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October 24, 2011

Via ECFS

Marlene H. Dortch, Esq.
Secretary
Federal Communications Commission
445 Twelfth Street, S.W., Room TW-A325
Washington, D.C. 20554

Re: ***In re Applications of AT&T Inc. & Deutsche Telekom AG for Consent to Assign or Transfer Control of Licenses & Authorizations***
WT Docket No. 11-65
REDACTED – FOR PUBLIC INSPECTION

Dear Ms. Dortch:

Attached please find a redacted version of the white paper entitled, "Explanation of the Compass Lexecon Merger Simulation Model." This paper originally was submitted in the above-referenced docket on August 23, 2011.

Please let Joan Marsh of AT&T (202-457-3120) or me know if any questions arise.

Respectfully submitted,

Attachment

cc (via email): Kathy Harris, Esq.
Ms. Kate Matraves
Jim Bird, Esq.
Best Copy and Printing, Inc.

Explanation of the Compass Lexecon Merger Simulation Model

Dennis W. Carlton and Mark A. Israel[1]

August 23, 2011

1 Introduction

At the July 13, 2011 Economist Workshop, we referenced the results of a quantitative economic analysis of the competitive effects of the proposed merger between AT&T and T-Mobile USA (TMUS).[2] This analysis included a merger simulation model that used as an input, among other factors, estimates of incremental network costs (for standalone AT&T and T-Mobile, as well as for the merged firm) from a network engineering model developed by AT&T, along with estimates of network quality improvements due to the merger.[3] On July 25, 2011, we submitted preliminary results from this economic analysis along with the supporting computer code.[4] On August 19, we met with Staff of the Federal Communications Commission ("the Commission") to discuss the model.

In this white paper, we derive the equations underlying the economic model and discuss how we incorporate cost efficiencies and quality improvements into the model.

2 Overview of Merger Simulation Model

To implement our merger simulation analysis, we assume that five firms provide mobile telephony services: AT&T, T-Mobile USA (TMUS), Verizon Wireless, Sprint-Nextel, and a composite firm denoted

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[1] Carlton is the David McDaniel Keller Professor of Economics at the Booth School of Business of The University of Chicago and a Senior Managing Director of Compass Lexecon. He has been retained by AT&T in this matter. Israel is a Senior Vice President and Managing Director in the Washington, DC office of Compass Lexecon. He has been retained by Deutsche Telekom and T-Mobile USA in this matter.

[2] *See Applications of AT&T Inc. and Deutsche Telekom AG for Consent to Assign or Transfer of Control of Licenses and Authorizations*, Notice of Ex Parte Meeting, WT Docket No. 11-65, July 15, 2011, available at http://fjallfoss.fcc.gov/ecfs/document/view?id=7021692592.

[3] Our current analysis is based on Version 3.0 of the AT&T Engineering Analysis. This analysis was submitted to the FCC on August 11, 2011.

See Applications of AT&T Inc. and Deutsche Telekom AG for Consent to Assign or Transfer of Control of Licenses and Authorizations, Letter from Richard L. Rosen and Nancy Victory to Marlene Dortch, WT Docket No. 11-65, August 11, 2011, available at http://fjallfoss.fcc.gov/ecfs/document/view?id=7021702191.

[4] *See Applications of AT&T Inc. and Deutsche Telekom AG for Consent to Assign or Transfer of Control of Licenses and Authorizations,* Response to Letter of July 20, 2011 (redacted), filed by AT&T Inc. and Deutsche Telecom AG, WT Docket No. 11-65, July 25, 2011, available at http://fjallfoss.fcc.gov/ecfs/document/view?id=7021697124.

