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February 21, 2019

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:

Pursuant to Section 1.1206(b) of the Commission's Rules, 47 C.F.R. § 1.1206(b), notice is hereby provided of a written *ex parte* presentation in the above-referenced docket. Attached please find additional information regarding (a) the plans for combining the T-Mobile US, Inc. ("T-Mobile) and Sprint Corporation ("Sprint") networks during the 2019 to 2021 timeframe that immediately follows the merger of the two companies and (b) an extension of the economic analysis of Mark Israel, Michael Katz and Bryan Keating ("IKK") to cover the 2019 to 2021 transition period.

The purpose of this submission is to address the Commission's questions regarding the merger's effects during the 2019-2021 period during which the T-Mobile and Sprint networks are being combined ("transition period"). The bottom line is that consumers begin benefitting from network improvements immediately in the first year following the merger close and those benefits only increase each year thereafter. During the three-year transition period, New T-Mobile outperforms standalone T-Mobile and Sprint in network capacity and speed. Moreover, the economic analysis by IKK finds that consumer welfare is enhanced in each year, and that the merger is welfare enhancing in IKK's baseline case and all sensitivity cases.

Once the transaction is approved and consummated, New T-Mobile will execute on a three-year network transition and customer migration process that will:

- Provide a superior experience for all customers at all migration stages, with minimal disruption;

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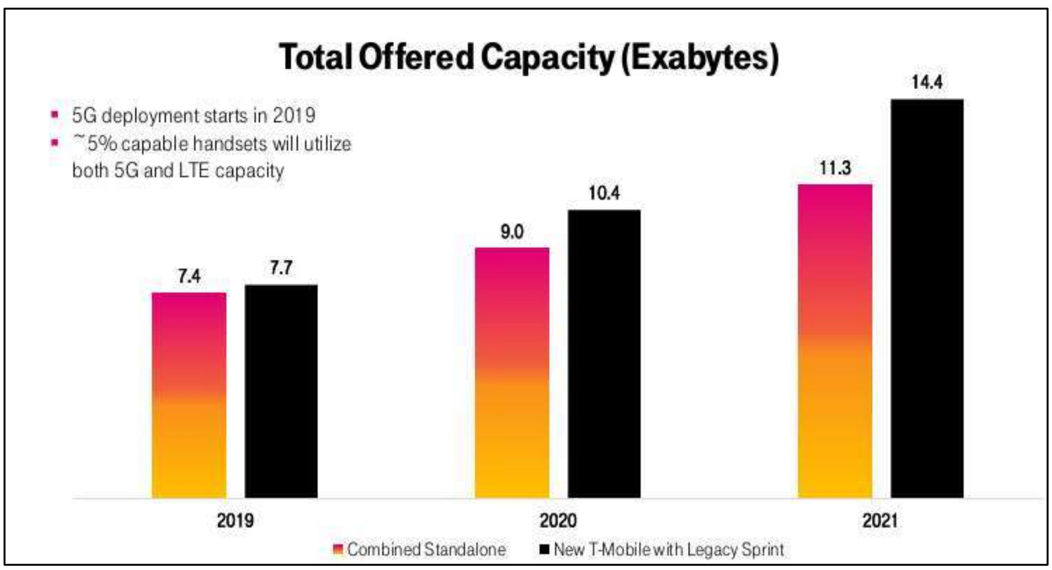
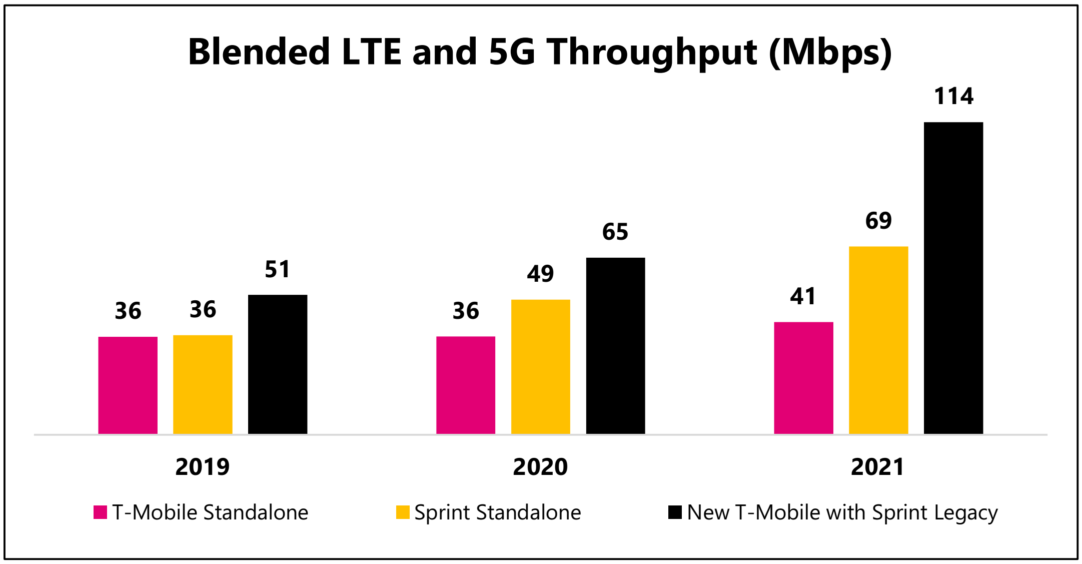
- Actively migrate customers from legacy technologies to 5G;
- Deliver a best-in-class LTE and 5G network offering and experience; and
- Maximize synergy benefits through timely and efficient execution.

As detailed in the attached declaration of Mark McDiarmid, T-Mobile's Senior Vice President of Radio Engineering and Development, New T-Mobile will provide expanded roaming to Sprint subscribers soon after the deal closes. Those Sprint customers will experience immediate performance improvements, including more reliable coverage and data speed experiences. Throughout the transition period, New T-Mobile will continue to increase network capacity and throughput beyond that which the standalone companies could offer.

During this period, the capacity available to consumers will exceed the combined standalones each year, and the improvement increases each year (0.3 exabytes in 2019; 1.4 exabytes in 2020, and 3.1 exabytes in 2021):



The average throughputs also will increase each year with the following positive results for T-Mobile, Sprint and New T-Mobile customers:



The attached supplemental filing by IKK quantifies and explains the economic impacts of these plans. IKK finds that consumers benefit in each year of the 2019 to 2021 transition period (as well as the following years through 2024). In the IKK baseline case, the merger creates $359 billion in incremental consumer surplus. To put this number in context, given that there are 346 million total wireless subscribers nationwide in 2018 across all wireless carriers, the total gains in consumer surplus correspond to gains of $1,036 per subscriber. Moreover, because these findings are the result of an analysis that includes many conservative assumptions, the actual consumer benefits may be significantly larger. In sum, this analysis demonstrates that the projected combination of lower marginal costs and higher network quality will prevent any adverse unilateral competitive effects in the 2019 through 2021 period, in fact, the merger will strengthen competition and increase consumer welfare.

T-Mobile has provided individual site information, including cost information for the 2019-2021 plan. The enclosed drive includes "Attachment A," which provides site information for the New T-Mobile 2021 network plan. The "SiteRef" tab details the configuration and incremental 5G deployments for each site by the end of 2019, 2020, and 2021. Columns CP-CR of the "SiteRef" tab provide site configuration "codes" that correspond to the incremental 5G deployments in each year, and columns CS-CX provide the costs associated with those incremental deployments in each year. The "Mapping" tab provides the mapping from the configuration codes to the associated deployments. Finally, the "Overlays" tab provides the unit cost information for the different incremental deployments, which is referenced in the "Mapping" tab.

This filing contains information that is "Highly Confidential" pursuant to the Protective Order filed in WT Docket No. 18-197.[1] Accordingly, pursuant to the procedures set forth in the Protective Order, a copy of the Highly Confidential Filing, along with a USB drive containing back-up materials, is being provided to the Secretary's Office. In addition, two copies of the Highly Confidential Filing, along with a USB 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 counsel for T-Mobile US, Inc.

Respectfully submitted,

DLA Piper LLP (US)

/s/ Nancy Victory

Nancy Victory
Partner

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

Attachments

[1] Applications of T-Mobile US, Inc., and Sprint Corporation for Consent to Assign Licenses, Protective Order, WT Docket No. 18-197 (June 15, 2018).

ATTACHMENT A

DECLARATION OF MARK MCDIARMID

Senior Vice President of Radio Network Engineering and Development, T-Mobile US, Inc.

DECLARATION OF MARK MCDIARMID

Senior Vice President of Radio Network Engineering and Development, T-Mobile US, Inc.

1. My name is Mark McDiarmid, and I am Senior Vice President of Radio Network Engineering and Development at T-Mobile US, Inc. ("T-Mobile"). In that role, I am responsible for radio access network design, integration, and device technology, as well as the way in which T-Mobile engineers its spectrum, including repurposing spectrum for efficiency.

2. This declaration describes the plan for New T-Mobile to integrate the Sprint and T-Mobile networks and to migrate the Sprint customer base to the New T-Mobile network. It also explains why combining the two companies' networks unlocks significant efficiencies, some of which provide an immediate boost to capacity upon integration, and most of which will continue to provide benefits as New T-Mobile adds incremental capacity over the long term.

3. T-Mobile has relied on the methodology developed, and employed highly successfully, in the MetroPCS transaction to plan the migration of Sprint customers and integration of network resources into the New T-Mobile network.[1]

   a. With regard to network integration, New T-Mobile will use the existing T-Mobile network as its "anchor," increase network density and coverage with Sprint keep sites, deploy Sprint's PCS and 2.5 GHz spectrum on legacy T-Mobile sites, and use the T-Mobile spectrum portfolio on Sprint's keep sites.

   b. With regard to customer migration, New T-Mobile will employ the principles described Figure A. Supply (spectrum and keep sites) and demand (Sprint customers) will be migrated at the same time so that Sprint and T-Mobile

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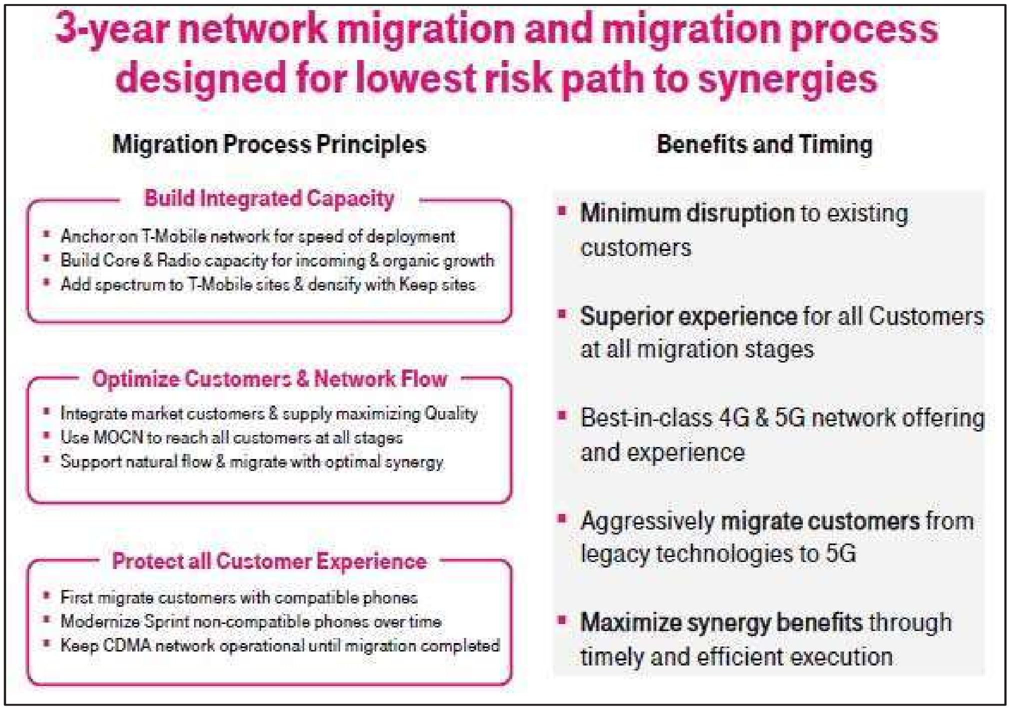
[1] This methodology has been previously detailed in the declaration June 18, 2018 and September 17, 2018 declaration of Neville Ray. This declaration provides further detail and explanation.

customers' quality of experience will be maintained or enhanced during the migration.

