August 31, 2016

Ex Parte

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street SW
Washington, DC  20554

Re:  Special Access for Price Cap Local Exchange Carriers, WC Docket No. 05-25, RM-10593; Investigation of Certain Price Cap Local Exchange Carrier Business Data Services Tariff Pricing Plans, WC Docket No. 15-247; Business Data Services in an Internet Protocol Environment, WC Docket No. 16-143

Dear Ms. Dortch:

Sprint Corporation (“Sprint”) hereby supplements the record in the above-captioned proceedings with the attached Declaration of Chris Frentrup, Senior Economist at Sprint and former Federal Communications Commission (“FCC” or “Commission”) economist, and David E.M. Sappington, former FCC Chief Economist (“Declaration”).

Sprint and its consultants have reviewed various publicly-available sources of data that could potentially be used to calculate an appropriate Total Factor Productivity for Business Data Services (“BDS”) for the purposes of establishing a one-time reduction to existing price caps for TDM services and a going-forward X-factor for all BDS. As a result of this review, Dr. Frentrup and Dr. Sappington have determined that the Connect America Cost Model (“CACM”) data track the input price growth rates for BDS more closely than other available data. As explained in the attached Declaration, Dr. Frentrup and Dr. Sappington have made several enhancements to the Commission’s analysis that employed the CACM to derive estimates of the rate at which BDS costs have increased in recent years and are likely to increase in the near future in order to determine the appropriate parameters for the upcoming price cap regulation of BDS. With these suggested enhancements, Drs. Frentrup and Sappington believe the Commission can use the CACM-based calculations to derive appropriate price adjustments. In addition, Drs. Frentrup and Sappington’s calculations support the PCI one-time reduction and going-forward X-factor proposed in the Verizon-INCOMPAS framework.

Pursuant to the Commission’s rules, I have filed a copy of this for inclusion in the public record of the above-referenced proceedings. Please contact the undersigned with any questions.

Sincerely,

Jennifer Bagg
Counsel to Sprint Corporation

Attachment
In the Matter of

Business Data Services in an Internet Protocol Environment

Investigation of Certain Price Cap Local Exchange Carrier Business Data Services Tariff Pricing Plans

Special Access for Price Cap Local Exchange Carriers

AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services

WC Docket No. 16-143
WC Docket No. 15-247
WC Docket No. 05-25
RM-10593

DECLARATION OF

CHRIS FRENTRUP AND DAVID E.M. SAPPINGTON

August 31, 2016
I. INTRODUCTION

A. Qualifications.

1. Our qualifications appear in previous filings in this proceeding.1

B. Purpose of this Declaration.

2. The Federal Communications Commission (“the Commission”) has identified three possible approaches to determining appropriate parameters for the upcoming price cap regulation of business data services delivered via time division multiplexing (“BDS”).2 One of these approaches involves using the Connect America Cost Model (“CACM”) to derive estimates of the rate at which BDS costs have been increasing in recent years and are likely to increase in the near future.3

3. The purpose of this declaration is to enhance the Commission’s analysis that employs the CACM and to use this enhanced analysis to identify appropriate parameters for the upcoming BDS price cap regulation regime. Our enhanced analysis explicitly accounts for the economic depreciation of capital inputs and separates the labor and capital components of plant-specific capital expenditures. It also incorporates operating expenses that are not plant-specific as well as expenses that are non-plant related.4 Our analysis

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3 Id. ¶¶ 408-11.

4 Non-plant related costs are primarily retail service functions—marketing, sales, and customer service.
implies that an initial reduction in the price cap index (“PCI”) of at least 17.1% and an initial X-factor of at least 3.94% are appropriate.

C. Outline of this Declaration.

4. This declaration proceeds as follows. Section II reviews the principles that underlie the identification of an appropriate initial PCI adjustment and X-factor. Such identification relies heavily upon the specification of relevant total factor productivity (“TFP”) and input price growth rates. Section III identifies our choice of a TFP growth rate and explains how we enhance the Commission’s analysis to estimate the relevant BDS input price growth rate. Section IV presents the initial PCI reduction and X-factor that arise from our analysis. Section V concludes, reiterating the merits of an initial PCI reduction of at least 17.1% and an initial X-factor of at least 3.94%.

II. THE PRINCIPLES OF PRICE CAP REGULATION

5. We begin by reviewing the principles that underlie the identification of an appropriate PCI adjustment at the start of a new price cap regulation regime and an appropriate X-factor. Price cap regulation is based upon the following important conclusion: if the prices that a firm charges for its products are initially set to secure a normal profit, then the firm will continue to earn a normal profit if its prices increase at a rate equal to the difference between the rates at which its input prices rise and its productivity increases.