"Other". We further assume that each firm offers a single product, with a price equal to the average revenue per subscriber (ARPU) for each firm.[5]

We specify a linear demand system for mobile telephony:

$$\begin{aligned} s_1 &= a_1 + \sum_{i=1}^{5} b_{1i} p_i \\ &\vdots \qquad\qquad \vdots \\ s_5 &= a_5 + \sum_{i=1}^{5} b_{5i} p_i \end{aligned} , \qquad (1)$$

where s_j represents the quantity demand for firm *j*, p_j represents the ARPU for firm *j*, and a_j and b_{ji} are parameters of the demand system.[6] This can be rewritten in matrix form (where bold indicates vectors or matrices) as:

$$\boldsymbol{s} = \boldsymbol{a} + \boldsymbol{bp}. \qquad (2)$$

To calibrate the parameters of the linear demand system, we first derive own-price elasticity from the Lerner index:

$$\varepsilon_{jj} = -\frac{1}{m_j}, \qquad (3)$$

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5 We obtain estimated ARPUs from Bank of America Global Wireless Matrix 4Q10 (See Attachment 1). Figures are for US Carriers for CY10 (pp. 206-207). For "Other", we compute the ARPU as an average of Leap and MetroPCS. We weight the ARPUs by the number of subscribers.

BoA computes ARPU as follows:

> "The monthly Average Revenue Per User is calculated by dividing Service revenues by the average subscriber base during the quarter. Service revenues include monthly service charges and usage fees, roaming, long distance, and subscriptions to mobile data services. Some operators also include non-service revenues (e.g. equipment sales) in their ARPU calculation, while others exclude revenues from roaming by nonsubscribers or from incoming traffic." (p. 210)

Thus, it is appropriate to view the prices used as including both pre-paid and post-paid subscribers.

We used overall ARPU for several reasons, including: **[Begin T-Mobile USA Highly Confidential Information]**

[End T-Mobile USA Highly Confidential Information]; and ii) we do not have access to ARPUs for new subscribers for all firms in the model.

6 In our calibration, we normalize quantities in each period by the size of each market in 2011. This means that our quantities will sum to 100 in 2011, but as costs and prices change, they generally will not sum to 100.

where m_j is the margin for firm *j.* We assume that the margin for each firm is equal to **[Begin T-Mobile USA Highly Confidential Information]** **[End T-Mobile USA Highly Confidential Information]**.[7] Based on the standard Lerner condition, this implies an own-price elasticity of approximately **[Begin T-Mobile USA Highly Confidential Information]** **[End T-Mobile USA Highly Confidential Information]**.

To derive cross-elasticities, we assume diversion among firms in the industry is proportional to the share of gross additions.[8] This yields the following equation:

[7] Neither AT&T's nor T-Mobile USA's T-Mobile USA's accounting data calculates the margins in the form appropriate for our economic model. **[Begin T-Mobile USA Highly Confidential Information]**

[End T-Mobile USA Highly Confidential Information].

[8] We compute shares of subscribers and gross additions among mobile telephony providers using data from **[Begin AT&T Highly Confidential Information]**

[End AT&T Highly Confidential Information].

We do not rely on porting data because they can provide inaccurate diversion estimates since they are only based on subscribers who port their numbers. This is unlikely to provide a random sample of subscribers.

$$\begin{aligned} \varepsilon_{ij}\big|_{i\neq j} &= \frac{\partial s_i}{\partial p_j}\frac{p_j}{s_i} \\ &= \frac{\frac{\partial s_i}{\partial p_j}}{\frac{\partial s_j}{\partial p_j}}\left(\frac{\partial s_j}{\partial p_j}\frac{p_j}{s_j}\right)\frac{s_j}{s_i} \\ &= \left(\frac{s_i}{1-s_j}\right)\left(\varepsilon_{jj}-\varepsilon_0\right)\frac{s_j}{s_i}. \end{aligned} \tag{4}$$

When computing the cross-price elasticities, we scale the diversion in equation (4) by $\varepsilon_{jj} - \varepsilon_0$, where ε_0 is the industry elasticity.[9] Put differently, we assume that, for a one percent increase in the price of good *j*, ε_0 percent of sales of good *j* are lost to the industry, with $\varepsilon_{jj} - \varepsilon_0$ percent going to other firms in the industry.[10] This captures the fact that other wireless providers may not recapture 100 percent of diverted sales due to a price increase, as well as the fact that subscribers will decrease usage following price increases.