Figure A: Migration Principles



4. During each year of the migration period, New T-Mobile's capacity will grow and its average performance will improve. For instance, Figures B and C provide additional detail:

Figure B: Offered Capacity

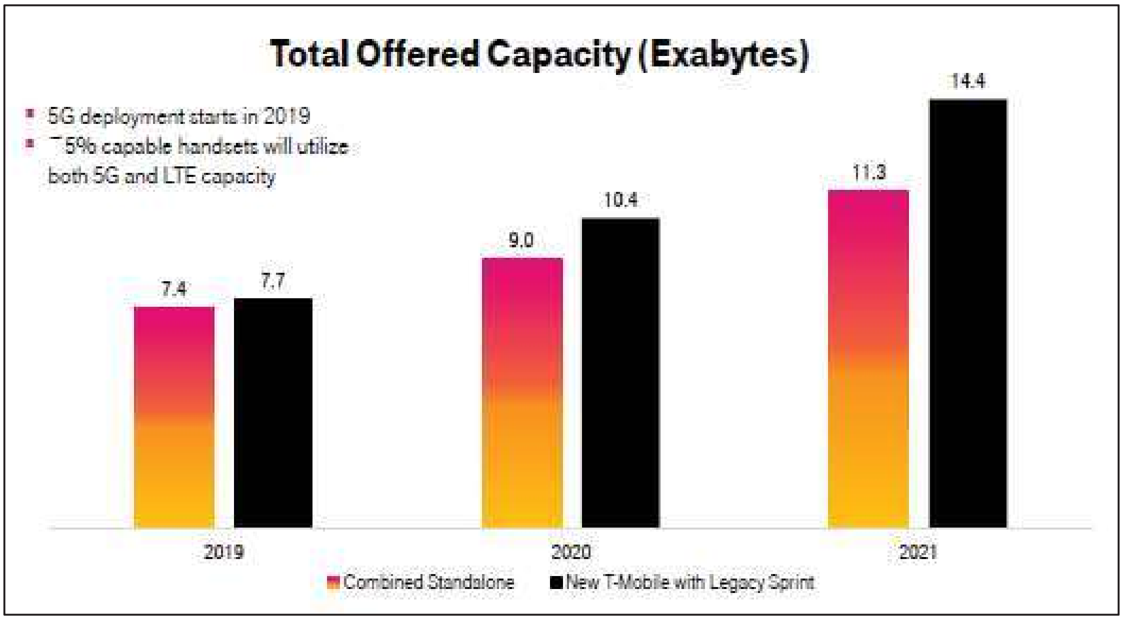
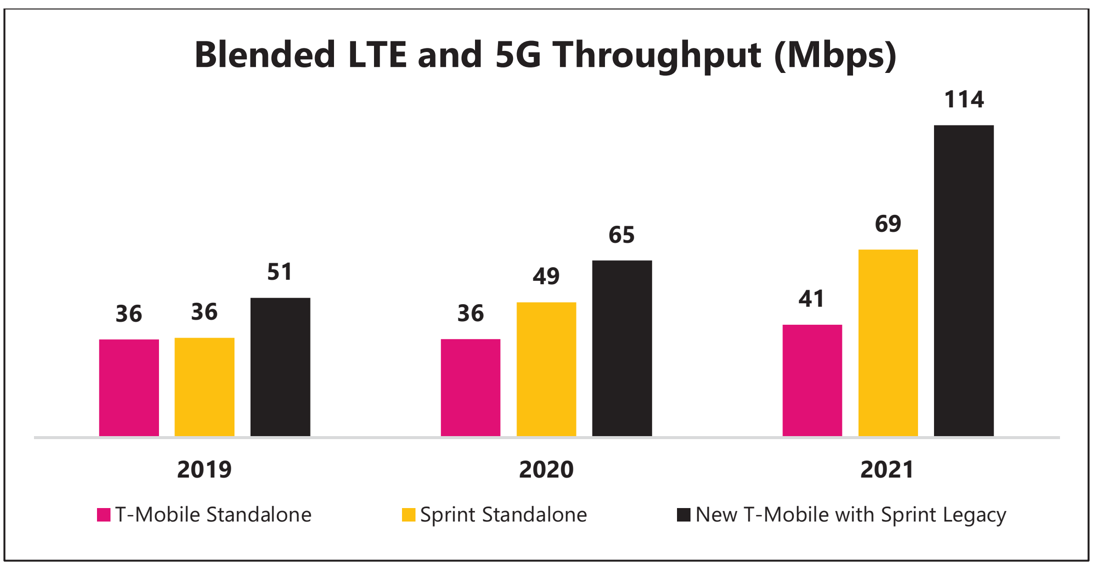


Figure C: Average Throughput



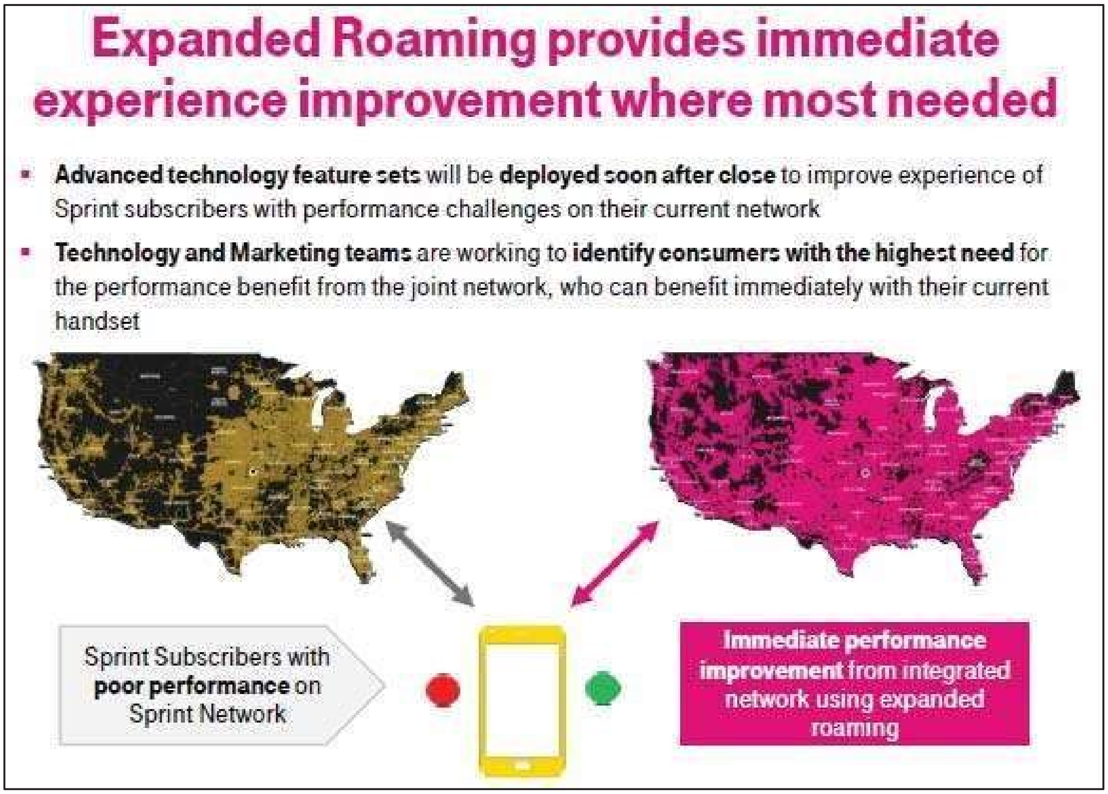
5. Given these significant efficiencies for New T-Mobile and the large amount of decommissioning synergies, the company plans to migrate Sprint customers and shut down the Sprint network as expeditiously as possible. Based on the MetroPCS experience, T-Mobile expects that this process will take up to three years.

6. T-Mobile has now developed a more detailed proposed build plan to cover the initial years, during which Sprint customers will be migrated to the New T-Mobile network. The migration and integration processes are dynamic and, as with the MetroPCS transaction, require the company to adapt to real-time circumstances. During the migration, the parties will need to adapt to the timing of the spectrum transfer between the parties, the timing of release of the 600 MHz spectrum by broadcasters (which could allow for accelerated Sprint customer migration), and the timing of regulatory approvals related to site enhancements. The parties are further constrained by the operational realities of needing site visits to determine the specific equipment and site reinforcement measures needed at individual sites. Despite these uncertainties in the interim period, T-Mobile remains confident it will implement its full baseline plan by 2021. As Neville Ray explained in his September 17th declaration, even in the face of hypothetically lower traffic levels, New T-Mobile will build the projected combined network baseline for 2021. Below, I summarize New T-Mobile's plans at a high level; the site-level details of these plans are contained in the model files submitted along with this declaration.

7. Soon after closing, all new customers will be added to the New T-Mobile network, regardless of which brand they elect to purchase. In addition, for the Sprint subscribers that currently have the greatest performance challenges, New T-Mobile will activate advanced feature sets such as multi-operator core network (MOCN) so that these subscribers will see benefits even while they still have a Sprint SIM card and access to the Sprint network, as illustrated in Figure D. Sprint customers who access the T-Mobile network through technologies such as MOCN will enjoy a better experience for several reasons, perhaps most significantly because they will no longer have to transition through the poorest experience on any Sprint spectrum band, and lose a

connection with the Sprint network, before latching onto the T-Mobile network. Instead, under MOCN, they will have access to the best available experience of either network..

Figure D



8. T-Mobile plans to migrate up to a quarter of the legacy Sprint customers to the New T-Mobile network by the end of 2019. T-Mobile plans to undertake several projects by the end of 2019 to combine the legacy networks and enhance New T-Mobile's capacity, including the following:

a. New T-Mobile will continue the capacity enhancement projects currently underway or planned in the near future by standalone T-Mobile, including [redacted]

b. New T-Mobile will move 5+5 MHz of Sprint PCS spectrum to New T-Mobile sites to support the incremental migrating customers. [redacted] of the anchor T-Mobile sites that require capacity to be augmented due to increased traffic can add this spectrum with a simple configuration change and without the need for a radio upgrade.

c. New T-Mobile will add 2.5 GHz radios to T-Mobile sites, with [redacted] completed by the end of 2019.[2] Where these sites overlap with T-Mobile's 600 MHz spectrum additions, T-Mobile will make both improvements at the same time where these upgrade activities align from a timing perspective. T-Mobile expects to use up to [redacted] (and before decommissioning the Sprint network) to help accelerate customer migration without harming the existing Sprint user experience.

d. New T-Mobile will upgrade existing T-Mobile radios with 5G-capable PCS/AWS radios, single radios with the capability of handling both PCS and AWS spectrum. T-Mobile will align these upgrades with the 2.5 GHz additions to achieve cost efficiencies from doing both at once ("clubbing benefits"), such that [redacted] will be upgraded in 2019 for future use.

9. T-Mobile plans to undertake further projects by the end of 2020 to combine the legacy networks and enhance New T-Mobile's capacity, including the following:

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[2] This timing may be delayed by a delay in the close of the Transaction.

a. New T-Mobile will continue standalone T-Mobile's planned capacity enhancement projects, [redacted]

b. New T-Mobile will move 5+5 additional MHz of Sprint PCS spectrum to New T-Mobile sites to support the incremental migrating customers. [redacted] that require capacity to be augmented due to increased traffic will be able to add this additional spectrum with a simple configuration change and without the need for a radio upgrade.

c. New T-Mobile will continue to add 2.5 GHz radios to T-Mobile sites, with the expectation that a total of [redacted] will be completed by the end of 2020 (i.e., [redacted]. Where these sites overlap with T-Mobile's 600 MHz spectrum additions, T-Mobile will make both improvements at the same time where these upgrade activities align from a timing perspective. As noted above, T-Mobile expects to use [redacted] on these sites to help accelerate customer migration without harming the existing Sprint user experience.

d. New T-Mobile will continue to upgrade existing T-Mobile radios with 5G-capable PCS/AWS radios. As in 2019, T-Mobile will align these upgrades with the 2.5 GHz additions to achieve the clubbing benefits, such that a total of [redacted] will be upgraded by the end of 2020.

e. New T-Mobile will upgrade many Sprint low- and mid-band radios and the base station equipment of the Sprint retain sites as needed to support increased traffic and improve coverage, as well as to align RAN vendors and satisfy New T-Mobile technology standards. T-Mobile expects that [redacted] of the retained sites will receive these upgrades by the end of 2020. Note that certain legacy Sprint equipment will remain in place on these sites through 2021 to ensure the Sprint CDMA/LTE footprint remains consistent.

10. T-Mobile anticipates that the above efforts will allow New T-Mobile to migrate about 60 percent of Sprint customers to New T-Mobile by the end of 2020.

11. T-Mobile plans to undertake further projects by the end of 2021 to combine the legacy networks and enhance T-Mobile's capacity, including the following:

a. New T-Mobile will continue standalone T-Mobile's capacity enhancement projects, including [redacted]

b. New T-Mobile will move the rest of Sprint's PCS spectrum to the New T-Mobile network.

c. New T-Mobile will continue to add 2.5 GHz radios to T-Mobile sites, with the expectation that a total of [redacted] will be completed by the [redacted]. Where these sites overlap with T-Mobile's 600 MHz spectrum additions, T-Mobile will make both improvements at the same time. As noted above, T-Mobile expects to use [redacted] on these sites to help accelerate customer migration.

d. New T-Mobile will continue to upgrade existing T-Mobile radios with 5G-capable PCS/AWS radios. As in 2019, T-Mobile will align these upgrades with the 2.5 GHz additions to achieve the clubbing benefits, such that a total of [redacted] will have been upgraded by the end of 2021.

e. New T-Mobile will continue to upgrade the Sprint low- and mid-band radios and the base station equipment of the Sprint retain sites as needed to support increased traffic and improve coverage, as well as to align RAN vendors and satisfy New T-Mobile technology standards. T-Mobile expects that [redacted] of the retained Sprint sites will have received these upgrades by the end of [redacted].

12. T-Mobile anticipates that the above efforts will allow New T-Mobile to migrate the remaining Sprint customers to New T-Mobile by the end of 2021 and begin efforts to decommission the legacy Sprint network.

13. T-Mobile's recent experience with the MetroPCS integration provides a track record that indicates that New T-Mobile should be able to migrate Sprint customers on or before the timeline described, while also maintaining or improving the quality of their experience.

14. T-Mobile can provide this increased capacity and improved throughput, together with lower network costs overall and per incremental subscriber, as a result of the material efficiencies that come from combining the Sprint and T-Mobile standalone networks. These efficiencies come from several sources, including the deployment of Sprint PCS spectrum on existing T-Mobile sites that will provide an immediate increase in capacity upon integration, and

which will continue to provide additional benefits as New T-Mobile adds incremental capacity in the future.

a. **Deploying Sprint PCS spectrum on T-Mobile's existing PCS radios:** [redacted] T-Mobile's existing PCS radios can accept 5+5 MHz of Sprint's PCS spectrum and [redacted] can accept up to 10+10 MHz of that spectrum with only a simple configuration change. This means that, during the migration, New T-Mobile will be able to deploy this spectrum quickly and cheaply across nearly all of the T-Mobile anchor sites. Moreover, all new PCS hardware that T-Mobile installs will support all of Sprint's PCS spectrum (up to 15+15 MHz in some locations) without additional cost. Thus, each time that New T-Mobile replaces an existing LTE-only radio with a dual mode LTE/5G radio or does a sector add or cell split involving PCS in the future, it will obtain more capacity (T-Mobile PCS/AWS + Sprint PCS) for the same cost (one radio) than would either standalone network.

b. **Lower cost options to resolve congestion:** During the migration period, New T-Mobile will take advantage of the 600 MHz roll-out that T-Mobile plans as a standalone network to add 2.5 GHz radios to many T-Mobile anchor sites, doing so at relatively low incremental cost due to clubbing benefits. Even on towers where New T-Mobile does not plan to initially deploy 2.5 GHz, going forward New T-Mobile will be able to deploy a 2.5 GHz radio as a congestion solution where T-Mobile would have had to implement the more costly congestion solutions—small cells, sector adds, or cell splits. Moreover, as illustrated in Figure E, New T-Mobile will be able to

deploy a single cell split with all spectrum bands at a much lower cost [redacted] of CapEx and [redacted] of OpEx) than it would take for the standalones to perform two cell splits with their respective spectrum bands (together, [redacted] of CapEx and [redacted] of OpEx). This happens because many of the costs of a cell split do not increase with the amount of spectrum that is deployed and other cost components increase less than proportionally to the amount of spectrum deployed.

