to all T-Mobile brands of [redacted] and diversion from all T-Mobile brands to all Sprint brands of [redacted][67] Aggregating our diversion ratios from the brand level to the firm level, we estimate diversion of [redacted] from all Sprint brands to all T-Mobile brands and [redacted] from all T-Mobile brands to all Sprint brands.[68]

67 [redacted] See Israel, Katz, and Keating Declaration, ¶ 178, pp. 130–131, "Table 28: Diversion Ratio Estimates."

68 [redacted]

4. MERGER SIMULATION

80. We evaluate the potential competitive effects of the proposed merger using a merger simulation. Our simulation estimates how the proposed merger would change the equilibrium market outcome observed today based on different assumptions about merger-specific marginal cost reductions and network quality improvements. Since consumers place substantial value on network quality, we find the proposed merger to be procompetitive for various combinations of marginal cost reductions and improvements in network quality that are conservative relative to what we understand New T-Mobile may be able to achieve relative to the standalones.

81. Beyond Sprint and T-Mobile internalizing the competition between their brands, the scenarios in the rest of this section evaluate the equilibrium outcome for different combinations of the following three changes after the proposed merger relative to today.

- Reductions in marginal costs for merging party brands
- Improvements in the average and worst standardized speeds offered by the merging party brands
- Improvements in the average and worst coverage (time on LTE) offered by the merging party brands

82. The rest of this section proceeds as follows.

- We first discuss the analytical components of the merger simulation, the steps we take to calculate the market equilibrium and quantify the effects of the proposed merger (§ 4.1).
- Turning to our merger simulation results, we calculate the level of marginal cost reductions that would be sufficient to make the proposed merger competitively neutral, without any improvement in network quality. We proceed to recalculate these critical marginal cost efficiencies for different levels of network quality improvements that we understand are well within what the merging parties expect to result from the network integration (§ 4.2).
- We then conduct a similar exercise to calculate the level of quality improvements solely relating to speed that would be sufficient to make the proposed merger competitively neutral under different assumptions about the marginal cost efficiencies that may be realized (§ 4.3).

- Finally, we consider a scenario that conservatively captures some of the complementarities that the merging parties expect, including better coverage for Sprint and better speeds for T-Mobile (§ 4.4).

83. Overall, we find that the proposed merger is procompetitive under a wide range of assumptions regarding marginal cost efficiencies and network quality improvements that we understand to be well within what the merging parties expect will result from the network integration.

4.1. We employ a standard merger simulation framework to examine the competitive impact of the proposed merger benchmarked against the industry as observed at present, taking into account the change in ownership as well as the potential for marginal cost efficiencies and network quality improvements

84. We use the demand model along with the standard assumption that carriers reach a pricing equilibrium where they each set price to maximize profits. Within this framework, we calculate the profit-maximizing price for each brand, given the prices of every other brand.[69] By construction, the equilibrium corresponds to observed prices and shares if there is no merger, Sprint and T-Mobile are separate companies, and their network qualities and marginal costs are at their current levels.

85. All of our merger simulation scenarios start from the same pre-merger price and share baseline, as observed in current data.[70] We then allow for a range of post-merger scenarios that assume different quality improvements and marginal cost reductions.[71] [redacted]

[69] Specifically, carrier j chooses prices of all its brands, $p_b, b \in B_j$, to maximize its profit across all brands: $\pi_j = \sum_{b \in B_j} \sum_i (p_b - c_b) s_{ib} w_i$, where c_b indicates marginal cost for brand b, s_{jb} is the probability consumer i chooses brand b, and w_i is the individual's weight [redacted]

[70] We describe the pre-merger prices and shares in more detail in Appendix § 5.2, "Inputs and assumptions."

[71] The merger simulation scenarios we contemplate do not include repositioning from AT&T and Verizon, e.g., to respond to competitive pressure from New T-Mobile by investing further in network quality. The Guidelines recognize repositioning as a factor that could deter or counteract anticompetitive unilateral effects. See Guidelines § 6.1 ("In some cases, non-merging firms may be able to reposition their products to offer close substitutes for the products offered by the merging firms. Repositioning is a supply-side response that is evaluated much like entry, with consideration given to timeliness, likelihood, and sufficiency. See Section 9. The Agencies consider whether repositioning would be sufficient to deter or counteract what otherwise would be significant anticompetitive unilateral effects from a differentiated products merger.").