Given an elasticity matrix, the parameters of linear demand system are equivalent to:

$$\boldsymbol{b} = \boldsymbol{\varepsilon}.* \left(\boldsymbol{s}\left(\boldsymbol{p}^{-1}\right)'\right) \tag{5}$$

and

$$\boldsymbol{a} = \boldsymbol{s} - \boldsymbol{b}\boldsymbol{p}. \tag{6}$$

Denote the profit function for firm *f* as:

$$\Pi_{\mathrm{f}} = \sum_{\mathrm{r}\in\mathcal{F}_{\mathrm{f}}} \mathrm{p_r}\,\mathrm{s_r}(\mathrm{p}) - \mathrm{C_f}\big(\mathrm{s_r}(\mathrm{p})\big), \tag{7}$$

where $\mathrm{C_f}(\cdot)$ is the total cost function for firm *f*.[11] We assume that firms choose prices to maximize profits. In equilibrium, prices must satisfy the following first-order conditions:

$$\boldsymbol{s}(\boldsymbol{p}) + \boldsymbol{\Omega}(\boldsymbol{p})(\boldsymbol{p}-\boldsymbol{c}) = \boldsymbol{0}, \tag{8}$$

where

9 In the linear model, elasticity values (own-price, cross-price, and industry) change as one moves along the demand curve (with different prices). So, for example, an assumption that the industry elasticity is -1.0 applies only at the initial equilibrium. However, of the sales lost by firm *j* (following a price increase by firm *j*), the relative share going to other firms in the industry, versus sales lost to the industry, remains the same at different prices.

10 One can assess the sensitivity of the simulation results to the assumed industry elasticity by altering ε_0.

11 We assume that marginal costs are constant, i.e. $\mathrm{C_f}\big(\mathrm{s_f}(\mathrm{p})\big) = \mathrm{c_{0,f}} + \mathrm{c_{1,f}}\mathrm{s_f}$.,

$$\Omega_{rj}(p) = \begin{cases} \dfrac{\partial s_j(p)}{\partial p_r}, & \text{if } \exists f: \{r, j\} \subseteq \mathcal{F}_f \\ 0, & \text{otherwise} \end{cases} \\ = \begin{cases} b_{jr}, & \text{if } \exists f: \{r, j\} \subseteq \mathcal{F}_f \\ 0, & \text{otherwise} \end{cases}. \tag{9}$$

We use Equation (8) along with observed prices and quantities to infer current marginal costs for each firm.[12] We then use results from the AT&T Engineering Analysis to compute the increase in marginal network costs between today and 2014 and 2015.[13, 14] We then use Equation (8) to derive equilibrium but-for prices in 2014 and 2015 given the increased baseline marginal costs. It is straightforward to use these prices along with Equation (2) to compute baseline quantities.

From this baseline state, the merger has three effects:

1. It changes the matrix Ω to reflect the fact that post-merger AT&T and TMUS internalize lost sales that are diverted to the merging partner;
2. It changes marginal costs; and
3. It changes the quality of the two networks.

To simulate post-merger prices and output, we first assume that marginal costs decrease from the stand-alone value to the post-merger value for each firm. We incorporate quality changes into the model by defining the post-merger intercepts of the demand curves as:

$$\boldsymbol{a}^{\boldsymbol{post}} = \boldsymbol{a} + \boldsymbol{b}\left(\boldsymbol{\Delta P}^{\mathbf{quality}}\right). \tag{10}$$

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12 These marginal costs are equivalent to $ARPU\ x\ (1 - m)$, where m is defined in note 7.

13 We assume that integration will be completed by 2014. 201X marginal costs are calculated as today's marginal costs plus the incremental radio-network costs as projected by the Engineering Analysis. Other elements of marginal costs, including subscriber acquisition costs and customer-care costs, are assumed to remain at today's levels.

For simplicity, marginal network costs today are assumed to be zero, meaning that the increase between today and 2014/2015 is given by the value of marginal network costs in the AT&T Engineering Analysis for 2014 or 2015. **[Begin AT&T and T-Mobile USA Highly Confidential Information]**

[End AT&T and T-Mobile USA Highly Confidential Information]. Changing this assumption (allowing positive marginal network costs today) would reduce the cost increase between today and 2014 or 2015, but would not change the key input: the difference between standalone and merged-firm marginal network costs.