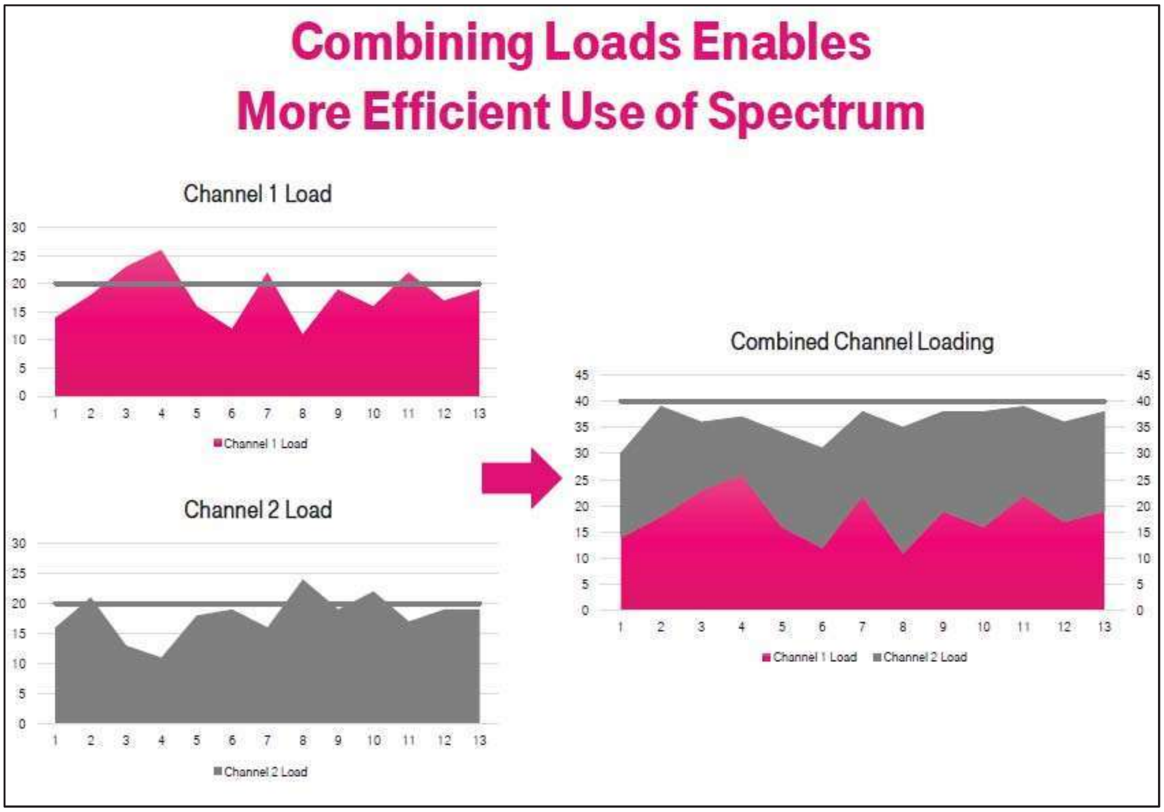
Figure E

[redacted]

c. **More spectrum allows each MHz of spectrum to be used more efficiently:** Both T-Mobile's and Sprint's network schedulers allocate capacity across spectrum bands at 2ms intervals. While there are similarities in the timing of traffic from T-Mobile and Sprint customers from hour to hour, there are still many cases where one network is congested while the other is not (even if

peaks are similarly timed, they may have different height), and the number of simultaneous users during each 2ms interval within that hour fluctuates randomly. For both these reasons, a T-Mobile sector may be congested while the overlapping Sprint sector is less busy, and vice versa. As separate networks, T-Mobile cannot "borrow" capacity from Sprint's spectrum (nor Sprint from T-Mobile's) during these times, so that spectrum is not being used to its full potential. As illustrated by Figure F below, New T-Mobile will be able to manage all of the capacity together and so ensure that each unit of capacity is most fully utilized. (This is similar to why a two-lane highway can support more traffic than two one-lane roads.) This not only increases the capacity at existing sites where both companies' spectrum is deployed, but it further increases the capacity of each additional sector add or cell split as the network grows. In other words, combining the T-Mobile and Sprint networks makes use of excess capacity on either network where the other is congested, and thus is a zero cost congestion solution.

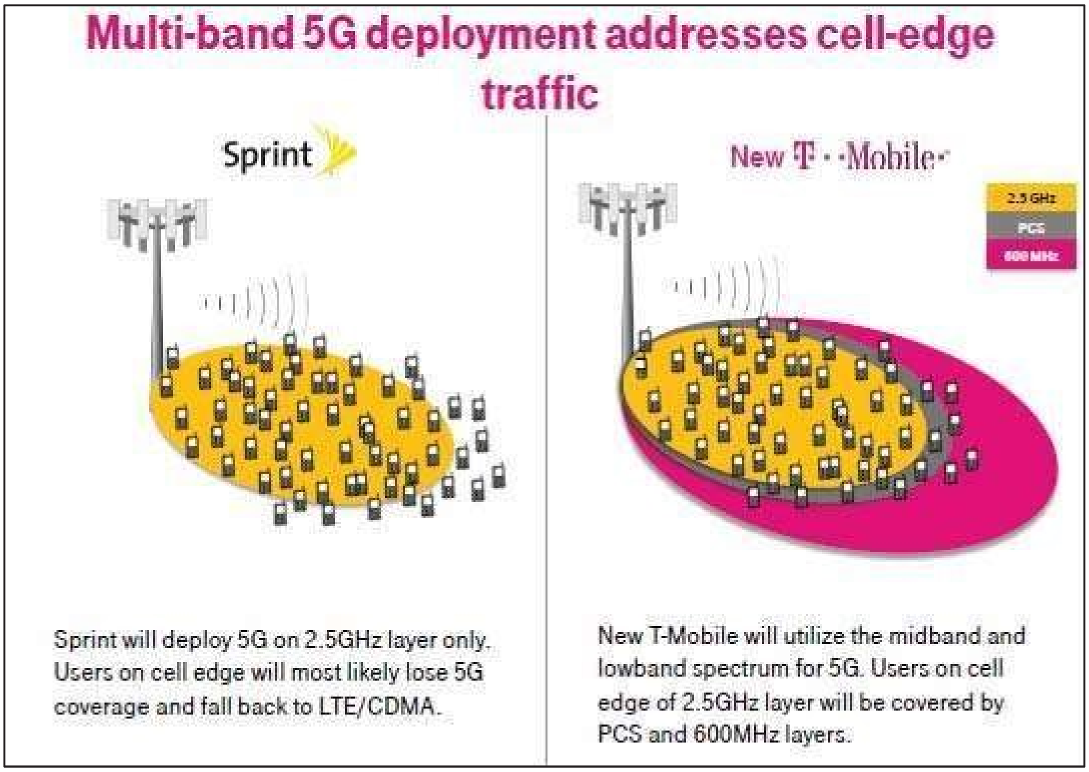
Figure F



d. **Complementary spectrum allows each MHz of spectrum to be used more efficiently:** New T-Mobile will be able to use both Sprint's 2.5 GHz spectrum and T-Mobile's 600 MHz spectrum much more efficiently than the standalones can on their own by taking advantage of their particular strengths and mitigating their comparative weaknesses. Sprint's 2.5 GHz spectrum's extremely limited propagation characteristics, its lack of 5G low-band spectrum, and its limited PCS spectrum result in it receiving a high percentage of its traffic at the cell edge, where the Signal-to-Interference and Noise ratio (SINR) is lower and spectral efficiency is consequently lower. This is particularly true for the uplink (signals transmitted from the handset to the tower), because handset transmit power levels are lower and the proportion of

time allocated to transmit uplink information is less than the downlink. To resolve this, New T-Mobile will be able to much more efficiently use the 2.5 GHz spectrum is several ways. First, New T-Mobile will use its 600 MHz spectrum for uplink where and when advantageous, effectively eliminating the 2.5 GHz uplink limitation and making full use of the 2.5 GHz downlink range advantage (and increasing battery life for subscribers). In doing this, New T-Mobile will use these characteristics of its 600 MHz spectrum to make Sprint's 2.5 GHz spectrum more effective. Second, New T-Mobile will be able to assign a higher percentage of 2.5 GHz capacity blocks to users who are close to the cell center. By using that 2.5 GHz to address much of the load on the cell, New T-Mobile then frees up its larger amount of capacity of the cell's PCS and AWS spectrum to focus on serving subscribers in the mid-range of the cell and finally a greater portion of the capacity of the cell's 600 MHz to serve users close to the cell edge, as illustrated by Figure G. Thus, New T-Mobile is able to better use the 2.5 GHz spectrum where it is most efficient, bearing the burden of most of the cell's near-in load, while also increasing the effective capacity of the better-propagating spectrum bands for users outside the effective footprint of 2.5GHz spectrum. This ensures better coverage, capacity, and consistency of experience than Sprint or T-Mobile could offer alone—even in areas where the cell density would be the same. This not only increases the capacity at existing sites where both companies' spectrum is deployed, but it further increases the capacity of each additional sector add or cell split as the network grows.

Figure G



e. **Keep sites are cheaper and faster than cell splits:** Keep sites will require fewer or no zoning approvals and lease changes, which reduce the cost and time to deploy new hardware relative to a full cell split.

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

Mark McDiarmid
Senior Vice President of Radio Network
Engineering and Development
T-Mobile US, Inc.

ATTACHMENT B

EXTENSION OF THE ISRAEL, KATZ, AND KEATING ANALYSIS TO 2019-2020

Mark Israel, Michael Katz, and Bryan Keating

February 20, 2019

1. INTRODUCTION

In our earlier declaration filed with the Federal Communications Commission ("Commission"), we presented a merger simulation analysis demonstrating that the proposed merger will strengthen competition and benefit consumers from 2021 through the foreseeable future.[1] Our earlier assessment began in 2021 (based on the network build plans and model as of year-end 2021[2]) because that is when customer migration and the integration of the Applicants' networks are expected to be largely complete.[3] During the time before that date, which we referred to as the "integration period," network integration (as opposed to incremental capacity expansion in direct response to changes in demand) is expected to be the dominant driver of New T-Mobile's network investment.[4]

In a February 9, 2019, meeting between representatives of the Applicants and the Commission Chairman, his staff, and members of the T-Mobile/Sprint Transaction Team, Commission staff requested that the Applicants submit additional evidence regarding the proposed merger's benefits to customers as well as its effects on prices during the integration period.

When preparing our earlier declaration, we did not have sufficient information regarding New T-Mobile's integration process to model the effects of the merger during the integration period. The Applicants have since developed the necessary information regarding their integration plan, and in this response to the staff's request we report the results of extending our analysis to include the integration period. *Our central finding is that the merger will increase consumer welfare and therefore promote competition and benefit consumers*. Specifically, we find that the

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1 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*).

2 Because the companies are forward-looking, modeling the end-of-year states of each network provides relevant information for assessing the effects of the merger throughout the prior year.

3 The Applicants intend to have fully migrated Sprint customers to the New T-Mobile network within three years after the close of the transaction. (Reply Declaration of Neville R. Ray, Executive Vice President and Chief Technology Officer, T-Mobile US, Inc., September 17, 2018, WT Docket No. 18-197 (hereinafter *Ray Reply Declaration*), ¶ 42.) The Applicants anticipate that there will continue to be activity associated with incorporating network assets acquired from Sprint fully into the New T-Mobile Network even after the primary integration period has concluded. (See, e.g., *id.,* Table 7.)

4 *Id.,* ¶ 15.

proposed merger will increase the expected net present value of consumer welfare; indeed, we find that the proposed merger will benefit consumers in *each year* for the foreseeable future.

2. ACCOUNTING FOR THE DIFFERENTIATING CHARACTERISTICS OF 2019-2020 RELATIVE TO 2021-2024

To model 2019 and 2020, it is necessary to account for several differentiating characteristics relative to 2021-2024, including:[5]

- New T-Mobile's network investment will be driven primarily by integration considerations;
- New T-Mobile will face near-term price constraints;
- LTE will be more commercially significant; and
- the Applicants will have limited ability to modify certain network investments.

Below, we discuss how our modeling approach accounts for each of these differentiating characteristics.

A. New T-Mobile's Network Investment in 2019-2020 will be Driven Primarily by Integration Considerations

T-Mobile has indicated that it will be focused on integrating the networks as quickly as possible and that it will build the planned combined baseline network for 2021 even if traffic were, hypothetically, to be substantially less than the sum of the projected standalone traffic levels.[6]

It is important to recognize that, because the Network Build Model is solely a model for identifying congestion and the network investment necessary to relieve it, the model does not fully account for integration considerations. For example, the Network Build Model does not account for the facts that network consistency and coverage are elements of network quality beyond data speed that are important to consumers[7] and, thus, that a wireless service provider network must provide broad and consistent coverage in order to compete successfully. To account for these integration considerations in our modeling, we use the planned New T-Mobile baseline network as our starting point through 2021.[8]

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5 Unless noted otherwise, all model years discussed herein refer to the end of the year.

6 *Ray Reply Declaration,* ¶ 15.

7 *IKK Declaration,* § III.B.3.

8 Sprint and T-Mobile have modeled both their standalone networks and the integrated New T-Mobile network as of December 31, 2019, and December 31, 2020. The standalone plans are described in Declaration of Neville R. Ray, Executive Vice President and Chief Technology Officer, T-Mobile US, Inc., June 18, 2018, WT Docket No. 18-197 (hereinafter *Ray Declaration*), § V; Declaration of John C. Saw, Chief Technology Officer, Sprint Corporation, June 18, 2018, WT Docket No. 18-197, § IV. New T-Mobile's network plans are summarized in Declaration of

B. New T-Mobile will Face Near-Term Price Constraints

If the proposed merger closes, New T-Mobile will face constraints on its near-term ability to raise retail and wholesale prices that were not modeled in our earlier analysis of 2021-2024.