6. To state this conclusion formally, let \( \dot{P} \) denote the rate at which the firm’s prices increase. Also let \( \dot{T} \) denote the rate at which the firm’s TFP increases, and let \( \dot{W} \) denote the rate at

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5 A normal profit is the minimum level of profit required to ensure that a supplier can continue to attract capital on reasonable terms and, as a result, will continue to serve the market.

6 See Sappington-Zarakas Declaration, Appendix A.
which the firm’s input prices rise. Then, if the firm’s prices are initially set to allow the firm to secure a normal profit, the firm will continue to earn a normal profit if its prices increase at the rate:

\[ \dot{P} = \dot{W} - \dot{T} \]  

(1)

7. Equation (1) indicates how the PCI should be adjusted at the outset of the new regime for regulating the prices of BDS. If the PCI that prevailed at the conclusion of the CALLS plan in 2005 limited the price cap local exchange carriers (“LECs”) to a normal profit on their supply of BDS, then the adjustment specified in equation (1) would allow these LECs to earn a corresponding normal profit at the start of the new price cap regime (which presumably will take place by the start of 2017). Specifically, the PCI (and thus the average level of the prices charged for BDS) should be reduced by the difference between the extent to which the price cap LECs’ input prices have increased and their TFP has increased in the provision of BDS between 2005 and 2016.7

8. The X-factor in a price cap regulation plan specifies the rate at which the prices of the regulated firm’s products must decline, on average, after adjusting for inflation. Formally:

\[ \dot{P} = I^E - X \]  

(2)

where \( I^E \) denotes the output price inflation rate in the economy and \( X \) denotes the X-factor.8 If the regulated firm’s prices are initially set to permit the firm to earn a normal profit on their supply of BDS in 2005, then a more pronounced reduction in the PCI is required to ensure that the index permits only a normal profit at the start of the upcoming price cap regime. See discussion infra Section IV.

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7 If the price cap LECs enjoyed above-normal profit on their supply of BDS in 2005, then a more pronounced reduction in the PCI is required to ensure that the index permits only a normal profit at the start of the upcoming price cap regime. See discussion infra Section IV.

8 Recall that \( \dot{P} \) represents the rate of increase of the prices that the regulated firm charges for its products.
profit, then an X-factor that is expected to permit the firm to continue to earn a normal profit under price cap regulation is:

\[ X = I - \dot{W}^e + \dot{T}^e \]  

(3)

where \( I \) reflects the rate of increase in the gross domestic product price index (“GDP-PI”), \( \dot{W}^e \) denotes the rate at which the firm’s input prices are expected to increase, and \( \dot{T}^e \) denotes the rate at which the firm’s TFP is expected to increase during the price cap regime.\(^9\)

III. ESTIMATING TFP AND INPUT PRICE GROWTH RATES

9. As equations (1) – (3) demonstrate, estimates of relevant TFP and input price growth rates are critical in identifying an appropriate initial PCI adjustment and X-factor for the upcoming price cap regulation regime. The data required to measure recent BDS-specific TFP and input price growth rates are not publicly available. Therefore, proxies for these rates must be secured.

A. Estimating TFP Growth Rates

10. Several parties in this proceeding recommend the use of data prepared by the U.S. Bureau

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of Economic Analysis (“BEA”) and the U.S. Bureau of Labor Statistics (“BLS”)\textsuperscript{11} to derive proxies for recent BDS TFP growth rates.\textsuperscript{12} These data pertain to the combined broadcasting and telecommunications (including both wireless and wireline) industries, and so have a much broader scope than the BDS industry, which is the focus of the present proceeding. However, TFP data that are specific to BDS or that seem more likely to closely track BDS TFP are not available. Consequently, for the present analysis, we employ the BEA/BLS data to derive TFP growth rates in the combined broadcasting and telecommunications industries and employ these growth rates as proxies for corresponding BDS TFP growth rates.

B. The Merits of Employing the CACM

\textsuperscript{11} The BEA/BLS data admit calculations of input price growth rates for the combined broadcasting and telecommunications industries. However, input price growth rates in these industries likely differ from BDS input price growth rates. The Commission has employed the CACM to calculate input price growth rates in the supply of residential broadband and voice services using a fiber-to-the-premise network.\textsuperscript{13} These input price growth rates may not parallel BDS input price growth rates exactly. However, they reflect input price growth rates for a wireline network rather than for the entire broadcasting and telecommunications industries combined, and so are likely to better

\footnotesize

\textsuperscript{12} See Meitzen-Schoech Report; Schankerman-Régibeau Report; Reply Comments of Mark E. Meitzen, Ph.D. and Philip E. Schoech, Ph.D., WC Docket Nos. 16-143, 15-247, 05-25, RM-10593 (filed Aug. 9, 2016) (“Meitzen-Schoech Reply”).