The margin excluding CapEx is **[Begin T-Mobile USA Highly Confidential Information]** **[End T-Mobile USA Highly Confidential Information]**.

14 We increase the marginal costs of AT&T and TMUS. **[Begin AT&T and T-Mobile USA Highly Confidential Information]**

[End AT&T and T-Mobile USA Highly Confidential Information].

We describe the computation of $\Delta P^{\text{quality}}$ in more detail in Section 0.

Next, we re-solve the FOC in Equation (8) given the new ownership structure and post-merger costs and quality. Given equilibrium post-merger prices, it is straightforward to compute post-merger output using Equation (2).

The change in output for the combined firm serves as one measure of whether the merger increases consumer welfare: Increases in output indicate that the merger is welfare-enhancing. While the parameters of the economic model are calibrated based on subscriber-level data (e.g., prices and shares are based on number of subscribers), it is most appropriate to interpret the predicted changes in industry output as referring to "equivalent" subscribers or usage. This is because the industry elasticity captures the fact that subscribers may respond to changes in price with changes in usage. Thus, to the extent that the model predicts an increase in output, that can be viewed as an increase in the number of subscribers, an increase in usage by the same number of subscribers, or a blend of the two.

An alternative metric is to compute the change in quality-adjusted prices. We define quality-adjusted prices as:

$$P^{quality-adjusted} = P + \Delta P^{\text{quality}}, \tag{11}$$

where P is the nominal price derived from equation (8) and takes into account the effect of quality on the relative demand curves. In general, changes in output and changes in quality-adjusted prices will have opposite signs. A decrease in quality-adjusted prices also indicates that the merger is welfare enhancing.[15]

3 Overview of Cost Efficiency Estimates Used in Merger Simulation Model

AT&T has developed and submitted a network engineering model that quantifies the cost savings expected to arise from the proposed transaction.[16] We obtain estimates from the AT&T Engineering Analysis of the incremental network CapEx and associated OpEx costs for AT&T and TMUS, both on a stand-alone basis and combined, for 2014-2016. Merger-related savings are based on costs for combined versus stand-alone entities.

15 Although pricing plans are set nationally, there are many elements of local competition and local pricing. That said, one could project a national average of local pricing effects by taking a suitably weighted average of the metro areas that we analyze. Additional study would be needed to determine the appropriate weights.

16 *See Applications of AT&T Inc. and Deutsche Telekom AG for Consent to Assign or Transfer of Control of Licenses and Authorizations*, Letter from Richard L. Rosen and Nancy Victory to Marlene Dortch, WT Docket No. 11-65, August 11, 2011, available at http://fjallfoss.fcc.gov/ecfs/document/view?id=7021702191.

More specifically, for each metropolitan area, the model determines the number of cell splits, oDAS, and iDAS required for each standalone company as well as the merged company.[17] Based on the unit capital and operating costs for each type of facility, the model determines annual costs as annual operating cost plus levelized (over an **[Begin AT&T Highly Confidential Information]** **[End AT&T Highly Confidential Information]** lifespan) capital cost.

With these inputs, the model determines the incremental cost based on year-over-year changes in costs and usage:

$$IncCost_t = \frac{Cost_t - Cost_{t-1}}{Usage_t - Usage_{t-1}}, \tag{12}$$

with usage measured as equivalent minutes of use (eMOUs).

Since our economic model is specified in terms of subscribers rather than eMOUs, we convert incremental cost per eMOU to incremental cost per sub based on usage per sub for the year in question. Because new subscribers sign two-year contracts, we average costs for two years (t and t+1) to compute the incremental cost of adding a subscriber in year(t).

In addition to the cost savings predicted by the AT&T Engineering Analysis, AT&T also indicates there would be additional network synergies (*e.g.* backhaul savings, synergies in the core network). We conservatively omit these other network synergies from our calculations. AT&T has also identified other cost savings via its merger synergy modeling. AT&T projects that these synergies will generate annual savings equal to at least **[Begin AT&T Highly Confidential Information]** **[End AT&T Highly Confidential Information]** of revenue. For simplicity, we conservatively assume marginal cost savings are equal to approximately **[Begin AT&T Highly Confidential Information]** **[End AT&T Highly Confidential Information]** of revenues.[18]

4 Overview of Quality Improvements Used in Merger Simulation Model

We quantify the value of improved quality in four steps. First, we estimate the effect of the merger on two quality metrics: i) signal strength gains; and ii) reduced need for customers with 3G Phones to spend

17 **[Begin AT&T Highly Confidential Information]** **[End AT&T Highly Confidential Information]** in all but relatively isolated cases in the time frame considered by the Engineering Analysis (through 2016). **[Begin AT&T Highly Confidential Information]** **[End AT&T Highly Confidential Information]**.