2.B.1 Retail Price Constraints

T-Mobile executives have stated that New T-Mobile will not raise prices in the near term because doing so would violate its brand promise to consumers and trigger a consumer backlash (in the form of reduced demand and increased churn) that would render the price increases unprofitable.[9] The company's business plan reflects the lack of price increases—in fact, the Applicants project that New T-Mobile's average revenue per user (ARPU) will decrease.[10] Consistent with these statements and business plans, T-Mobile has made the following public commitment not to raise prices: "New T-Mobile will make available the same or better rate plans as those offered by T-Mobile or Sprint as of today's date for three years following the merger."[11]

We model the near-term retail price constraints that New T-Mobile will face by assuming that New T-Mobile's prices in 2019 and 2020 can be no higher than the 2019 levels of the corresponding rate plans offered by the standalone companies and that New T-Mobile's rate plans in 2019 and 2020 are identical to those that would be offered by the standalone companies in all other respects.[12] We also consider two sensitivity cases: (1) we assume that that New T-Mobile will offer the same rate plans as would the standalone companies in 2019 and 2020; and (2) we consider the polar case in which the retail price constraints have no effect at all. Although the latter is an unrealistic assumption, it provides a lower bound on consumer benefits.

Mark McDiarmid, Senior Vice President of Radio Network Engineering and Development, T-Mobile US, Inc., February 19, 2019, WT Docket No. 18-197 (hereinafter *McDiarmid Supplemental Declaration*), ¶¶ 7-12. Our backup materials provided details on how all of the networks were modeled.

9 Declaration of Peter Ewens, Executive Vice President, Corporate Strategy, T-Mobile US, Inc., WT Docket No. 18-197, June 18, 2018 (hereinafter *Ewens Declaration*), ¶ 10.

10 *Ewens Declaration,* ¶ 8.

11 Letter from Nancy J. Victory, Counsel for T-Mobile US, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, February 4, 2019, WT Docket No. 18-197, p. 2.

12 Specifically, we assume that New T-Mobile's underlying rate plans do not deviate from those that the standalone companies offer in 2019 and that these constraints are reflected in the average prices that we use in our analysis.

2.B.2 Wholesale Price Constraints

[redacted][13]

We model these contractual constraints on New T-Mobile's near-term wholesale prices by assuming that it offers the same wholesale rates as would the standalone companies in 2019 and 2020. As a conservative sensitivity, we also consider the unrealistic case in which New T-Mobile would unilaterally renegotiate [redacted].[14]

C. LTE will be More Commercially Significant

LTE services will be much more commercially significant in 2019 and 2020 than in later years. Hence, we need to account for the marginal costs of serving LTE subscribers.[15] Based on guidance from executives of the Applicants, we calculate network marginal costs based on the LTE network in 2019 and based on a weighted average of the LTE and 5G networks in 2020.[16]

The importance of LTE also means that we need a more accurate measure of LTE throughput levels than was necessary for our 2021-2024 analysis. We worked with the T-Mobile engineers to estimate an empirical loading curve that maps sector loading (measured as busy-hour users per 5 MHz) to all-day user-experience throughputs, and we have used that loading curve to project LTE throughput in the analysis presented herein.[17]

D. The Applicants will have Limited Ability to Modify Certain Near-Term Network Investments

The Applicants' abilities to modify their network investments from planned levels will be limited in 2019 and 2020 due to the lead times associated with many network solutions (*e.g.*, the time

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13 See Appendix II.G for details.

T-Mobile has explicitly stated that it will honor all existing wholesale contracts. (Joint Opposition of T-Mobile and Sprint, September 17, 2018, WT Docket No. 18-197, p. 89.)

14 In fact, T-Mobile would not have the right unilaterally to renegotiate existing contracts. To model this case, we assume that the wholesale prices that New T-Mobile charges [redacted] are the same as those that standalone T-Mobile would charge, but we let the wholesale prices that New T-Mobile charges to Sprint MVNOs vary.

15 In 2021-2024, the relevant marginal costs are those of serving 5G customers. (See *IKK Declaration,* ¶ 88.)

16 See Appendix I.A for details.

17 This approach is similar to the loading curve approach used in the Network Build Model to determine 5G user-experience throughput. See Appendix I.B and our backup materials for details.

needed to obtain required permits or to order equipment). In addition, the companies have already made commitments or expended resources that could not be recouped if they were to implement fewer than the planned solutions.[18] In the case of New T-Mobile, T-Mobile has indicated that it will be focused on integrating the networks as quickly as possible, and because many solutions have significant lead times, the company will have limited flexibility to implement incremental solutions beyond the baseline plan during the integration period.[19]

Our analysis accounts for limitations on the ability to modify near-term network investments in two ways. First, we assess marginal costs over the 100%-to-110% range of projected traffic (rather than the 90%-to-100% range, as we used in 2021-2024).[20] Second, we assess network quality before incremental solutions because the baseline network reflects the expected traffic level and the network expected to be built.[21]

3. Projected Merger Efficiencies for 2019 and 2020

The consumer benefits of the proposed merger stem from its efficiencies. In this section, we describe and quantify certain projected merger efficiencies for 2019 and 2020.[22]

A. Modeled Sources of Efficiencies

The proposed merger will generate network efficiencies through several sources, some of which will increase capacity as soon as network integration occurs, and most of which will reduce—relative to the standalone companies—the marginal cost of adding capacity to serve incremental subscribers to the New T-Mobile network through 2024 and beyond.

3.A.1 More Efficient Use of Existing Network Assets and Spectrum

One source of efficiencies is that bringing together the two networks and two sets of customers will allow New T-Mobile to make more effective use of existing network assets to meet demand than can either firm acting alone—essentially creating additional capacity for free. These benefits arise from being able to handle traffic peaks that arise on one network by making use of

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18 See, e.g., Supplemental Declaration of John C. Saw, Chief Technology Officer, Sprint Corporation, February 19, 2019, WT Docket No. 18-197 (hereinafter *Saw Supplemental Declaration*), ¶ 3.

19 Declaration of Ankur Kapoor, Vice President of Network Technology, T-Mobile US, Inc., February 19, 2019, WT Docket No. 18-197 (hereinafter *Kapoor Supplemental Declaration*), § I.

20 As we explain further in Appendix I.A, this approach accounts for the sunk nature of some network investments.

21 As we explain further in Appendix I.B, this approach accounts for the inability to increase network investment significantly above planned levels.

22 The efficiencies that we identify will extend beyond 2020. We describe our quantification of efficiencies in 2021 and beyond in *IKK Declaration,* § IV.

capacity available on the other. These traffic peaks can arise across different sites or over time at a given site.

First, consider differences in traffic peaks across different sites. Where there are congested T-Mobile sites in areas where Sprint has excess capacity (i.e., it is operating at levels above its congestion thresholds), the proposed merger enables that excess capacity to be used for the T-Mobile customers, thus serving the full set of customers at levels above congestion thresholds, avoiding the low throughput levels that are especially disliked by consumers, and avoiding the need for costly solutions. The same holds where there are congested Sprint sites in areas where T-Mobile has excess capacity.

Next consider fluctuations over time. Consider two situations. In one case, there are two separate networks with sectors serving the same area, with x MHz of spectrum deployed on one sector and y MHz of spectrum deployed on the other. In the other case, there is a single sector on which $x+y$ MHz of spectrum have been deployed. The effective capacity of the single sector will be greater than the sum of the effective capacities of the two separate sectors. This follows from what are often called "queueing" efficiencies or "inventory management economies of scale."[23] Due to the stochastic nature of demand on a wireless network, at certain points in time at a given location, either the Sprint or T-Mobile networks may become congested at a time that the other is not congested. By combining the networks, excess capacity on either network can be used to offset congestion on the other; the full set of spectrum is available to the full set of customers. A simple analogy can be made to the way that call centers are often structured: Rather than have customers call a specific agent, which could result in one line's being jammed while another was empty, call centers route all calls to a central system that then distributes calls to the next available agent. By having a combined line in which the first caller goes to whichever agent is available, call center capacity can be better utilized, effectively creating additional capacity, improving the consumer experience, and reducing the need to hire more agents to deal with congestion, which would otherwise increase costs.

3.A.2 Site-specific Complementarities: More Cost-Effective Solutions

Another source of efficiencies arises because, when solutions are required, the proposed merger will facilitate the use of more cost-effective solutions to resolve congestion and, thereby, increase network quality.

First, bringing together the assets of Sprint and T-Mobile creates immediate, low-cost opportunities to expand the combined network that are not available to the standalone entities: T-Mobile's spectrum can be deployed through radios on Sprint sites and Sprint's spectrum can be deployed through radios on T-Mobile's sites. In some cases, this can be done at little or no incremental cost because spectrum can be deployed through existing radios. For example, New T-Mobile plans to deploy Sprint's PCS spectrum on existing T-Mobile radios.[24] Deploying

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23 See, e.g., James G. Mulligan (1983), "The Economies of Massed Reserves," *The American Economic Review*, 73**(4)**: 725-34; James G. Mulligan (1988), "Economies of Scale for the GI/G/c Queuing Model," *Mathematical and Computer Modelling,* 10**(7)**: 523-527.

24 *McDiarmid Supplemental Declaration,* ¶ 14.

additional spectrum to existing sites is a lower-cost method of increasing network capacity and quality than creating new sites (cell splits). The ability to utilize lower-cost solutions to meet the demands of additional traffic results in lower marginal costs.

Second, deploying combined spectrum on cell sites increases the incremental capacity generated by each cell split going forward. When new cell splits are required over time, the combined firm can deploy the combined spectrum holdings on the new sites and increase the capacity (and thus congestion reduction and quality enhancement) of each cell split without proportionately increasing the cost. Stated another way, absent the merger, the standalone firms would need two separate cell splits to deploy what the merged firm will be able to do as one, and a single, larger deployment costs less than the sum of the costs of the two corresponding standalone cell splits. For example, a New T-Mobile cell split with a configuration that includes 600 MHz, AWS/PCS, and 2.5 GHz spectrum without FD-MIMO would cost [redacted] in CapEx and [redacted] in annual OpEx. By contrast, a standalone T-Mobile cell split with a configuration that includes the 600 MHz and AWS/PCS bands would cost [redacted] in CapEx and [redacted] in annual OpEx, and a standalone Sprint cell split with a configuration that includes "tri-band" consisting of 800 MHz, PCS, and 2.5 GHz spectrum without FD-MIMO would cost [redacted] in CapEx and [redacted] in annual OpEx for a combined total of [redacted] in CapEx and [redacted] in annual OpEx.[25] Thus, New T-Mobile's CapEx would be [redacted] less than the sum of the standalone companies' CapEx, and its OpEx would be [redacted] less than the sum of the standalone companies' OpEx.[26] In sum, New T-Mobile will gain more capacity per dollar spent, thus reducing marginal cost and increasing the network quality benefits from a given expenditure.[27]

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25 Letter from Nancy J. Victory to Marlene H. Dortch, Re: Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, December 18, 2018, WT Docket No. 18-197, Attachment C.

26 In practice, we understand that Sprint would deploy FD-MIMO with an associated CapEx of [redacted] and annual OpEx of [redacted]. (Letter from Nancy J. Victory to Marlene H. Dortch, Re: Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, December 18, 2018, WT Docket No. 18-197, Attachment C.)

These numbers are provided as representative of the cost advantages of New T-Mobile relative to the standalone entities. There are other factors that affect the relative costs and are captured in our formal modeling (i.e., reflected in the marginal cost savings and quality valuation). These include: the specific configuration of spectrum deployed can vary across sites (e.g., based on differences in spectrum holdings), standalone Sprint's deployment of 2.5G FD-MIMO provides benefits for LTE (not 5G) relative to New T-Mobile's deployment of 2.5G without FD-MIMO, and New T-Mobile's deployment will have more spectrum allocated to 5G than the standalone entities, which makes New T-Mobile's deployment effectively larger (due to the higher spectral efficiency for 5G relative to LTE) even if the total spectrum deployed (5G plus LTE) is the same.

27 See also *McDiarmid Supplemental Declaration,* ¶ 14.

3.A.3 Accelerated Refarming due to Spectrum-Deployment Indivisibilities

T-Mobile management has concluded that, due to lumpiness in LTE spectrum deployment, the merged firm will be able to refarm spectrum from LTE to 5G more quickly than would the standalone companies, thus accelerating realization of the efficiency gains associated with 5G.[28]

B. Unquantified Consumer Benefits

It is important to recognize that there are consumer benefits that we do not quantify, including, among others:

- the Network Build Model does not incorporate the benefits from the use of a multi-operator core network (MOCN) and other supplementary network management tools, which will provide enhanced coverage for legacy Sprint customers prior to migration—New T-Mobile will be able to customize the use of these tools on a local basis;[29]
- the Network Build Model assumes that customers will migrate from the legacy Sprint networks to the New T-Mobile network uniformly on a national basis—however, New T-Mobile plans to implement locally optimized migration, which will yield superior overall network quality;[30]
- the modeling does not capture post-migration improvements in coverage, particularly for legacy Sprint customers;
- the modeling does not capture the benefits to customers from enhanced consistent user-experience throughput for New T-Mobile relative to the standalone entities, particularly Sprint; and
- the Network Build Model does not fully account for the quality value from the reduction in leakage from 5G to LTE or lower network capabilities for New T-Mobile relative to the standalone entities (e.g., lower latency).

The omission of these efficiencies from our formal analysis reduces the consumer benefits we project from the proposed merger, meaning our analysis is conservative on this dimension.

C. Marginal Cost Savings

As it will in 2021-2024, the proposed merger will reduce the marginal costs of providing network services in 2019 and 2020.[31] In addition to network marginal cost savings, the proposed merger will also generate savings in non-network marginal costs, and—for Sprint—roaming

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[28] *Ray Declaration*, ¶¶ 40-42.

[29] *McDiarmid Supplemental Declaration,* ¶ 7; *Kapoor Supplemental Declaration*, ¶ 11.

[30] *McDiarmid Supplemental Declaration,* ¶ 3; *Ray Reply Declaration,* ¶ 42.

[31] For descriptions of our calculation of network marginal cost efficiencies, see Appendix I.A below and *IKK Declaration,* § IV.A.

costs.[32] Table 1 below summarizes the sum of the marginal cost savings in 2019-2020 from all three types of merger efficiencies.[33]

TABLE 1
Marginal Cost Savings ($/Subscriber/Month)

[redacted]

D. Improved Network Quality

The analysis reported in the *IKK Declaration* showed that, in 2021-2024, New T-Mobile's planned network will offer higher throughput than will either standalone network, and it will also offer 5G coverage over a broader geographic area than would the standalone Sprint network.[34]

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32 For descriptions of our calculation of roaming and non-network cost efficiencies, respectively, see *IKK Declaration,* §§ III.B.2 and IV.B.