\textsuperscript{13} BDS Order & FNPRM ¶¶ 408-11.
reflect BDS input price growth rates than are the corresponding rates calculated using BEA/BLS data. As the Commission has noted, “there are no reasons to think that either (1) the underlying cost categories of the CACM or (2) the rates of change in input prices of these cost categories would be significantly different for business data services than for residential data services.”

12. Parties in this proceeding have advocated using BEA/BLS data rather than the CACM to inform estimates of BDS input price growth rates in part because doing so would provide a consistent methodology for calculating TFP and input price growth rates. Although the calculations would be consistent, they would pertain to the combined broadcasting and telecommunications industries, not the BDS industry, and in this sense could well be “consistently incorrect” for the present purpose. We are compelled to use the BEA/BLS TFP data because there is no superior alternative that is publicly available. In contrast, the CACM data employed by the Commission – which pertain to the wireline telecommunications sector rather than the broad combined broadcasting and telecommunications industries – provide a viable alternative to the BEA/BLS input price growth data.

C. Enhancing the Commission’s Estimates of Input Price Growth Rates

13. Questions have been raised about the manner in which capital equipment is treated in the Commission’s estimate of input price growth rates using the CACM. Specifically, it has been noted that the Commission’s CACM-based estimates of cost increases for capital equipment “appear simply to be estimates of the changes in initial purchase prices for

14 Id. ¶ 409.
15 Meitzen-Schoech Reply at 8.
various pieces of new capital equipment” and do not account for “economic depreciation of these capital goods resulting from the aging of assets and declines in their technological efficiency.”

14. We have enhanced the Commission’s calculations in three key respects. First, we account explicitly for the depreciation of capital equipment, introducing different depreciation rates for different types of plant investment. Second, we account for operating expenses attributable to plant investment, applying cost shares that pertain to these expenses. Third, we account for operating expenses that are unrelated to plant investment, again applying cost shares that pertain to these expenses.

15. The details of our analysis appear in the Appendix to this declaration. The analysis provides estimates of the annual input price growth rate in the supply of residential broadband services that are between −0.76% and 0.58%. We employ the mid-point of

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16 *Id.* at 7. Questions have also been raised about the Commission’s use of data produced by the Federal Reserve Bank of San Francisco to measure TFP growth rates when it employs the CACM to estimate input price growth rates. See, e.g., Meitzen-Schoech Report at 13. Because these TFP data pertain to an even broader set of industries than the broadcasting and telecommunications industries, we employ the identified BEA/BLS data to measure TFP growth rates.

17 The corresponding input price growth rates estimated by the Commission range from −1.16% to 0.43%. See Sappington-Zarakas Declaration, Table B1. The range of estimates reflects variation in the underlying estimates of changes in real estate, electronics, and labor costs (as explained in the Appendix). In addition, we note that by including non-plant related expenses in our analysis, we increase estimated input price growth rates and thereby reduce the initial PCI reduction and X-factor. If the analysis were confined to input price changes for plant-related capital cost and operating expense categories (i.e., the cost categories directly relevant to the provision of wholesale BDS), estimated input price growth rates would range from -1.17% to 0.30%.
this range (−0.09%) as our estimate of the annual rate at which BDS input prices change.\textsuperscript{18}

IV. IMPLICATIONS FOR THE PCI ADJUSTMENT AND X-FACTOR

A. The Initial PCI Adjustment

To calculate the PCI adjustment that should be implemented at the start of the new price cap regulation regime, we employ equation (1) and estimate the extent to which BDS input prices have increased more rapidly than BDS TFP between 2005 and 2016. Recall that our analysis using the CACM reveals that input prices decline at an annual rate of 0.09%. The BEA/BLS data reveal that for the period 2005–2014, TFP in the combined broadcasting and telecommunications industries increased at an annual rate of 1.60%.\textsuperscript{19} This annual TFP growth rate (1.60%) exceeds the identified annual input price growth rate (− 0.09%) by 1.69%. This annual 1.69% differential corresponds to a 17.1% difference between TFP growth and input price growth over an eleven-year period (2005–2016).\textsuperscript{20} Therefore, as equation (1) indicates, the current PCI should be reduced by 17.1% at the start of the new price cap regulation regime.