86. When we simulate the post-merger equilibrium all firms, including Verizon and AT&T, set new profit-maximizing prices. New T-Mobile maximizes its combined profits from all products owned by the merged firm taking into account any merger-specific marginal cost efficiencies. Demand reflects any merger-specific quality improvements.

87. We solve for equilibrium prices where no carrier has an incentive to change prices of their brands given the prices set by the other carriers. Prices that satisfy this condition for each brand constitute a Nash Equilibrium.

88. Once we find the post-merger market equilibrium, we calculate two metrics to evaluate the potential impact of the merger: aggregate changes in subscriber shares and compensating variation. We explain each of these metrics in turn.

- We first compute predicted post-merger changes to subscriber shares. This is a way to quantify the changes in the competitive positions of the firms in the industry. For example, if the merger results in a New T-Mobile that is better able to compete with AT&T and Verizon, then AT&T and Verizon may lose share and New T-Mobile may gain share relative to the standalones. Such an outcome would indicate the merger is procompetitive.
- Compensating variation is a standard measure of changes in consumer welfare.[72] Consumers would be willing to pay their compensating variation in order to replace their pre-merger options with their post-merger options, taking into account changes in price and network quality. We define the measure so that negative values of compensating variation indicate that consumer welfare increases, consistent with a reduction in quality-adjusted prices.

[72] We calculate aggregate compensating variation (CV) as: $CV = -\sum_i (W_i \left(log \sum_b e^{V_{ibl}^{merger}} - log \sum_b e^{V_{ibl}^{standalone}} \right) \frac{1}{\delta \sum_i W_i}$, where $V_{itlb} = \mathrm{u_{itlb}} - \epsilon_{ib} = \xi_{lb} + \delta p_b + \alpha_{tb} + \beta_t x_{ib} + \gamma_b C_i$. Compensating variation is used in numerous publications. For example, see Nevo, Aviv, "Mergers with differentiated products: the case of the ready-to-eat cereal industry," *RAND Journal of Economics,* Vol. 31, No. 3, 2000, pp. 395–421.

4.2. The proposed merger is procompetitive with modest marginal cost efficiencies under many assumptions regarding network quality improvements

89. We begin our merger simulation analysis by calculating the level of marginal cost reductions that would be sufficient to make the proposed merger competitively neutral *without any* improvement in network quality. We then evaluate how this critical level of marginal cost reductions changes once we take into account the potential procompetitive effects of merger-specific network quality improvements relative to the standalones. In particular, we consider several scenarios of network quality improvements that we understand to be well within the range of what the merging parties expect will result from the network integration.

- A ten percent improvement in standardized speeds within each geogrid today. This results in a ten percent increase in both the average and the worst speeds that would be experienced by consumers using the merging party brands relative to the standalones.
- A 0.1 Mbps improvement in standardized speeds within each geogrid. This results in a 0.1 Mbps increase in both the average and the worst speeds that would be experienced by consumers using the merging party brands relative to the standalones.
- A scenario consistent with the merger rationale where, after the proposed merger, Sprint brands benefit from T-Mobile's coverage and T-Mobile brands benefit from Sprint's speeds, in each geogrid where we measure a quality gap with the other merging party brands today.[73]
- Finally, as another way to consider network quality improvements, a scenario where the merging party brands narrow or close the coverage and speed network quality gap they experience with Verizon in each geogrid where we measure a quality gap today. [74] We also conduct the same exercise with regards to the network quality gap with AT&T.

90. We find that for the proposed merger to be competitively neutral, the merging parties need marginal cost reductions that are within the range of reductions that Israel, Katz, and Keating have estimated will arise from the

[73] For further detail on how we implement this scenario, see § 4.2.4, "Critical marginal cost efficiencies assuming conservative improvements for Sprint in coverage and for T-Mobile in speed."

[74] For further detail on how we implement this scenario, see § 4.2.5, "Critical marginal cost efficiencies assuming network quality improvements that close or narrow the network quality gap with one of the two leading firms."

network integration. This is particularly true once we take into account any of the above conservative network quality improvement scenarios.