33 Table 1 provides estimated efficiencies in the Maintain Case, in which we assume that New T-Mobile maintains the same usage levels and LTE/5G migration paths as would the standalone companies. **Table 11** in Appendix II.H provides analogous estimates in the Relax Case, in which we assume that New T-Mobile relaxes restrictions on usage so that average usage per subscriber is equal to "unconstrained" demand and accelerates handset migration to 5G relative to the standalone companies.

34 *IKK Declaration,* § III.B.3.

Here, we extend the analysis of network quality to 2019 and 2020. As noted above, there are substantial quality benefits of combining network assets for which the Network Build Model does not account, such as improvements in the consistency of user experience, and it therefore provides a conservative estimate of quality benefits.

Table 2 below presents estimates of the dollar valuations that consumers will place on the changes in throughput in 2019 and 2020 under two alternative approaches to projecting LTE throughput.[35]

TABLE 2
Consumer Benefits of Merger Throughput Improvements ($/Subscriber/Month)

[redacted]

Table 2 shows that T-Mobile customers would experience improved network throughput as a result of the merger, regardless of which LTE throughput projection methodology is used. By contrast, whether our throughput-focused measure of Sprint customers' valuation is higher for New T-Mobile than for standalone Sprint depends on the throughput projection methodology used (the two estimates are roughly centered around zero).

When considering these estimated quality valuations, it is critical to recognize two reasons why actual post-merger experience is likely to be superior to these estimates:

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35 As described Appendix I.B below, we project LTE throughput using two approaches, each of which is a refinement of T-Mobile's ordinary-course model. These refinements are needed because of the importance of measuring user-experience throughput in the lower tail of the distribution of users per 5 MHz when analyzing the integration of the Sprint and T-Mobile networks in 2019 and 2020.

- First, the Applicants have stated their intention to avoid degrading the network experience of Sprint customers, consistent with their migration of MetroPCS customers to the T-Mobile network, and will do so using tools not fully captured by the Network Build Model.[36]
- Second, these estimates focus only on sector-level throughput and do not include any value of improvements in consistency of experience or network coverage that Sprint customers would enjoy as a result of the proposed merger. Sprint has found that a lack of consistent experience is a significant source of customer dissatisfaction.[37]

Based on the discussion above, a reasonable (indeed, conservative, given the omitted consumer benefits, including improvements in coverage and consistency) approach to using the results presented in Table 2 is to assume that, post-merger, Sprint customers would experience network performance in 2019-2020 that is approximately equal in value to that of the standalone Sprint network on average.

4. CONSUMERS WILL BENEFIT FROM THE PROPOSED MERGER

In summary, our simulation analysis demonstrates that, even if one maintains our conservative assumptions, the projected merger efficiencies will outweigh any adverse competitive effects from the loss of a competitor.

We first present year-by-year changes in consumer welfare due to the merger. We find that the merger will benefit consumers in each year for the foreseeable future. As shown by these results, due to the timing of the realization of efficiencies, the proposed merger will generally become increasingly beneficial for consumers over time. To provide a single summary measure of the overall consumer welfare benefits of the merger, we calculate the net present value (NPV) of annual consumer welfare effects.[38]

A. Consumer Surplus Changes for 2019-2024

Table 3 and Table 4 below report the projected effects that the proposed merger will have on consumer surplus in each year from 2019-2024 using the two approaches to projecting LTE

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36 *McDiarmid Supplemental Declaration,* ¶ 3. See also § **Error! Reference source not found.** above.

37 *Saw Supplemental Declaration*, ¶ 2.

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

throughput and demonstrate that the merger will benefit customers in each year during that time period under either approach.[39]

TABLE 3
Consumer Surplus Change by Year: Site-Specific Scaling ($/Subscriber/Month)

[redacted]

[39] The numbers reported in Table 3 and Table 4 are expressed on a per-subscriber, per-month basis.

TABLE 4
Consumer Surplus Change by Year: Mean Scaling ($/Subscriber/Month)

[redacted]

B. Net Present Value (NPV) of Consumer Benefits

Table 5 demonstrates that consumers will benefit from the proposed merger by considering three views of the NPV of consumer benefits:[40]

- **Baseline Case:** We use a discount rate of two percent (the upper bound of the discount rate recommended by the Council of Economic Advisors for studies of intertemporal

[40] Even if one thought that net harm from the merger could arise in certain years (something we do not find), the NPV provides an appropriate way to balance the net effects of the merger across years. Unlike in the case of an infrequently purchased good—for which trading off future welfare effects and near-term welfare effects involves trading off the utility of *different* consumers—the vast majority of mobile wireless consumers will purchase services today and for many years in the future. This fact means that the NPV of welfare effects is relevant even from the point of view of a single consumer, which reinforces the conclusion that the NPV calculation is an appropriate way to evaluate the proposed merger's overall welfare effects and that the proposed merger will benefit consumers and strengthen competition.

consumption),[41] and we assume that net consumer benefits in each year after 2024 remain at the 2024 level.[42]

- **Intermediate Sensitivity Case:** In this case, we assume: (a) a discount rate of two percent, and (b) annual consumer welfare effects from 2025 through 2029 equal to the 2024 level, with a terminal value of projected consumer benefits equal to zero after 2029.
- **Conservative Sensitivity Case:** In this case, we assume: (a) a very high (and thus very conservative) annual discount rate of 10 percent,[43] and (b) a terminal value of projected consumer benefits equal to zero after 2024.

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41 For purposes of computing the NPV of consumer welfare, it is appropriate to use a discount rate that corresponds to one used to evaluate intertemporal consumption patterns. The Council of Economic Advisors recently recommended using a discount rate of "at most 2 percent." (Council of Economic Advisors, "Discounting for Public Policy: Theory and Recent Evidence on the Merits of Updating the Discount Rate," Issue Brief, January 2017 (hereinafter *CEA Issue Brief*), p. 3.)

42 For a discussion of this assumption, see *IKK Declaration,* ¶ 151.

43 For example, the Office of Management and Budget currently uses discount rates of three and seven percent when performing cost-benefit analyses. (*CEA Issue Brief,* p. 1.)

TABLE 5
Net Present Value of Consumer Welfare Effects ($ billions)

[redacted]

Under all three sets of assumptions, our analysis shows that the merger is welfare enhancing in our baseline case and all sensitivity cases. In our baseline case, the merger creates [redacted] in incremental consumer surplus. To put this number in context, given 346 million wireless subscribers in 2018, the total gains in consumer surplus correspond to gains of [redacted] per subscriber.[44]

We also consider two sensitivity cases with respect to the retail price constraints. In one, we assume that New T-Mobile will offer the same rate plans as would the standalone companies in 2019 and 2020. In this case, the NPV of consumer welfare benefits in our baseline specification would be [redacted][45] In the other sensitivity case, we assume, counterfactually, that the retail price constraints have no effect at all. Even in this unrealistic, worst-case scenario, the NPV of consumer benefits in our baseline specification would be [redacted].[46]

It should be kept in mind that these numbers are the result of an analysis that includes several conservative assumptions—the actual consumer benefits may be significantly larger. In sum, this analysis demonstrates that the projected combination of lower marginal costs and higher

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44 For a description of the sources of subscriber estimates, see *IKK Declaration,* note 164.

45 The estimates for each sensitivity case are available in our backup materials.

46 The estimates for each sensitivity case are available in our backup materials.

network quality would prevent any adverse unilateral competitive effects and, in fact, the merger would strengthen competition and increase consumer welfare.

5. CONCLUSION

In the *IKK Declaration,* we presented a merger simulation analysis demonstrating that the proposed merger will strengthen competition and benefit consumers from 2021 through the foreseeable future. We now have sufficient information regarding New T-Mobile's network integration process to extend our analysis to include 2019 and 2020. We find that the central conclusion of our original analysis continues to hold: the proposed merger of Sprint and T-Mobile will promote competition and benefit consumers. Specifically, we find that the proposed merger will increase the expected net present value of consumer welfare; indeed, we find that the proposed merger will benefit consumers in *each year* for the foreseeable future.

APPENDIX I: METHODOLOGY FOR 2019 AND 2020

As described above, certain characteristics of the marketplace in 2019 and 2020 make it necessary to modify slightly our merger efficiencies methodology to apply it to those years.

One feature is that LTE services are much more commercially significant in 2019 and 2020 than in later years. Hence, we need to account for the marginal costs of serving LTE subscribers.[47] The importance of LTE also means that we need a more accurate measure of LTE throughput levels than was necessary for the 2021-2024 analysis.

A second feature is that the Applicants' abilities to modify their network investments from planned levels are limited in 2019 and 2020 due to the long lead times associated with many network solutions (e.g., the time needed to obtain required permits or to order equipment). The effects of reduced flexibility include:

- **Standalone Sprint:** Sprint has indicated that, in 2019 and 2020, it will implement only the solutions identified in its baseline network plan—it will not build the incremental solutions identified by the Network Build Model.[48]
- **Standalone T-Mobile:** T-Mobile has indicated that, in 2019 and 2020, it will implement only the solutions identified in its baseline network plan—it will not build the incremental solutions identified by the Network Build Model.[49]
- **New T-Mobile:** T-Mobile has indicated that, because it will be focused on integrating the networks as quickly as possible, and because many solutions have long lead times, the company will have limited flexibility to implement incremental solutions beyond the baseline plan during the integration period, but it will have some flexibility to move build plans within a geography.[50] T-Mobile has also indicated that it will build the planned combined baseline network for 2021 even if, hypothetically, traffic were substantially less than the sum of the projected standalone traffic levels.[51]

The reduced degree of flexibility affects the calculation of marginal costs as well as the modeling of network quality.

A. Marginal Cost

We begin by describing adaptations related to the projection of network marginal cost savings.

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47 In 2021-2024, the relevant marginal costs are those of serving 5G customers. (See *IKK Declaration,* ¶ 88.)

48 *Saw Supplemental Declaration,* ¶ 3.

49 *Kapoor Supplemental Declaration*, § I.

50 *Kapoor Supplemental Declaration*, § II.

51 *Ray Reply Declaration,* ¶ 15.

The Weighting of LTE and 5G Marginal Costs. As noted in the *IKK Declaration,* it is our understanding that 5G services and the 5G network will be the focus of pricing and strategic business decisions by 2021 and that the overwhelming majority of new customers in 2021 and beyond are likely to be customers with 5G-capable devices.[52] By contrast, it is our understanding that, because the vast majority of traffic will be on the LTE networks in 2019, focusing solely on LTE network marginal costs is a reasonable approximation to Sprint's and T-Mobile's actual pricing and other strategic behavior.[53] Because 2020 is a pivotal year in the transition from LTE to 5G, it is our understanding that the relevant marginal cost in 2020 is the traffic-weighted average of the marginal costs of LTE and 5G subscribers.[54]

Treatment of Legacy Sprint Networks. As described above, a substantial portion of Sprint traffic will remain on the legacy Sprint networks in 2019 and 2020. To accommodate traffic on the Sprint legacy networks, New T-Mobile plans to maintain Sprint's full CDMA and LTE footprints through 2021.[55] However, because new customers will not be served by the legacy Sprint networks, we exclude these networks from our calculation of the network marginal costs associated with incremental subscribers on New T-Mobile's network.[56]

Application of the Network Build Model. The economic analysis reported in the *IKK Declaration* generates network marginal cost predictions for 2021-2024 based on the incremental solutions identified by the Network Build Model as necessary to go from serving 90 percent of the baseline forecasted traffic level to 100 percent.[57] Quantifying network marginal costs in 2019 and 2020 requires a modified approach for the following reasons:

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52 *IKK Declaration,* ¶ 69, citing Reply Declaration of Peter Ewens, Executive Vice President, Corporate Strategy, T-Mobile US, Inc., September 17, 2018, WT Docket No. 18-197, ¶ 36; Reply Declaration of Brandon "Dow" Draper, Chief Commercial Officer, Sprint Corporation, September 17, 2018, WT Docket No. 18-197, ¶ 12.

53 Supplemental Declaration of Peter Ewens, Executive Vice President, Corporate Strategy, T-Mobile US, Inc., February 19, 2019, WT Docket No. 18-197 (hereinafter *Ewens Supplemental Declaration*), ¶ 3; Declaration of Brandon "Dow" Draper, Chief Commercial Officer, Sprint Corporation, February 19, 2019, WT Docket No. 18-197 (hereinafter *Draper Supplemental Declaration*), ¶ 2.

54 *Ewens Supplemental Declaration*), ¶ 3; *Draper Supplemental Declaration*), ¶ 2.

55 *McDiarmid Supplemental Declaration,* ¶ 9.

56 It is our understanding that shedding 10 to 20 percent of Sprint customers still on the legacy Sprint network would not lead to significant changes in the network and, thus, would not save New T-Mobile significant network expenditures (including OpEx). (*Kapoor Supplemental Declaration*, ¶ 10.)

57 *IKK Declaration,* ¶ 94 (and associated backup materials).

- **Standalone T-Mobile:** T-Mobile used its internal traffic forecasts and the Network Build Model to generate the baseline network plan.[58] For 2019 and 2020 (when LTE accounts for the large majority of the traffic), T-Mobile's baseline network plans are much closer to the full sets of solutions identified by the Network Build Model than are the plans for 2021 and beyond (when 5G is the principal source of incremental traffic). This pattern arises, in part, because the version of the Network Build Model that T-Mobile used to plan its baseline networks covered only LTE; it was necessary for T-Mobile to use other information sources to plan for its 5G deployment.[59]

  Because the planned baseline networks for 2019 and 2020 come close to providing the capacity needed to serve up to 100 percent of forecasted traffic, assessing changes in incremental costs from 90 to 100 percent of forecasted traffic would not yield a valid measure of network marginal costs. Instead, we assess the incremental costs of going from 100 to 110 percent of forecasted traffic.

- **Standalone Sprint:** Although Sprint does not use the Network Build Model to generate its baseline networks, it is our understanding that the Network Build Model provides a reasonable approximation to how Sprint thought about its 2019 and 2020 plans when formulating them.[60] We therefore use the same approach for standalone Sprint as described above for standalone T-Mobile.