\textsuperscript{18} We will also explain how our findings change if the lower- or the upper-end of the identified range of estimated input price growth rates is employed.

\textsuperscript{19} BEA/BLS data for 2015 and 2016 are not yet available. Consequently, we employ all of the data between 2005 and 2016 that are available to estimate a compound annual growth rate for this period. The TFP index increases from 90.216 in 2005 to 104.073 in 2014. U.S. Dep’t of Commerce, Bureau of Econ. Analysis, Nonmanufacturing Sectors and NIPA–level Nonmanufacturing Industries KLEMS Multifactor Productivity Tables by Industry, “Multifactor Productivity and Related KLEMS Measures from the NIPA Industry Database, 1987 to 2014, Broadcasting and Telecommunications (NAICS 515, 517),” http://www.bls.gov/mfp/mprdload.htm#Multifactor Productivity Tables (“BLS TFP Data”). The corresponding compound annual growth rate during the nine-year period is \((104.073/90.216)^{1/9} − 1 = 0.0160\).

\textsuperscript{20} \(0.171 = 1 − (1 − .0169)^{11}\).
17. Table 1 summarizes this calculation. The table also identifies the PCI reductions that would be appropriate if the annual input price growth rate reflected the identified low estimate (−0.76%) or the high estimate (0.58%) rather than the midpoint (−0.09%).

<table>
<thead>
<tr>
<th></th>
<th>TFP Growth Rate</th>
<th>Input Price Growth Rate</th>
<th>Annual Difference</th>
<th>PCI Adjustment²¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low</strong></td>
<td>1.60%</td>
<td>− 0.76%</td>
<td>− 2.36%</td>
<td>− 23.1%</td>
</tr>
<tr>
<td><strong>Midpoint</strong></td>
<td>1.60%</td>
<td>− 0.09%</td>
<td>− 1.69</td>
<td>− 17.1%</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>1.60%</td>
<td>0.58%</td>
<td>− 1.02%</td>
<td>− 10.7%</td>
</tr>
</tbody>
</table>

Table 1. Calculation of the PCI Adjustment

18. The PCI reductions identified in Table 1 presume that the price cap LECs were earning a normal profit at the end of the CALLS plan in 2005. In fact, evidence in the record suggests that the LECs were enjoying above-normal profit at this time. Specifically, Susan Gately employed BDS-specific data to demonstrate that the price cap LECs likely earned substantial above-normal profit on their supply of BDS between 2000 and 2004.²² Ms. Gately’s findings imply that PCI reductions in excess of those identified in Table 1 may well be appropriate to ensure that the price cap LECS are not afforded above-normal profit on an ongoing basis throughout the upcoming price cap regulation regime.

B. The X-factor

19. As equation (3) indicates, the appropriate specification of the X-factor requires an

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estimate of the TFP growth rate that will prevail during the upcoming phase of price cap regulation. Conceivably, one might employ the BEA/BLS TFP data from 2005 – 2014 to inform this estimate. However, this time period includes the Great Recession, which was the longest and deepest recession that the U.S. has experienced since the end of World War II. Consequently, TFP growth during this time period may well understate the TFP growth that is likely to prevail during the upcoming phase of price cap regulation. A longer time series of TFP data seems likely to provide a better estimate of TFP growth in the near future. Consequently, we employ the BEA/BLS TFP data from the time period between 1997 and 2014 to estimate future expected annual BDS TFP growth. This estimate of \( \dot{T}^e \) in equation (3) is 1.88%.  

20. The GDP-PI increased at an annual rate of 1.97% between 1997 and 2014. We use the identified \(-0.09\%\) growth rate as the estimate of the expected BDS input price growth rate during the initial phase of the upcoming price cap regulation regime (\( \dot{W}^e \) in equation (3)). Therefore, from equation (3), the appropriate X-factor is:

\[
X = 1.97\% - (-0.09\%) + 1.88\% = 3.94\%.
\]

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24 1997 is the earliest year that the Commission considers in the three approaches that it introduces for calculating PCI adjustments and X-factors. BDS Order & FNPRM ¶¶ 407-11.

25 The TFP index increases from 75.844 in 1997 to 104.073 in 2014. BLS TFP Data. The corresponding compound annual growth rate during the seventeen-year period is \((104.073/75.844)^{1/17} - 1 = 0.0188\).