4.2.1. Critical marginal cost efficiencies ignoring network quality improvements

91. We first conduct our merger simulation under the assumption that the proposed merger leads to *no* merger-specific network quality improvements. [redacted]

92. [redacted]

93. [redacted][75] [redacted]

[75] [redacted] See Israel, Keating, and Katz Declaration, p. 46, "Table 5: Sprint Domestic Roaming Costs (2019-2024)", p. 79, "Table 12: Summary of Marginal Cost Savings: New T-Mobile Maintains Usage Restrictions and LTE/5G Mix."

94. [redacted][76]

[redacted]

95. Instead of detailing the competitive effects outcomes for different combinations of marginal cost reductions for each firm, as we have above, we now focus on calculating the critical marginal cost efficiencies that make the

[76] This result is comparable to that in the Israel, Katz, and Keating Declaration, where they find that critical marginal cost reductions, without any quality improvements, are [redacted] See Israel, Katz, and Keating Declaration, p. 79, "Table 12: Summary of Marginal Cost Savings: New T-Mobile Maintains Usage Restrictions and LTE/5G Mix."

merger competitively neutral under the assumption that the proposed merger leads to no network quality improvements. [redacted]

[redacted]

[redacted]

[redacted]

4.2.2. Critical marginal cost efficiencies assuming a ten percent increase in speeds

96. The merging parties expect combining their complementary assets to lead to substantial improvements in network quality for New T-Mobile relative to what they expect to be able to offer as standalone firms.[77] To build intuition about the potential competitive effect of such improvements, in this subsection we assume that, relative to the standalones, the proposed merger leads to an improvement in the speeds that the merging party brands offer in each geogrid that is equal to ten percent of the speeds they offer today. This includes both average speed and worst speed.

97. This assumption is conservative in at least two ways. First, it does not account for the coverage improvements that the merging parties expect will result from the network integration, especially relative to the Sprint and Boost/Virgin standalones. Second, a ten percent improvement in delivered speed beyond their standalone plans is substantially below what the merging parties expect will result from the network integration.[78]

[77] For example, see Declaration of Neville R. Ray, June 18, 2018, ¶ 35 ("The ability of New T-Mobile to more quickly deliver a deeper 5G network and user experience than standalone T-Mobile is driven in part by the complementary spectrum assets of T-Mobile and Sprint."); Declaration of John Saw, June 18, 2018, ¶¶ 27, 32 ("Under the integration plan, the combined company's network will be anchored on the existing T-Mobile network of cell sites. This approach will allow the combined company to take advantage of T-Mobile's much denser cell site network and supplement the network with Sprint macro cell sites in areas where it would be advantageous to have additional capacity or density of coverage to provide a better network experience . . . In addition to better coverage, the ability for the combined company to utilize complementary low-, mid-, and high-band spectrum and deploy more spectrum on more sites will improve signal strength and provide a much more consistent data experience than subscribers would experience on Sprint's standalone network."); and Declaration of Brandon Draper, June 18, 2018, ¶ 7 ("Standalone Sprint will never be able to achieve the kind of network coverage, capacity, and performance that would be unlocked by the combination of Sprint and T-Mobile's complementary assets and scale.").

[78] For example, consider Figures 5 and 7 on pp. 48 and 51, respectively, of the Israel, Katz, and Keating Declaration, [redacted]

98. [redacted]

[redacted]

[redacted]

99. [redacted]

[redacted]

[redacted]

[redacted]

4.2.3. Critical marginal cost efficiencies assuming a 0.1 Mbps increase in speeds

100. Instead of improvements in average and worst standardized speed that are proportional to current speeds in a geogrid, in this subsection we consider a different set of scenarios, where the merging party brands improve their

standardized speeds by 0.1 Mbps in each geogrid. As in the prior scenario, we apply this improvement to both average speed and worst speeds.

101. [redacted][80] [redacted]

[redacted]

[79] [redacted] See our workpapers.

[80] See Exhibit 7.