- **New T-Mobile:** As discussed in the *IKK Declaration,* it is our understanding that the evolution of the New T-Mobile network prior to 2021 will be driven by requirements associated with integrating the Sprint and T-Mobile networks, as opposed to responding to changes in traffic levels.[61] As a conservative measure, we use the same approach to estimate New T-Mobile's marginal network costs in 2019 and 2020 as described above for standalone Sprint and T-Mobile. Specifically, we start from the planned New T-Mobile baseline network in each year and assess the costs of the incremental builds triggered by going from 100 to 110 percent of baseline forecasted traffic.

Although network plans are largely fixed in the very near term, the relevant marginal cost is the one underlying the profit-maximizing price that was (at least implicitly) used in determining the baseline forecasted traffic. That marginal cost incorporates the additional solutions that would

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58 See Letter from Nancy J. Victory, Counsel for T-Mobile US, Inc., to Marlene H. Dortch, Re: Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, December 18, 2018, WT Docket No. 18-197, Attachment B.

59 *Kapoor Supplemental Declaration*, ¶ 8.

60 *Saw Supplemental Declaration,* ¶ 4.

61 *IKK Declaration,* ¶ 57 (citing *Ray Reply Declaration*, ¶ 15.).

have been required in the baseline network to satisfy planning criteria had a lower price been set.[62, 63]

The following table summarizes the results expressed in network marginal costs per GB.[64]

TABLE 6
Network Marginal Costs per Gigabyte

[redacted]

The next table converts the marginal costs per GB into the corresponding marginal costs per subscriber per month.[65]

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62 From the perspective of economics, the marginal cost when network assets are fixed in the short run is equal to the cost to the network from the quality degradation that will result if new traffic is carried and congestion increases. In equilibrium, an economically rational firm will invest in its network up to the point that the marginal expenditures necessary to reduce congestion are equal to the cost of that congestion to the firm. Hence, along the equilibrium path, the marginal cost calculated using the Network Build Model will be approximately equal to the marginal cost that would be realized in terms of degraded network quality when network assets are fixed.

63 In the ordinary course of business, even over timeframes for which the existing network investment plans are largely fixed, neither Sprint nor T-Mobile treats network marginal costs as if they were zero. (Supplemental Declaration of Mark Roettgering, Senior Vice President of Commercial Strategy and Decision Analytics at T-Mobile US, Inc., February 15, 2019, WT Docket No. 18-197, ¶ 2; *Draper Supplemental Declaration*, ¶ 3.)

64 See backup materials for calculations.

65 See backup materials for calculations. The estimates for New T-Mobile are based on the weighted average projected usage levels for standalone Sprint and T-Mobile customers.

TABLE 7
Network Marginal Costs per Subscriber per Month

[redacted]

B. User-Experience Throughput

We now describe adaptations related to the projection of the impact of the proposed merger on user-experience throughput. We modify the approach used in the *IKK Declaration* in three ways.

Use of Baseline Networks before Solutions. The 2021-2024 analysis reported in the *IKK Declaration* evaluates throughput levels based on networks comprising the relevant baseline networks plus the incremental solutions identified by the Network Build Model.[66] For 2019 and 2020, we modify this approach and estimate throughput based on the planned baseline networks only—we do not consider any incremental solutions identified by the Network Build Model. We do this because each company has limited ability to implement additional solutions beyond the planned baseline levels for 2019 and 2020.[67]

Treatment of Legacy Sprint Networks. T-Mobile plans to migrate up to 25 percent of the legacy Sprint customers to the New T-Mobile network by the end of 2019 and approximately 60 percent of the legacy Sprint customers to the New T-Mobile network by the end of 2020.[68] As also noted above, New T-Mobile plans to maintain Sprint's full CDMA and LTE footprints to accommodate Sprint customers who have not yet migrated to the New T-Mobile network in 2019 and 2020. Our evaluation of New T-Mobile's network performance includes traffic on Sprint's

66 We conservatively assess the costs of incremental network solutions starting from the baseline network plans of standalone Sprint and T-Mobile in each year from 2021 through 2024 and starting from the baseline 2021 New T-Mobile plan for each year from 2021 through 2024. (*IKK Declaration*, ¶¶ 59-60.)

67 Said differently, given the limited ability to implement additional solutions for 2019-2020, the actual network, which determines realized quality, will be the network that has already been planned, not a network with additional solutions.

68 *McDiarmid Supplemental Declaration,* ¶¶ 8, 10.

legacy LTE network.[69] Specifically, to account for unmigrated Sprint customers, we compare the performance of the New T-Mobile network and the standalone networks as follows:

- For T-Mobile customers, we compare performance of the standalone T-Mobile network to performance of the New T-Mobile network. The performance for T-Mobile traffic on the New T-Mobile network reflects the distribution of T-Mobile subscribers across New T-Mobile sectors (T-Mobile sites and retained Sprint sites).
- For Sprint customers, we compare performance of the standalone Sprint network to the weighted-average performance of the legacy Sprint and New T-Mobile networks, where the weights are the proportion of Sprint traffic that is on each of those networks for the year in question, in order to reflect the average post-merger performance experienced by Sprint customers. As for T-Mobile, the performance for Sprint traffic on the New T-Mobile network reflects the distribution of the migrated Sprint subscribers across New T-Mobile sectors.

LTE Throughput/Loading Curve: The economic analysis reported in the *IKK Declaration* relies on the ordinary-course Network Build Model to estimate user-experience throughput on LTE networks. The Network Build Model estimates LTE user-experience throughput as follows.[70] Sector-level Ookla throughputs in 2017 are taken as inputs. To calculate LTE throughput in each subsequent year t, the Network Build Model scales those 2017 Ookla speeds by: (1) the ratio of sector loading (measured as users per 5 MHz of spectrum deployed) in 2017 to sector loading in year t; (2) a scaling factor that accounts for spectral efficiency gains; and (3) a scaling factor that accounts for solutions implemented (e.g., cell splits) between 2017 and year t.[71] This approach changes throughput in proportion to the inverse of the number of users per 5 MHz of spectrum (i.e., it takes the form of $1/x$).

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[69] Traffic on Sprint's legacy CDMA network is not included in the network model. However, it is our understanding that New T-Mobile's network will everywhere outperform this network. (*Kapoor Supplemental Declaration*, ¶ 4.) Hence, by omitting the proposed merger's benefits to Sprint's legacy CDMA customers, we understate the merger's efficiencies.

[70] For a description of how the Network Build Model estimates LTE throughput, see Document 5, submitted as part of a supplemental filing to the Commission on September 5, 2018. See Letter from Nancy J. Victory, Counsel for T-Mobile US, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, September 5, 2018, WT Docket No. 18-197 (hereinafter *Network Model Filing*).

[71] For example, consider a (hypothetical) sector with 90 busy hour (BH) users in 2017, 15 MHz of spectrum deployed, and an average (all-day) Ookla speed of 25 Mbps. Suppose the following changes occur between 2017 and 2021: (a) traffic doubles from 90 to 180 BH users; (b) spectrum deployed triples from 15 to 45 MHz; (c) spectral efficiency improves by 20 percent due to increased feature penetration; and (d) two cell splits are implemented at the site. Then, the sector loading changes from (90/(15/5)) = 30 to (180/(45/5) = 20. Combining all of the above factors, the throughput in 2021 is then 25 × ((30/20) × 1.2 × 1.8) = 81 Mbps.

In the ordinary course of its business, T-Mobile has found that this approach provides a good approximation of realized speeds at sector loading levels that are in the neighborhood of those at which T-Mobile determines that a sector is congested.[72] However, this functional form does not provide a good approximation of user throughputs in the tails of the distribution of users per 5 MHz. This issue is especially pronounced in the context of analyzing the integration of the Sprint and T-Mobile networks in 2019 and 2020. For example, in instances where substantial traffic gets loaded onto a sector starting with few users per 5 MHz (as occurs for many sectors when modeling the combination of the Sprint and T-Mobile networks), the $1/x$ curve predicts extremely low throughput even if the number of users per 5 MHz remains well below the thresholds that the Network Build Model assumes are associated with speeds such as its 4 Mbps congestion threshold.

To address this issue, we have worked with the T-Mobile network engineering team to develop an empirical loading curve that maps sector loading (measured as by busy-hour users per 5 MHz) to all-day Ookla throughputs.[73] This approach is similar to the loading curve used in the Network Build Model to determine 5G user-experience throughput.[74]

T-Mobile provided sector-hour-level data that report users per 5 MHz and Ookla speeds for 2×2 MIMO-capable handsets.[75] We limit our analysis to 2×2 MIMO-capable handsets because it is our understanding that such handsets correspond most closely to the handsets reflected in the 2017 Ookla data that serve as the pre-scaled values used as inputs to the Network Build Model.[76]

To estimate the empirical relationship between users per 5 MHz and Ookla throughput, we estimate a spline regression with knot points at 5, 10, 15, 20, 40, and 60 users per 5 MHz. Table 8 reports the results of this regression.

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72 For a discussion of the LTE congestion criteria in the Network Build Model, see Document 5, submitted to the Commission as part of the *Network Model Filing* on September 5, 2018. For a discussion of Ookla throughput, see Document 12 referenced above, also submitted as part of the *Network Model Filing*.

73 For clarity, we use this loading curve only to estimate LTE user-experience throughput. We continue to use the ordinary course model functionality to determine when the Applicants consider a sector to be congested for network planning purposes.

74 For a description of the 5G loading curve, see Document 41, submitted to the Commission as part of the *Network Model Filing* on September 5, 2018.

75 The sample contains 99,119 observations from October 4th, 2018 to November 30th, 2018.

76 *Kapoor Supplemental Declaration*, ¶ 3.

We scale these curves up over time to account for spectral efficiency gains. (See discussion below for information on how we implement this scaling.)

TABLE 8
LTE Throughput Busy-Hour Loading Curve Regression Estimates

Variables	Busy Hour Coefficients
Users per 5 MHz [0,5]	-0.9541*
	(0.4964)
Users per 5 MHz [5, 10]	-1.9369***
	(0.2776)
Users per 5 MHz [10, 25]	-1.3147***
	(0.0822)
Users per 5 MHz [25, 40]	-0.6460***
	(0.0695)
Users per 5 MHz [40, 60]	-0.2166***
	(0.0758)
Users per 5 MHz [60, 200]	-0.0976*
	(0.0540)
Constant	55.88
Site Fixed Effects	Yes
No. of Observations	99,119
R-Squared	0.6934

Notes: [1] Robust standard errors clustered by site and day in parentheses. *** p<0.001, ** p<0.01, * p<0.05; [2] Splines generated at knots 5, 10, 25, 40 and 60.

We use this regression to define two curves. First, for any given number of busy-hour users per 5 MHz, we use the regression to estimate the corresponding busy-hour throughput. Second, analogous to the estimation of the 5G throughput curve, we derive the all-day average throughput corresponding to any given number of busy-hour users per 5 MHz as follows:

- We use the distribution of T-Mobile's traffic across the day to map users per 5 MHz in the busy hour into users per 5 MHz for the non-busy hours in the sector.
- For each resulting sector-hour pair, we use the regression estimates in Table 8 to calculate the corresponding throughput.[77]
- We then compute a weighted average all-day throughput for each sector-day pair.
- Finally, to calibrate the all-day average loading curve, we regress all-day average user-experience throughput on the sector busy-hour number of users per 5 MHz using the same spline specification described above. Table 9, below, presents the all-day spline regression estimates.

77 We set the throughput equal to zero for all observations with users per 5 MHz greater than 139.

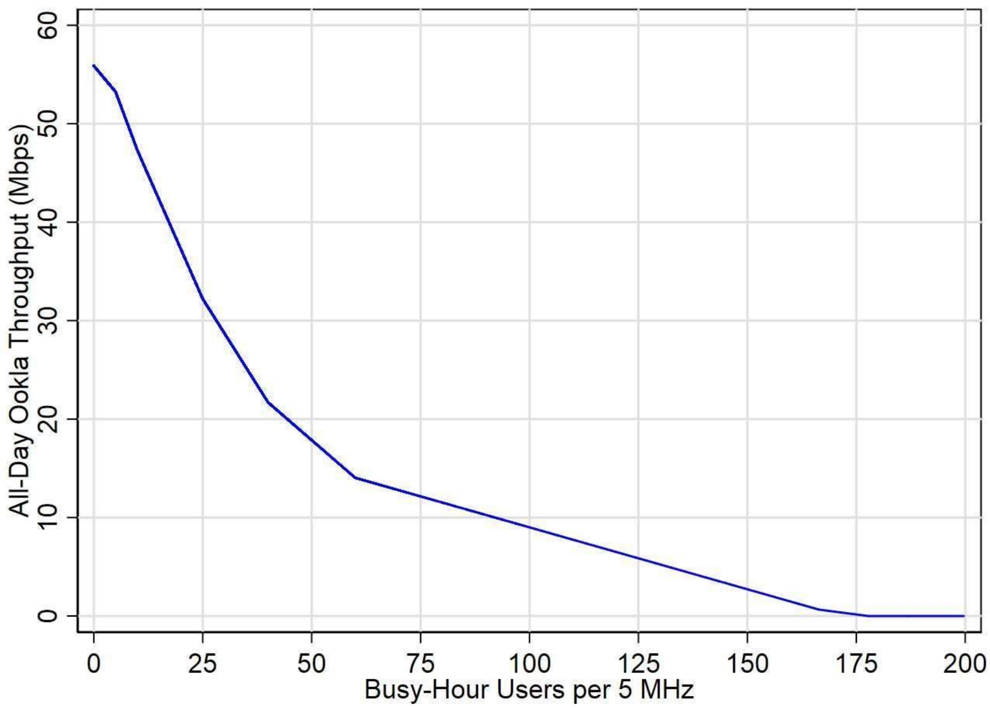
TABLE 9
LTE Throughput All-Day Average Loading Curve Regression Estimates

Variables	All Hour Coefficients
Users per 5 MHz [0,5]	-0.5291***
	(0.0028)
Users per 5 MHz [5, 10]	-1.1881***
	(0.0016)
Users per 5 MHz [10, 25]	-1.0061***
	(0.0005)
Users per 5 MHz [25, 40]	-0.7011***
	(0.0007)
Users per 5 MHz [40, 60]	-0.3827***
	(0.0015)
Users per 5 MHz [60,200]	-0.1258***
	(0.0032)
Constant	55.61
Site Fixed Effects	Yes
No. of Observations	64,682
R-Squared	0.9998

Notes: [1] Robust standard errors clustered by site and day in parentheses. *** p<0.001, ** p<0.01, * p<0.05; [2] Splines generated at knots 5, 10, 25, 40 and 60.