26 The GDP-PI index increases from 78.493 on 10/1/1997 to 109.321 on 10/1/2014. GDP-PI Data. The corresponding compound annual growth rate during the seventeen-year period is \((109.321/78.493)^{1/17} - 1 = 0.0197\).
21. Table 2 summarizes these calculations. The table also identifies the PCI reductions and X-factors that would arise from using the low end or the high end of the estimated range of input price growth rates rather than the midpoint of this range.\textsuperscript{27}

<table>
<thead>
<tr>
<th>CACM Input Price Growth Rate</th>
<th>TFP Growth Rate ([1])</th>
<th>Input Price Growth Rate ([2])</th>
<th>GDP-PI Growth Rate ([3])</th>
<th>X-Factor ([3] - [2] + [1])</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1.88%</td>
<td>− 0.76%</td>
<td>1.97%</td>
<td>4.61%</td>
</tr>
<tr>
<td>Midpoint</td>
<td>1.88%</td>
<td>− 0.09%</td>
<td>1.97%</td>
<td>3.94%</td>
</tr>
<tr>
<td>High</td>
<td>1.88%</td>
<td>0.58%</td>
<td>1.97%</td>
<td>3.27%</td>
</tr>
</tbody>
</table>

Table 2. Calculation of the X-factor

IV. CONCLUSIONS

22. We have enhanced the Commission’s analysis that employs the CACM to identify appropriate parameters for the upcoming BDS price cap regulation regime. Our enhanced analysis permits different assets to depreciate at different rates, separates the labor and capital components of plant-specific capital expenditures, and accounts for operating expenses that are not plant-specific. Our analysis implies that the PCI should be reduced by at least 17.1\% at the start of the price cap regime and an initial X-factor of at least 3.94\% should be implemented.

\textsuperscript{27} If data from 2005 – 2014 were employed to calculate \(\dot{I}\) and \(\dot{T}^e\) in equation (3) and if the estimated input price growth rate remained at −0.09, the resulting X-factor would be \(X = 1.89\% - (-0.09\%) + 1.60\% = 3.58\%\). The corresponding X-factors would be: (i) 4.25\% if the low estimate of the input price growth rate (−0.76\%) were employed along with 2005 – 2014 data; and (ii) 2.91\% if the high estimate of the input price growth rate (0.58\%) were employed along with 2005 – 2014 data.
Technical Appendix

I. Introduction

1. This technical appendix explains the derivation of input price growth rates based on data applied in the Connect America Cost Model (“CACM”) and related sources. These data provide categories of the costs as well as the percentage of total network investment cost accounted for by each cost category. The data also provide estimates of annual price changes for each cost category. The estimated annual price change for the inputs used in building a wireline network is the sum of the price changes for each individual cost category weighted by their percentage cost shares.

2. The annual price change data from the CACM are directly applicable to estimating the annual changes in the input prices used in providing wireline services. The costs of providing service involve four types of costs (“cost areas”) that are incurred annually: 1) the cost of using the network, as measured by an annual capital cost associated with the cost of capital and depreciation of the network plant (“capital cost”); 2) plant-specific operating expenses (“plant-specific opex”); 3) expenses related to the network plant but not directly attributable to a specific plant component (“plant-non-specific operating expenses”); and 4) expenses incurred in running a wireline business but not directly related to the wireline plant (“non-plant-based operating expenses”).

3. The inputs used in providing wireline service are similar to those used in building a wireline network. The CACM was developed by CostQuest in response to requirements associated with the USF/ICC Transformation Order. The model itself includes numerous spreadsheets including input tables. CostQuest has also provided additional information through blog postings. Finally, the CACM was reviewed by Marvin Sirbu, David Reed, and Christiaan Hogendorn (i.e., a peer review). The FCC’s “Response to Professor Hogendorn” also provides data concerning cost categories, cost shares, and “low estimate” and “high estimate” annual price changes.
wireline network. The percentage shares of inputs for providing wireline services versus building a wireline network may differ. We explain the adjustment of input shares to account for these differences later in this technical appendix. Also, as explained further below, the costs associated with three cost areas (capital cost, plant-specific opex, and plant-non-specific opex) involve the use of underlying plant investment, which is made up of long-lived assets. We make adjustments to allow only the portion of assets that are consumed in a given year to be reflected in estimated annual price changes by adjusting for the economic lives of the assets.

4. This technical appendix includes five additional sections. We introduce data from the CACM sources that we use as inputs into our calculations of annual price changes in Section II. We derive the capital cost of providing wireline service (i.e., associated cost of capital and depreciation) in Section III. We explain adjustment for the economic lives of assets in Section IV, and also calculate the annual price changes for three cost areas: capital cost; plant-specific opex; and plant-non-specific opex. We explain the derivation of annual price changes for non-plant based opex in Section V. In Section VI, we identify the estimated annual input price changes, which range from -0.76% to +0.58%.