102. [redacted]

[redacted]

4.2.4. Critical marginal cost efficiencies assuming conservative improvements for Sprint in coverage and for T-Mobile in speed

103. We now consider a scenario that conservatively captures some of the complementarities that the merging parties expect. In particular, Sprint's footprint and in-building penetration lags behind T-Mobile's today. T-Mobile's coverage should improve as it fully deploys its recently acquired 600 MHz spectrum. Similarly, while T-Mobile leads Sprint in certain national speed tests, Sprint's network delivers high speeds in areas where its 2.5 GHz spectrum is fully deployed in light of its propagation characteristics.

104. New T-Mobile plans to combine the complementary spectrum assets of Sprint and T-Mobile to deliver better coverage and better speeds in more areas than either standalone can deliver on its own. We calculate the marginal costs that would make the merger competitively neutral under a scenario that captures some of these improvements to the following limited degree.

- If Sprint has lower time on LTE than T-Mobile in a particular geogrid where we can measure both, we improve Sprint to T-Mobile's time on LTE value.
- If T-Mobile has lower speeds than Sprint in a particular geogrid where we can measure both, we improve T-Mobile to Sprint's speed value.
- To the extent that Sprint or T-Mobile improve in a geogrid, we also improve the corresponding non-premium brand, Boost/Virgin or MetroPCS, respectively.[81]

105. These network quality improvements are likely conservative in that they do not reflect any improvement in many areas where Sprint or T-Mobile consumers do not use their phones today, but likely would with the combined network. They are also conservative in that we do not allow for any coverage improvements for T-Mobile or speed improvements for Sprint. Nor do we allow for any coverage improvements for Sprint or speed improvements for T-Mobile in geogrids where each, respectively, is presently ahead of its merger partner in network quality.

106. [redacted]

[81] In particular, for each geogrid where a premium brand has improved, we calculate the network quality value we would impute for its corresponding non-premium brand if that value were missing. If the imputed value is greater than the actual (or previously imputed) value, we replace the actual value with the newly imputed value.

[redacted]

107. [redacted]

[redacted]

108. [redacted]

[redacted]

109. [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

4.2.5. Critical marginal cost efficiencies assuming network quality improvements that close or narrow the network quality gap with one of the two leading firms

110. As another way to consider the potential for network quality improvements, in this subsection we consider scenarios where New T-Mobile experiences improvements in speed and coverage in geogrids where one of the two leading firms today offers better quality than one or more of the merging party brands. We view this exercise as informative to the question of whether a 4-to-3 merger that makes the two weaker competitors into one stronger competitor is likely to lessen competition. We find that not to be the case.

111. Starting with Verizon, we conduct the following exercise. In each geogrid, we check whether the standardized speed that the Sprint premium brand offers is slower than that offered by Verizon. Where that is the case, we increase the post-merger speed of the Sprint brand in the geogrid to the speed that Verizon offers in the same geogrid. We do the same for Sprint coverage. Finally, we check for similar improvements for the T-Mobile premium brand, but not for Boost/Virgin or MetroPCS, which we leave at their observed levels.

112. We present the results of this exercise in Exhibit 23.

[redacted]

113. We therefore find that with these quality improvements, the proposed merger is procompetitive even if there are *no* marginal cost efficiencies. [redacted] The competitive benefits are greater should there be marginal cost improvements for one or both sets of brands.

114. We do not present a graphical representation of the critical marginal cost efficiencies for the scenario shown in Exhibit 23, because the proposed merger is procompetitive in this scenario without *any* marginal cost efficiencies.

115. We also conduct a more conservative version of this exercise. Once again we compare Sprint and Verizon speeds at the geogrid level. Now, instead of increasing Sprint's speed to Verizon's in geogrids where the former is lagging, we instead improve Sprint's speed by half of the quality gap to Verizon's. In that sense, we are only narrowing the network quality gap rather than closing it. Similarly we narrow the gap for coverage and do the same for the T-Mobile premium brand, but not the Boost/Virgin and MetroPCS non-premium brands.