Figure 1 shows the resulting all-day curve, which we use to project LTE user-experience throughput. In particular, we use this estimated all-day loading curve to translate forecasted busy-hour users per 5 MHz, adjusted for solutions and applying spectral efficiency gains, into all-day user-experience throughput.

FIGURE 1
LTE Throughput All-Day Loading Curve



We utilize the all-day loading curve to estimate LTE throughput using the sector-level Network Build Model results in two ways:[78]

- **Site-Specific Scaling**: Under this approach, we project LTE throughput by multiplying the LTE loading curve throughput times a site-specific "error term," which captures the deviation of realized speed at that site from the predicted speed in 2017. Specifically, we calculate *Thru-2021 = (Loading Curve-2021) * (Spectral Efficiency Adj. Factor) * Error Term*, where:

  — *Thru-2021* is the projected user throughput in 2021 (with analogous calculations for any other forecast year);

  — *Loading Curve-2021* represents lookup from the loading curve based on users per 5 MHz in 2021, adjusted for solutions (both pending and incremental);

  — *Spectral Efficiency Adj. Factor* accounts for improvements in spectral efficiency over time (e.g., 1.2 for a 20 percent efficiency gain);

  — *Error Term* equals (Actual Ookla speed in 2017) / (Predicted Ookla-2017); and

[78] These two approaches are analogous to assuming that there are persistent unobserved site-specific effects or not.

— *Predicted Ookla-2017* represents the predicted value from the loading curve based on users per 5 MHz in 2017.

- **Mean Scaling**: We calculate LTE throughput by multiplying the LTE loading curve throughput by a common scaling factor for every sector in a given network (0.94 for NTM and SATM and 0.64 for Sprint). The scaling factor for each network is equal to the weighted-average of the sector-specific error terms discussed above. Specifically, we calculate *Thru-2021 = (Loading Curve-2021) × (Spectral Efficiency Adj. Factor) × Scale Factor*, where:

— the first three terms are as described above; and

— *Scale Factor* is the weighted average of the *Error Term*, across all sectors.

APPENDIX II: EXTENSIONS AND UPDATES

To estimate the effects of the proposed merger in 2019 and 2020, it is necessary to determine values for several parameters described below. We have also implemented a few refinements to the Network Build Model to accommodate this analysis. In some cases, these updates and modifications also apply to our 2021-2024 analysis.

A. Congestion Criteria

It is our understanding that T-Mobile has formulated plans to use a congestion threshold of 4 Mbps on all 5G sectors and 2 or 4 Mbps on LTE sectors in 2019 and 2020 and then increase this threshold to 12 Mbps on 5G sectors and LTE sectors that serve 5G handset traffic ("leakage sectors") as 5G matures in 2021 and subsequent years.[79] These congestion thresholds apply to both the standalone T-Mobile and New T-Mobile networks.[80]

By contrast, Sprint's plans are less fully formed, and it has not yet adopted a specific 5G congestion threshold. It is our understanding that Sprint anticipates using a congestion threshold of 5 Mbps on 5G sectors and leakage sectors in 2019 and 2020 (and 4 Mbps for LTE sectors without leakage), and anticipates transitioning to a threshold of 12 Mbps or higher in later years, but the exact timing of the transition path has not been determined and will depend on both financial constraints and competitive conditions.[81] Sprint has indicated that a reasonable

[79] For a discussion of LTE congestion criteria, see Document 5 and Document 28, submitted to the Commission as part of the *Network Model Filing* on September 5, 2018. For a discussion of the 5G congestion criteria, see Document 19, also submitted as part of the *Network Model Filing*.

[80] *Id.*

[81] *Saw Supplemental Declaration,* ¶ 5.

approach to modeling Sprint as a standalone company is to use congestion thresholds of 4 Mbps for LTE sectors and 5 Mbps for 5G and leakage sectors in 2019 and 2020.[82]

The 2021-2024 analysis presented in the *IKK Declaration* assumed that Sprint, like T-Mobile, would transition to a 12 Mbps congestion criterion for 5G and leakage sectors by 2021. Because the precise timing of the transition for Sprint's leakage-sector congestion threshold is uncertain, we have conducted a sensitivity analysis in which we assume that Sprint adopts a 5 Mbps criterion for leakage sectors not just in 2019-2020, but also in 2021-2024.[83]

Table 10 below reports the results of our consumer welfare analysis under the alternative assumption that standalone Sprint's congestion threshold for leakage sectors is 5 Mbps or 12 Mbps in 2021-2024.[84] As the table shows, the change in the leakage-sector congestion threshold does not change our overall conclusions that the merger is expected to strengthen competition and raise consumer welfare in 2021-2024.[85] The projected consumer welfare effects remain positive in all cases.[86]

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82 *Id.* In practice, Sprint uses band-specific throughput targets of (1.5 Mbps for 800 MHz spectrum, 2 Mbps for 1.9 GHz spectrum, and 5 Mbps for 2.5 GHz spectrum). (SPR-FCC-06941031 at SPR-FCC-06941033.)

83 We continue to assume that Sprint's other congestion criteria are 4 Mbps on LTE sites serving no 5G handsets and 12 Mbps on 5G sites in 2021 and beyond.

84 In our backup materials, we present results based on all combinations of: (i) the Adjusted and Unadjusted Nevo models; (ii) the Maintain and Relax Cases; and (iii) site-specific and mean scaling of the LTE throughput curve. In all years from 2021 to 2024, in all these permutations, projected efficiencies exceed the critical efficiencies.

85 Intuitively, the choice of congestion threshold for leakage sectors has little overall effect on the bottom line because it gives rise to offsetting effects: The lower threshold reduces Sprint's network marginal costs (which reduces the merger efficiencies), but also reduces Sprint's network quality (which raises the merger efficiencies).

86 In fact, even with reduced marginal cost efficiencies, in most cases (including our baseline case), marginal cost efficiencies alone are sufficient to offset upward pricing pressure.

TABLE 10
Amount by which Projected Efficiencies Exceed Critical Efficiencies with Alternative Leakage Sector Congestion Thresholds for Standalone Sprint: 2021-2024 ($/Subscriber/Month)

[redacted]

B. Additional Endogenous Solution Options

In order to allow a more complete analysis of network development during the integration period, the Network Build Model has been modified to add the following options to the set of solutions that the model can use as incremental solutions to address congestion:

- Overlay mmWave spectrum: applicable to standalone T-Mobile and New T-Mobile. The unit CapEx for an mmWave overlay is [redacted] with clubbing and [redacted] without clubbing, and the OpEx is [redacted] per year.[87]

[87] Letter from Nancy J. Victory to Marlene H. Dortch, December 18, 2018, Re: Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations; WT Docket No. 18-197, Attachment C.

- Overlay AWS/PCS spectrum: dual LTE/5G capable equipment, applicable to New T-Mobile.[88] The unit CapEx for an AWS/PCS overlay is [redacted] with clubbing and [redacted] without clubbing, and the OpEx is [redacted] per year.[89]
- Overlay of 2.5G spectrum to address LTE congestion:[90] dual LTE/5G capable equipment,[91] applicable to standalone Sprint and New T-Mobile.[92] The unit costs for a 2.5G overlay for LTE are the same as the unit costs for a 2.5G overlay for 5G, as they use the same equipment and provide the same service.

In addition, the model has been modified such that, for all deployments of 2.5G spectrum for 5G, the 2.5G spectrum is also deployed for LTE, to the extent that 2.5G spectrum is available for LTE given the spectrum holdings and re-farming plan.

C. Spectrum Deployment in Sprint Baseline Network

The Applicants have prepared site/sector-specific specifications of the baseline plans for the standalone and New T-Mobile networks in 2019 and 2020. This information is embedded in the extended version of the Network Build Model for each entity. In the course of developing the detailed plans for 2019-2020, Sprint analyzed more closely its plans for some of the sites included in its network plan primarily to expand coverage and determined that additional spectrum should be added to some of these sites as part of the baseline network, resulting in some minor modifications to the specifications for 2021-2024. This additional spectrum deployment in the baseline network has the effect of reducing the merger efficiencies by a small amount relative to those reported in the *IKK Declaration* because it increases Sprint's network quality, and we conservatively treat all of the costs associated with the standalone baseline networks as sunk, rather than marginal, in our merger simulations.

To use the most up-to-date information, we utilize these updated plans in projecting the effects of the proposed merger for 2021-2024.

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88 AWS/PCS overlays were an option for standalone T-Mobile in the prior version of the model; this change adds that capability to New T-Mobile.

89 Letter from Nancy J. Victory to Marlene H. Dortch, Re: Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, December 18, 2018, WT Docket No. 18-197, Attachment C.

90 In the previous version, 2.5G overlays were allowed for addressing 5G congestion, but not for LTE congestion.

91 All 2.5G overlays for LTE congestion also provide 5G capacity (based on spectrum availability).

92 The TM engineering team has provided data for Sprint 2.5G spectrum available for LTE by sector, which was not an input in the prior version of the model.

D. Solution Unit Costs

Our analysis relies on marginal cost predictions generated by applying dollar unit costs to the incremental solutions identified by the Network Build Model. The analysis reported in the *IKK Declaration* relied on unit cost figures supplied by the Applicants' outside counsel.[93]

As described in the December 18, 2018, letter from Nancy Victory, T-Mobile has refined its estimates of the unit costs associated with incremental solutions for standalone T-Mobile and New T-Mobile in response to a request from the Commission for additional documentation of those unit costs.[94] We use these updated unit costs in our analysis.

In addition, Sprint has now provided unit costs for deployment of a cell site with mMIMO functionality, which has higher costs than a new cell site without mMIMO deployed.[95] In the *IKK Declaration,* we conservatively assumed that no Sprint cell splits included mMIMO deployments when assigning unit costs. We now apply the unit costs for deployment of a cell site with mMIMO functionality where the Network Build Model deploys such functionality.

E. Sprint Traffic Levels

In the *IKK Declaration,* we used the estimated number of subscribers and LTE/5G handset mix that was developed for Sprint by the T-Mobile team for use in the Network Build Model. We now use Sprint's internal "18.2" customer demand forecasts for the number of subscribers and the LTE/5G handset mix.[96]

F. Diversion Ratios

The baseline case reported in the *IKK Declaration* relied on diversion ratios based on the best measure of *switching rates* available in the record.[97] However, as we described in our December 14, 2018, and February 7, 2019, submissions, switching rates are, at best, rough proxies for the diversion ratios, and the latter are the relevant metrics for assessing the competitive effects of mergers.[98] After we had completed the analysis reported in the *IKK Declaration,* John Asker, Tim Bresnahan, and Kostis Hatzitaskos (ABH) submitted a white paper describing a

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93 *IKK Declaration*, note 103.

94 Letter from Nancy J. Victory to Marlene H. Dortch, Re: Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, December 18, 2018, WT Docket No. 18-197, Attachment C.

95 See our backup materials for the relevant unit costs.

96 SPR-FCC-04338918 at SPR-FCC-04338924.

97 *IKK Declaration,* Appendix I, § C.3.

98 Letter from Nancy J. Victory, Counsel for T-Mobile US, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, December 14, 2018, WT Docket No. 18-197; Letter from Nancy J. Victory, Counsel for T-Mobile US, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, February 7, 2019, WT Docket No. 18-197.

sophisticated structural model of consumer demand utilizing detailed individual-level micro data from the Nielsen Mobile Performance product with which they directly calculate true diversion ratios based on own- and cross-elasticities.[99] ABH's estimated diversion ratios are far superior to those based solely on switching rates. Because the ABH model provides the best available estimates of the relevant substitution patterns, we use diversion ratios derived from that model in our baseline analysis, while also demonstrating that our analysis is robust to using diversion ratios derived from other sources of data.

G. Treatment of Existing Wholesale Contracts

Our simulation analysis separately models TracFone and a collection of Sprint MVNOs.

[redacted] of T-Mobile's wholesale MVNO volume. [redacted] currently has a contract with T-Mobile that extends through [redacted].[100] This contract specifies [redacted] We account for the [redacted] contract by [redacted].

Sprint sells wholesale network access to a variety of MVNOs. MVNOs accounting for at least [redacted] of Sprint's MVNO revenue have contracts with Sprint that [redacted] and MVNOs accounting for at least [redacted] of Sprint's MVNO revenue have contracts with Sprint that [redacted].[101]

Given the competition between MVNOs, we assume that New T-Mobile would not be able profitably to raise wholesale prices on those MVNOs [redacted], so we [redacted] all wholesale prices paid by Sprint MVNOs [redacted]. As a sensitivity case, we also consider a scenario in which we allow the model to determine wholesale prices for Sprint Resellers ([redacted]), but continue to [redacted] (given the [redacted] contract).

H. Marginal Cost Savings for the Relax Case

In the text, Table 1 reports the projected marginal cost savings for the Maintain Case. Table 11 below reports the corresponding figures for the Relax Case.[102]

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99 John Asker, Timothy F. Bresnahan, and Kostis Hatzitaskos, *Economic Analysis of the Proposed Sprint/T-Mobile Merger* § 3, Nov. 6, 2018, Attachment A to Letter from Nancy J. Victory, Counsel for T-Mobile US, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, WT Docket No. 18-197 ("*ABH White Paper*").

100 [redacted] (see Exhibit 1 in our backup materials); [redacted], [redacted] (see Exhibit 2 in our backup materials).

101 See backup materials for calculation.

102 Recall that, in the Relax Case, we assume that New T-Mobile relaxes restrictions on usage so that average usage per subscriber is equal to "unconstrained" demand and accelerates handset migration to 5G relative to the standalone companies.

TABLE 11
Marginal Cost Savings per Subscriber: Relax Case ($/Subscriber/Month)

[redacted]

APPENDIX III: UPDATED CALCULATIONS FOR 2021-2024

In this Appendix, we report the effects of the extensions and updates discussed in the prior section on key projections for 2021-2024.

A. Marginal Cost Savings

Projected marginal cost savings are affected by changes in: (i) unit costs; (ii) Sprint traffic forecasts; (iii) Sprint baseline networks; and (iv) the use of additional endogenous solutions. Table 12 below reproduces the figures reported in *IKK Declaration* Table 12.

TABLE 12
***IKK Declaration* Summary of Marginal Cost Savings: Maintain Case ($/Subscriber/Month)**

[redacted]

Table 13 reports the updated figures for the Maintain Case.