II. Data and Inputs

5. **Capital Expenditures.** The CACM provides data on ten categories of capital expenditure ("capex") inputs, as well as shares of total capital expenditures and associated annual changes for each category. These data are included in the input tabs of
the CACM\textsuperscript{2} and in documentation concerning the results of the peer review of CACM Version 2, summarized by the FCC.\textsuperscript{3}

6. The ten cost categories are labor, fiber, poles, conduit, drop, optical network terminals ("ONT"), fiber pedestals, splitters, electronics, and land/buildings. The capital expenditure cost categories and cost shares are as specified by the FCC in its \textit{BDS Order \\& FNPRM} in Appendix C, Table 2.

7. We use the annual price changes provided by the FCC in Appendix C in Tables 3 and 4 of the \textit{BDS Order \\& FNPRM} for labor and land/buildings, respectively. We use the annual price changes for fiber, poles, conduit, drop, ONT, fiber pedestals, splitters, and electronics provided in the FCC’s Response to Professor Hogendorn at page 3. Both sources (the FCC’s Appendix C of its \textit{BDS Order \\& FNPRM} and its Response to Professor Hogendorn) provide low-value and high-value estimates of annual price changes.\textsuperscript{4}

8. The categories of capital expenditure cost inputs, cost shares, and annual price changes are summarized in Table 1.

\textsuperscript{2} CACM input data are composed of 13 files available at https://www.fcc.gov/bureaus/web/Connect_America_Cost_Model_v4.1.1Default%20Inputs.zip. Opex input data are provided in the “Opex V8.xlsx” file.

\textsuperscript{3} FCC, Response to Professor Hogendorn, 3 (rel. July 25, 2013) (“Response to Professor Hogendorn”).

\textsuperscript{4} The low-value and high-value estimates coincide for fiber, poles, conduit, drop, ONT, fiber pedestals and splitters. \textit{Id.} at 3.
Table 1: Shares and Annual Price Changes by Category of Capital Expenditure

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost Share</th>
<th>Annual Price Change</th>
<th>Low Estimate</th>
<th>High Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>[a] 59.60%</td>
<td>2.47%</td>
<td>2.77%</td>
<td></td>
</tr>
<tr>
<td>Fiber</td>
<td>[b] 2.90%</td>
<td>-5.00%</td>
<td>-5.00%</td>
<td></td>
</tr>
<tr>
<td>Poles</td>
<td>[c] 1.20%</td>
<td>2.00%</td>
<td>2.00%</td>
<td></td>
</tr>
<tr>
<td>Conduit</td>
<td>[d] 2.20%</td>
<td>0.00%</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Drop</td>
<td>[e] 1.40%</td>
<td>-2.00%</td>
<td>-2.00%</td>
<td></td>
</tr>
<tr>
<td>ONT</td>
<td>[f] 9.10%</td>
<td>-5.00%</td>
<td>-5.00%</td>
<td></td>
</tr>
<tr>
<td>Fiber pedestals</td>
<td>[g] 2.70%</td>
<td>-5.00%</td>
<td>-5.00%</td>
<td></td>
</tr>
<tr>
<td>Splitters</td>
<td>[h] 5.70%</td>
<td>-5.00%</td>
<td>-5.00%</td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>[i] 6.40%</td>
<td>-30.00%</td>
<td>-10.00%</td>
<td></td>
</tr>
<tr>
<td>Land/Buildings</td>
<td>[j] 8.70%</td>
<td>3.56%</td>
<td>5.07%</td>
<td></td>
</tr>
</tbody>
</table>

Sources and Notes:
[1][a]-[j]: BDS Order & FNPRM, Appendix C, Table 2
[2]-[3][a]: BDS Order & FNPRM, Appendix C, Table 3
[2]-[3][b]-[i]: Response to Professor Hogendorn at 3
[2]-[3][j]: BDS Order & FNPRM, Appendix C, Table 4

9. **Economic Lives.** Economic lives for each cost category are taken from a CACM input table that provides the life (in years) for each type of capital expenditure. Economic lives listed in the CACM input table were assigned to the nine non-labor categories of capital expenditure following the mapping (from the cost elements included in the CACM to the cost categories evaluated in the peer review process) provided by CostQuest. The economic life for “switching” was applied to the ONT and electronics capital cost categories. The economic lives for the nine (non-labor) categories of capital

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5 FCC, workbook “ACF8 50 V6.xlsx,” tab “Inputs,”
https://www.fcc.gov/bureaus/wcb/Connect_America_Cost_Model_v4.1.1Default%20Inputs.zip ("Workbook ACF8 50 V6").