The transaction does not result in a *net* purchase of spectrum. The merged firm has the same amount of spectrum as the stand-alone firms have combined. Hence, there is no incremental cost of spectrum associated with the proposed transaction, though the combined firm may be able to use existing spectrum more efficiently.

18 Our model also conservatively ignores protections consumers receive from their existing contracts and the fact that TMUS consumers can keep their rate plans when they expire, even when upgrading to a comparable device.

time on 2G network.[19] Second, we determine the extent to which churn decreases as these quality metrics improve. Third, we convert changes in churn into "price equivalents" reflecting the dollar value of quality improvements. Finally, we adjust the relative demand curves to reflect changes in quality.

One source of quality improvements is the increase in signal strength, including from greater cell site density.[20] AT&T estimates that it will add approximately **[Begin AT&T Confidential Information]** **[End AT&T Confidential Information]** incremental TMUS cell sites to its existing network of 55,000 cell sites.[21] The signal strength benefits of this denser cell network are not captured by the AT&T Engineering Analysis, which incorporates only capacity-related benefits, not coverage benefits. Put differently, the Engineering Analysis captures the fact that a denser cell grid uses spectrum more efficiently, lowering network-related costs. The fact that the denser cell grid also means greater signal strength ("more bars") on average for customers is an additional benefit, above and beyond the cost benefits captured by the Engineering Analysis.[22]

On a market-by-market basis, AT&T quantifies improvements in signal strength as follows:[23]

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[19] We have conservatively omitted many other elements of quality improvement likely to flow from the merger including: lower dropped/blocked call rates; throughput increases; and reduced latency and other advantages coming from LTE.

[20] Another source of signal strength gains for TMUS customers is the building penetration benefits of AT&T's 850 MHz spectrum. We have conservatively omitted from this benefit to TMUS customers from our analysis.

[21] *See Applications of AT&T Inc. and Deutsche Telekom AG for Consent to Assign or Transfer of Control of Licenses and Authorizations*, Reply Declaration of William Hogg, WT Docket No. 11-65, June 9, 2011, ¶ 34.

[22] A simple example may further illustrate the point. Suppose two standalone networks each need 300 cell towers to serve network load, so the combined number of cell towers is 600. Because of the efficiencies of combining the networks, suppose the combined firm needs only 400 towers to serve all customers of both firms. This means that the network-related costs of the combined firm are lower (per subscriber) than the costs of the standalone firms. At the same time, it is *also* true that all subscribers of both standalone firms now have access t o a 400 tower cell grid, rather than a 300 tower cell grid, increasing average signal strength. And there is no capacity concern with loading all the subscribers of both firms on 400 towers, as the network engineering model is built to make sure there is sufficient capacity in each network to maintain capacity-related quality targets.

[23] AT&T has quantified this improvement for four metro areas included in our sample: **[Begin AT&T Highly Confidential Information]** **[End AT&T Highly Confidential Information]**. The posited improvement in signal quality is derived from an integration analysis performed by AT&T network engineers to determine which sites will be used in the post-merger network. This analysis is separate from the Engineering Analysis. The integration analysis is very labor intensive. As a result, we do not have data for all metro areas evaluated in the Engineering Analysis.

We use estimates for specific metro areas where applicable. For metro areas where we do not have data, we apply the average signal strength improvement taken across the four metro areas for which we do have data.

[Begin AT&T Highly Confidential Information]

[End AT&T Highly Confidential Information].