TABLE 13
Updated Summary of Marginal Cost Savings: Maintain Case ($/Subscriber/Month)

[redacted]

Table 14 below shows the marginal cost savings reported in *IKK Declaration* Table 14 for the Relax Case.

Table 14
***IKK Declaration* Summary of Marginal Cost Savings: Relax Case ($/Subscriber/Month)**

[redacted]

Table 15 below reports the updated marginal costs savings for the Relax Case.

Table 15
Updated Marginal Cost Savings: Relax Case ($/Subscriber/Month)

[redacted]

B. Valuation of Throughput Improvements

The valuation of throughput improvements is affected by the throughput projection approach as well as changes in the Sprint traffic forecast and baseline spectrum deployment, and the addition of endogenous solutions.

Table 16 below reproduces the results of *IKK Declaration* Table 21 showing the value of throughput improvements in the Maintain Case.[103]

TABLE 16
***IKK Declaration* Valuation of Throughput Improvements: Maintain Case**

[redacted]

Table 17 and Table 18 below report the corresponding calculations using the updated inputs, once for each of the two approaches to projecting LTE throughput levels.

[103] We have modified the labeling for clarity, but the results are identical to those in the *IKK Declaration*.

TABLE 17
Updated Valuation of Throughput Improvements:
Maintain Case; Site-Specific Scaling

[redacted]

TABLE 18
Updated Valuation of Throughput Improvements:
Maintain Case; Mean Scaling

[redacted]

Table 19 below reproduces the results of *IKK Declaration* Table 23 showing the value of throughput improvements in the Relax Case.

TABLE 19
***IKK Declaration* Valuation of Throughput Improvements:**
Relax Case

[redacted]

Table 20 and Table 21 below report the corresponding calculations using the updated inputs, once for each of the two approaches to projecting LTE throughput levels.

TABLE 20
Updated Valuation of Throughput Improvements:
Relax Case; Site-Specific Scaling

[redacted]

TABLE 21
Updated Valuation of Throughput Improvements:
Relax Case; Mean Scaling

[redacted]

ATTACHMENT C

SUPPLEMENTAL DECLARATION OF JOHN C. SAW

Chief Technology Officer, Sprint Corporation

SUPPLEMENTAL DECLARATION OF JOHN C. SAW

Chief Technology Officer, Sprint Corporation

1. My name is John C. Saw, and I am Chief Technology Officer for Sprint Corporation ("Sprint"). In this role, I am responsible for technology development, network planning, engineering, deployment, and service assurance of the Sprint network. My qualifications are listed in my declaration attached to the Public Interest Statement in support of the transaction, filed on June 18, 2018. I submit this declaration to provide information requested by Drs. Israel, Katz, and Keating.

2. As part of Sprint's effort to continually improve our network, we pay close attention to what consumers value in their wireless experience. Among other things, customers not only value network speed in areas where Sprint has coverage, but they also value consistency of experience and overall availability of network coverage. Lack of consistent network experience is a significant source of subscriber dissatisfaction, and network inconsistency is a contributing factor to subscriber churn.

3. To facilitate modeling of the expected performance of Sprint's standalone network in the future, Sprint provided permitted representatives from the T-Mobile engineering team with Sprint's future network build plan. This plan includes the incremental network solutions that Sprint plans to implement for the years 2019 and 2020 that would have the effect of increasing Sprint network capacity. I understand that current iterations of T-Mobile's capacity planning model call for additional capacity enhancements beyond those specified in Sprint's standalone network plan in 2019 and 2020 to prevent congestion, given the traffic forecast and planning criteria used in the model. However, as a standalone company, Sprint would not implement the additional capacity enhancements identified by the T-Mobile capacity planning

model for 2019 and 2020. Over this time frame, Sprint's network build plan is largely locked in and Sprint has limited ability to deviate from its planned network investment.

4. Although Sprint does not use T-Mobile's network capacity model to plan its network in the ordinary course of business, Sprint monitors capacity utilization and congestion on its network and attempts to prevent or address congestion issues and deliver certain throughput targets with incremental network enhancements. Given this is the main function of T-Mobile's network capacity model, the model provides a reasonable approximation as to how Sprint developed network plans for 2019 and 2020.

5. Similar to T-Mobile, Sprint uses speed thresholds to flag and monitor areas of its network where congestion may arise. However, we have not yet adopted a congestion criteria for our 5G network. We anticipate eventually transitioning to a 12 Mbps or higher throughput threshold after our 5G network has been deployed, but we do not have a timeline for this potential transition, which will be contingent on both financial constraints and competitive dynamics. In 2019 and 2020, we anticipate using a 5 Mbps threshold for 5G and for leakage sectors, which are sectors where 5G handsets can only access our LTE network. Accordingly, for purposes of modeling the Sprint network, using a 4 Mbps threshold for LTE and a 5 Mbps threshold for 5G and leakage sectors is a reasonable approach for 2019 and 2020.

6. I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed on February 17, 2019.

John C. Saw
Chief Technology Officer
Sprint Corporation

ATTACHMENT D

DECLARATION OF ANKUR KAPOOR

VICE PRESIDENT OF NETWORK TECHNOLOGY, T-MOBILE US, INC.

DECLARATION OF ANKUR KAPOOR

VICE PRESIDENT OF NETWORK TECHNOLOGY, T-MOBILE US, INC.

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 planning.

2. The engineering model used in connection with the planning for New T-Mobile is built upon the ordinary course engineering tool that T-Mobile has used since 2011/2012 and has been utilized to dictate capacity expansion expenditures. Using estimates of future subscribers and network usage, the model predicts congestion and determines the capacity enhancements necessary to prevent that congestion. Neville Ray explained the inputs, outputs, and mechanics of this model in his declaration filed on September 17, 2018 (the "Neville Ray Declaration"). My team and I are responsible for the development and use of this model, which forecasts network growth and identifies capacity enhancement solutions to mitigate congestion.

3. The engineering model relies on Ookla data to measure user experience throughput in 2017, which is the baseline period in the network model. While there are inevitably a mix of different handset capabilities accessing the network any given time, handsets with 2x2 MIMO capability most closely reflect the mix in 2017 when these Ookla data were collected.

4. The engineering model is focused on the LTE and 5G networks; it does not model Sprint's CDMA network. However, T-Mobile plans to maintain Sprint's full CDMA footprint until all Sprint customers are migrated to the New T-Mobile network. Because traffic on Sprint's CDMA network will be decreasing as Sprint customers migrate to the New T-Mobile network throughout the migration period while total capacity on the CDMA network remains the same, we expect that Sprint's CDMA network will provide a higher level of performance to

customers remaining on the CDMA network than they would receive from the standalone Sprint network. New T-Mobile's LTE and 5G networks will of course outperform Sprint's legacy CDMA network across the entire network.

I. Ordinary Course Capacity Enhancements Require Significant Lead Time

5. T-Mobile uses this engineering model in its annual capacity planning cycles. The capacity enhancements identified in these planning cycles often require substantial lead time to implement. For example, planning for and executing spectrum overlays can take nearly a year, and planning for and executing cell splits can take one to two years in the best case and often longer. As a result, our capacity enhancement plans are largely fixed in the short term, since our planning cycles inform the capacity expansion budget within which we operate.

6. Consistent with its ordinary course practices, T-Mobile as a standalone company will implement solutions currently in its baseline network plan for 2019 and 2020, derived from its previous planning cycle.

II. The New T-Mobile Network Will Not Materially Deviate from Pre-2021 Baseline Plan

7. We used our engineering model to predict the congestion that would occur from adding Sprint subscribers and their usage to the T-Mobile network, which New T-Mobile plans to use as the "anchor" network, and to determine how to use Sprint's network assets to combat that congestion. Because we expect that all Sprint customers will be migrated to the New T-Mobile network by the end of 2021, our initial planning focused on the configuration of the network needed to serve the combined customer base and traffic in that year and beyond.

8. We used our ordinary course LTE engineering model for this analysis, and thus the baseline plan generated by this model identified solutions based on LTE technology and

usage assumptions. As detailed in documentation previously submitted to the Commission, we used other planning tools to develop our 5G site plan.[1]

9. In response to requests by the agencies reviewing the transaction, we also accelerated the development of a national deployment plan for New T-Mobile in 2019 and 2020 based on our planned baseline 2021 network. The same lead time required for incremental capacity enhancements in the ordinary course will apply to the New T-Mobile build out plan in these years. We will be focused on migrating customers and executing this integration plan as quickly as possible between 2019 and 2021. As a result, we will have a very limited ability to consider and execute incremental solutions beyond our current baseline network plan prior to 2021, although we will have some flexibility within geographies to shift parts of our current build plan.

10. We will regularly evaluate the customer experience during the migration period to ensure that the Sprint CDMA and LTE customer experience is not degraded. We would maintain essentially the same legacy Sprint network configuration even if 10 to 20 percent of Sprint customers expected to stay on the network did not, as our concern is with maintaining coverage and consistency. New T-Mobile would need to continue to maintain Sprint's CDMA footprint even without these customers and, while it might be able to refarm certain LTE spectrum more quickly, we would not enjoy any material cost savings. Thus, losing a portion of Sprint's customers would not lead to significant network expenditure savings. This is yet another reason why New T-Mobile will make every effort to retain and, ultimately, migrate legacy Sprint customers.

[1] *See* "Document 10a 5G Site Selection" for an explanation of the 5G site selection method used.

III. The Integration of the Two Networks Will Generate Additional Benefits to Consumers in the Interim Period.

11. The engineering model does not capture the benefits from using supplementary network management tools we will have at our disposal to enhance customer experience during the transition period. For instance, we will use Multi-Operator Core Network ("MOCN") technology, which is further explained in the Neville Ray Declaration, to give Sprint customers access to the T-Mobile network during the migration period, and this can be customized on a localized basis. MOCN and other tools help to maximize the benefit of using both networks, while improving customer experience and bringing immediate benefits to consumers.

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

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

ATTACHMENT E

SUPPLEMENTAL DECLARATION OF PETER EWENS

Executive Vice President, Corporate Strategy, T-Mobile US, Inc.

SUPPLEMENTAL DECLARATION OF PETER EWENS

Executive Vice President, Corporate Strategy, T-Mobile US, Inc.

1. My name is Peter Ewens, and I currently serve as the Executive Vice President, Corporate Strategy for T-Mobile US, Inc. ("T-Mobile"). In this role, I have a wide range of responsibilities that include long-term strategic planning.

2. To remain competitive, T-Mobile must make ongoing network investments to accommodate subscriber growth and increasing demand by subscribers for network services (e.g., mobile data). In choosing our level of network investment, we must balance the incremental cost of increasing capacity against how much consumers will value the resulting improvement to our network. In considering these costs in the ordinary course of business, we focus on the primary technology that new subscribers will use and which technology network will carry the most traffic.

3. In 2019, we expect that most new T-Mobile customers will still use LTE handsets and that the vast majority of traffic will be on our LTE network. Accordingly, using LTE-based costs is a reasonable approximation of how T-Mobile would think about the incremental costs for that year. By contrast, in 2020, a substantial amount of new customers will have 5G handsets and an increasing amount of traffic will be on our growing 5G network. Given these changes, it is a better approximation to use the traffic-weighted average of the marginal costs of LTE and 5G subscribers to estimate costs for 2020.

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

Peter Ewens
Executive Vice President, Corporate Strategy
T-Mobile US, Inc.

ATTACHMENT F

DECLARATION OF BRANDON "DOW" DRAPER

Chief Commercial Officer, Sprint Corporation

DECLARATION OF BRANDON "DOW" DRAPER

Chief Commercial Officer, Sprint Corporation

1. My name is Brandon "Dow" Draper. I am Chief Commercial Officer for Sprint Corporation ("Sprint"). I submit this declaration to provide information requested by Drs. Israel, Katz, and Keating.

2. Sprint takes into account the primary technology that new subscribers will use and which technology network will carry the most traffic when projecting future costs and making decisions about pricing to consumers. In 2019, the vast majority of traffic will be on the LTE network. As a result, focusing solely on the LTE network for marginal cost is a reasonable approximation of Sprint's actual pricing and strategic behavior for the year. We predict that by the year 2020 we will see significant growth in the usage of 5G technology and adoption of 5G handsets; accordingly, the most relevant marginal cost in 2020 will be the traffic-weighted average of the marginal costs of LTE and 5G subscribers. By 2021, we are currently predicting that 5G services and the 5G network will be the focus of pricing and strategic business decisions.

3. Sprint's analysis of the cost of providing wireless services to its subscribers considers many costs associated with its service, including network costs. Even when existing network investment plans are largely fixed, Sprint views a portion of network costs as marginal costs. Sprint's calculation of marginal cost incorporates additional targeted capacity investments that become necessary to improve consumer experience levels. These incremental investments to prevent degradation of the consumer experience on the network may be considered marginal costs for Sprint and must be taken into account when making pricing decisions that affect demand for Sprint's services.

4. I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed on February 18, 2019.

Brandon "Dow" Draper
Chief Commercial Officer
Sprint Corporation

ATTACHMENT G

SUPPLEMENTAL DECLARATION OF MARK ROETTGERING

Senior Vice President of Commercial Strategy and Decision Analytics at T-Mobile US, Inc.

DECLARATION OF MARK ROETTGERING

Senior Vice President of Commercial Strategy and Decision Analytics at T-Mobile US, Inc.

1. My name is Mark Roettgering. I am a Senior Vice President of Commercial Strategy and Decision Analytics at T-Mobile US, Inc. ("T-Mobile"). In that role, I oversee a team that collects and analyzes competitive intelligence data, including both porting data and survey data regarding customer switching behavior. My team also analyzes the costs associated with serving T-Mobile's subscribers, including network costs, in consideration of pricing decisions.

2. In analyzing the costs of its subscribers, T-Mobile considers the multiple costs associated with service, including network costs. Although short-term network costs are largely fixed, T-Mobile does not treat network marginal costs as zero. T-Mobile plans its network to combat congestion, and serving more subscribers requires incremental investment to prevent those subscribers' usage from congesting the network. This incremental investment is a marginal cost to T-Mobile and must be taken into account when making pricing decisions that will affect the demand for T-Mobile's services.

3. I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct. Executed on February 15, 2019.

Mark Roettgering
Senior Vice President of Commercial Strategy
and Decision Analytics
T-Mobile US, Inc.