6 CostQuest, workbook “breakout-gm-and-mapping.xlsx,” tab “Mapping Page 10 to ACF,”
expenditure are summarized in Table 2. We derive an economic life of capitalized labor later in this appendix.

**Table 2: Economic Lives by (Non-Labor) Category of Capital Expenditure**

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Economic Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber</td>
<td>25.00</td>
</tr>
<tr>
<td>Poles</td>
<td>25.00</td>
</tr>
<tr>
<td>Conduit</td>
<td>50.00</td>
</tr>
<tr>
<td>Drop</td>
<td>25.00</td>
</tr>
<tr>
<td>ONT</td>
<td>12.00</td>
</tr>
<tr>
<td>Fiber pedestals</td>
<td>25.00</td>
</tr>
<tr>
<td>Splitters</td>
<td>25.00</td>
</tr>
<tr>
<td>Electronics</td>
<td>12.00</td>
</tr>
<tr>
<td>Land/Buildings</td>
<td>40.00</td>
</tr>
</tbody>
</table>

Sources and Notes:
[1]: ACF8 50 V6

10. **Labor Intensity.** The capitalized labor cost associated with each non-labor capital cost category can be computed based on the intensity of labor involved in deploying the assets specified in the CACM. The values for intensity of labor are reported in the CostQuest documentation of the CACM model, and represent the portion of capitalized labor costs that are associated with each type of equipment.\(^7\) Table 3 summarizes the intensity of labor used in the nine non-labor categories of capital expenditure. The labor share of total capital expense associated with a cost category is equal to the overall labor capital expense share (59.60%, from Table 1) multiplied by the labor intensity in the cost category. For example, the labor expense share (of total plant investment) associated

with fiber is 59.60% x 32.71% = 19.50%.

Table 3: Labor Intensity by (Non-Labor) Category of Capital Expenditure

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Labor Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber</td>
<td>32.71%</td>
</tr>
<tr>
<td>Poles</td>
<td>3.91%</td>
</tr>
<tr>
<td>Conduit</td>
<td>9.37%</td>
</tr>
<tr>
<td>Drop</td>
<td>2.79%</td>
</tr>
<tr>
<td>ONT</td>
<td>18.78%</td>
</tr>
<tr>
<td>Fiber pedestals</td>
<td>4.92%</td>
</tr>
<tr>
<td>Splitters</td>
<td>10.07%</td>
</tr>
<tr>
<td>Electronics</td>
<td>8.71%</td>
</tr>
<tr>
<td>Land/Buildings</td>
<td>8.75%</td>
</tr>
</tbody>
</table>

Sources and Notes:
[1]: Page 10 Update

11. **Economic Life of Capitalized Labor.** The economic life of capitalized labor is computed as a weighted average of the reported lives for the nine non-labor categories of capital expense, where the weights are the associated labor intensities. This calculation yields a weighted average value for the economic life of capitalized labor equal to 25.08 years.

12. **Operating Expenses.** Operating and maintenance expenses (“opex” or “expenses”) are represented as a percentage of expenditure made in the related capital cost category, following the approach and data used in the CACM. The CACM input data provide a breakdown of these operating expenses and their estimated values as a function of the relevant plant investment, the size of the network (number of loops), and the
population/business density of the geography covered.⁸ We have aggregated the available information for the largest network size in a “large urban” geography.⁹

13. **Plant-Specific Opex.** Annual opex for the plant-specific categories cable and wire (which include subcategories for aerial and underground fiber optic lines, poles, and conduit systems), circuit equipment/transport, and switching are estimated as a percentage of capital expenditures in the associated capital investment categories. The derivation of annual operating expenses (broken down by material-based and labor-based opex) for plant-specific cable and wire, circuit equipment/transport, and switching is shown in Table 4. The operating expenses for this cost area represent 2.78% of total capital expenditures.