116. We present the results of this more conservative exercise in Exhibit 24. [redacted]

[redacted]

117. [redacted]

[redacted]

118. We also perform similar exercises in which the merging parties close, or narrow, the quality gap today with AT&T rather than Verizon. The results are qualitatively very similar to the results for the Verizon scenarios presented in this section.[82]

[82] When we increase the quality of the merging party networks to close the quality gap with AT&T, the proposed merger is procompetitive without any marginal cost reductions. In the more conservative scenario in which we increase the quality of the merging party networks to narrow the quality gap with AT&T by half of what it is today, getting to a procompetitive outcome only requires modest marginal cost efficiencies, similar to those required in the scenario where they narrow the network quality gap with Verizon. [redacted]

4.3. The proposed merger is procompetitive with quality improvements solely related to speed well within the range the merging parties expect will result from the network integration, even if only modest marginal cost efficiencies are realized

119. In this subsection, we consider a series of scenarios that explore the effect that merger-specific quality improvements *solely related to speed*, both average and worst, would have on the competitive outcome. We find that making New T-Mobile more attractive in terms of speed makes the proposed merger procompetitive under a wide range of scenarios.

120. These scenarios are conservative in the sense that they do not account for other expected benefits of the proposed merger. In particular, we make the following conservative assumptions across all scenarios in this subsection.

- First, we do not account for any of the expected coverage improvements for the Sprint brands.
- Second, we consider these scenarios crediting all, half of, or none of the reductions in marginal cost Israel, Katz, and Keating have estimated for 2021 under their "maintain" scenario.[83]

121. Under these conservative assumptions, we proceed to calculate the competitive effects of the proposed merger if the Sprint and T-Mobile brands receive a speed increase that is (a) proportional to a percentage of their current speed in each geogrid, or (b) constant across all geogrids.

122. [redacted][84]

[83] These reductions correspond to the 2021 estimates of network marginal cost reductions estimated by Israel, Katz, and Keating, [redacted] See Israel, Katz, and Keating Declaration, p. 79, "Table 12: Summary of Marginal Cost Savings: New T-Mobile Maintains Usage Restrictions and LTE/5G Mix." [redacted] See Israel, Katz, and Keating Declaration, ¶¶ 77–79.

[84] See fn. 78 above.

4.3.1. Critical percentage speed improvements for different levels of marginal cost efficiencies

123. [redacted]

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4.3.2. Critical level speed improvements for different levels of marginal cost efficiencies

130. We now consider another set of scenarios where rather than speed increasing by some percentage of pre-merger speed in the geogrid, speed increases by a certain number of Mbps. [redacted]

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138. We find that, since consumers place substantial value on network quality, even when we assume the merging parties only achieve a fraction of the marginal cost reductions estimated by Israel, Katz, and Keating, or even none at all, the proposed merger is procompetitive under a range of improvements in network quality that are conservative relative to what we understand to be achievable by New T-Mobile.

4.4. A scenario conservatively capturing some of the speed and coverage benefits that Sprint and T-Mobile expect to realize from combining their complementary spectrum assets demonstrates that the proposed merger is procompetitive

139. Finally, we present more detailed merger simulation results for the scenario where, consistent with the merger rationale, Sprint closes the coverage gap with T-Mobile and T-Mobile closes the speed gap with Sprint. This corresponds to one of the quality improvement scenarios we described in more detail in our earlier evaluation of critical marginal cost efficiencies (see § 4.2.4). As a final input to the merger simulation, we consider the marginal cost efficiencies Israel, Katz, and Keating estimated for their "maintain" scenario in 2021 (see § 4.3).

140. These estimates include network efficiencies, roaming efficiencies for the Sprint postpaid, and non-network efficiencies. [redacted][85]

141. [redacted]

[85] Israel, Katz, and Keating Declaration, p. 79, "Table 12: Summary of Marginal Cost Savings: New T-Mobile Maintains Usage Restrictions and LTE/5G Mix."

[86] [redacted]

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142. [redacted]

143. In particular, we consider the following sensitivities:

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- [redacted]
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- [redacted]

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4.5. Conclusion from merger simulation scenarios

144. Overall, our merger simulation offers an economically coherent framework, grounded in detailed industry data, for understanding the competitive significance of the proposed merger. Our demand estimation findings suggest that consumers place substantial value on the quality of their network experience. This explains our merger simulation findings that the proposed merger is procompetitive under a wide range of assumptions regarding marginal cost efficiencies and network quality improvements, which we understand to be well within what the merging parties expect will result from the network integration.

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