[Begin AT&T Highly Confidential Information]

[24] **[End AT&T Highly Confidential Information]**

A second source of quality improvement is the reduction in number of calls for which 3G-capable handsets must operate on a 2G network. Since AT&T has a more extensive 3G network than TMUS, we compute this benefit for current TMUS subscribers.[25] To quantify this benefit, we first compare, on a market-by-market basis, estimates of the average percent of calls on 3G handsets conducted on 2G network for both AT&T and TMUS.[26] We then assume that TMUS' average will improve to AT&T's average as a result of the merger. Next, we translate the reduction in percentage of 3G on 2G into a reduction in total churn **[Begin AT&T Highly Confidential Information]** **[End AT&T Highly Confidential Information]**.[27]

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[24] **[Begin AT&T Highly Confidential Information]** **[End AT&T Highly Confidential Information]**.

[Begin AT&T and T-Mobile USA Highly Confidential Information] **[End AT&T and T-Mobile USA Highly Confidential Information]**.

[25] Note that there will also be a benefit to AT&T subscribers to the extent that standalone capacity constraints, which are relieved by the merger, lead some customers with 3G phones to be bumped down to the 2G networks. Our calculations conservatively omit this benefit to AT&T subscribers.

To receive this benefit, TMUS 3G subscribers must have phones that can access the AT&T 850/1900 spectrum. We understand that TMUS projections indicate that **[Begin T-Mobile USA Highly Confidential Information]** **[End T-Mobile USA Highly Confidential Information]** of TMUS subscribers will have such phones by Q2 2012. We also understand that **[Begin T-Mobile USA Highly Confidential Information]** **[End T-Mobile USA Highly Confidential Information]** TMUS subscribers are expected to have such phones by 2014.

[26] See **[Begin AT&T and T-Mobile USA Highly Confidential Information]** **[End AT&T and T-Mobile USA Highly Confidential Information]**.

[27] See **[Begin AT&T Highly Confidential Information]** **[End AT&T Highly Confidential Information]**.

Finally, we apply the computed churn reductions to the portion of the TMUS subscriber base with 3G-capable handsets.[28]

In order to incorporate improvements in quality into the merger simulation model, we must convert reductions in churn into "price equivalents." Improvements in network quality shift the demand curve facing the merged network outward, reducing the quality-adjusted price for any given nominal price. **[Begin T-Mobile USA Highly Confidential Information]**

[End T-Mobile USA Highly Confidential Information], we base calculations of equivalent price reduction on changes in churn.

In particular, let *ΔX/X* denote the percentage change in churn induced by a quality increase. The value of the quality improvement can be determined by asking what percentage price decrease would be necessary to induce the same percentage decrease in churn, holding the quality constant:

$$\frac{\Delta P}{P} \times \varepsilon_{churn} = \frac{\Delta X}{X}. \tag{13}$$

Therefore, an increase in quality raises consumer welfare by the same amount as would a price reduction equal to:[29,30]

$$\Delta P^{\text{quality}} = P \times \frac{1}{\varepsilon_{churn}} \times \frac{\Delta X}{X}. \tag{14}$$

[Begin T-Mobile USA Highly Confidential Information]

[31]

[End T-Mobile USA Highly Confidential Information]. We conservatively base our analysis on an assumed elasticity of -1.0. This is conservative because a larger price elasticity (in absolute value) implies smaller price equivalents for quality improvements. **[Begin T-Mobile USA Highly Confidential Information]**

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28 Approximately **[Begin T-Mobile USA Highly Confidential Information]** **[End T-Mobile USA Highly Confidential Information]** of TMUS calls are made on 3G-capable handsets in its UMTS footprint. See **[Begin T-Mobile USA Highly Confidential Information]** **[End T-Mobile USA Highly Confidential Information]**.

29 Economists at the Department of Justice have applied similar techniques to evaluate the consumer welfare increases arising from airline mergers. See Ken Heyer, Carl Shapiro, and Jeffrey Wilder (2009), "The Year in Review: Economics at the Antitrust Division, 2008–2009," *Review Industrial Organization*, at 7.

30 Equation (8) shows how we incorporate equivalent price changes into the merger simulation model.

31 See **[Begin T-Mobile USA Highly Confidential Information]** **[End T-Mobile USA Highly Confidential Information]**.

[End T-Mobile USA Highly Confidential Information].