---


⁹ CACM input data in Workbook Opex V8.xlsx includes “Large Urban,” “Large Suburban,” and “Large Rural” company options that specify opex costs in terms of a percentage of investment areas (e.g., annual pole opex is specified as a percentage of pole investment). The input table also provides factors to adjust opex for smaller-sized companies. The annual input prices calculated in this technical appendix forego any size adjustment, and are therefore indicative of large wireline companies. Review of CACM inputs indicates that the opex percentages of plant investments are the same for Large Urban and Large Suburban; we select “Large Urban” as representative of the large companies under review. Alternatively, use of “Large Rural” leads to a higher value for total plant-specific opex and a lower value for non-plant-based opex, which would result in lower combined (across cost areas) annual input price changes than is the case under the Large Urban or Large Suburban options.
Table 4: Plant-Specific Operating Expenses as Share of Total Capital Investment

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>FO Aerial Cable Investment</td>
<td>Multiple</td>
<td>3.76%</td>
<td>12.70%</td>
<td>30.00%</td>
<td>0.14%</td>
<td>30.09%</td>
<td>0.34%</td>
</tr>
<tr>
<td>FO Buried Cable Investment</td>
<td>Multiple</td>
<td>0.53%</td>
<td>12.70%</td>
<td>40.00%</td>
<td>0.03%</td>
<td>30.09%</td>
<td>0.06%</td>
</tr>
<tr>
<td>FO Underground Investment</td>
<td>Multiple</td>
<td>4.15%</td>
<td>12.70%</td>
<td>30.00%</td>
<td>0.16%</td>
<td>30.09%</td>
<td>0.37%</td>
</tr>
<tr>
<td>Poles Investment</td>
<td>Poles</td>
<td>2.55%</td>
<td>1.20%</td>
<td>100.00%</td>
<td>0.03%</td>
<td>2.33%</td>
<td>0.06%</td>
</tr>
<tr>
<td>Conduit Investment</td>
<td>Conduit</td>
<td>0.37%</td>
<td>2.20%</td>
<td>100.00%</td>
<td>0.01%</td>
<td>5.58%</td>
<td>0.02%</td>
</tr>
<tr>
<td>Circuit / Transport Investment</td>
<td>ONT</td>
<td>2.80%</td>
<td>9.10%</td>
<td>100.00%</td>
<td>0.25%</td>
<td>11.20%</td>
<td>0.31%</td>
</tr>
<tr>
<td>Switch Investment</td>
<td>Electronics</td>
<td>8.48%</td>
<td>6.40%</td>
<td>100.00%</td>
<td>0.54%</td>
<td>5.19%</td>
<td>0.44%</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.16%</strong></td>
<td></td>
<td><strong>1.61%</strong></td>
</tr>
<tr>
<td><strong>Materials + Labor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>2.78%</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sources and Notes:
[1]: Workbook Opex V8.xlsx
[2]: BDS Order & FNPRM, Appendix C, Table 2. The material share for the fiber optic costs investments map to cost categories “Fiber,” “Drop,” “Fiber pedestals,” and “Splitters”; that is, 2.9% + 1.4% + 2.7% + 5.7% = 12.7%. Material shares for the other categories are taken directly from Appendix C, Table 2.
[3]: “Fiber split” of 30% / 40% / 30% reflects notes in Mapping Page 10 to ACF that “Buried [fiber] should be given greater weight.”
[5]: (Labor share of total) x (Labor share of cost category)
Labor share of total: BDS Order & FNPRM, Appendix C, Table 2

14. **Plant-Non-Specific Operating Expenses.** Annual operating expenses for this area include network support that is not directly attributable to a specific plant component. These annual expenses are estimated as a percentage of total capex in the network. The relevant data are derived from Workbook Opex V8.xlsx. Annual opex for network operations is 2.18% of total plant investment. Annual opex for general support and network support is 1.58%. Combined, these non-plant specific operating expenses represent 3.77% (after rounding) of total plant investment.
15. **Non-Plant-Based Opex.** Non-plant-based opex includes costs of operating a wireline network that are not related to supporting the network plant. Costs in this area include sales and marketing, and general and administrative expenses. The annual opex for general and administrative functions is provided in Workbook Opex V8.xlsx, and is equal to 3.50% of total plant investment. We employed the special access category of ARMIS data from 2000-2007 to estimate annual opex for the customer operations and sales and marketing functions. These data indicate that annual expenses for customer operations and sales and marketing expenses are 99% of annual general and administrative expenses. Accordingly, we estimate the annual opex for customer operations, sales, and marketing to be 99% of the annual general and administrative expenses provided in CACM. Specifically, we estimate the annual opex for customer operations, sales, and marketing to be 3.47% of total capex (0.99 times 3.50%, which is 3.47%). Total non-plant-based operating expenses represent 6.97% of total plant investment (3.50% + 3.47%).

16. **WACC.** The weighted average cost of capital ("WACC," or cost of capital) is used to determine the annual expense associated with network use. We employ the WACC used in the CACM, which is 8.5% on a post-tax basis. The pre-tax WACC is calculated as the post-tax tax rate divided by one less the corporate tax rate (35%), or \(0.085 / (1-0.35) = 13.08\%\).

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III. Derivation of Capital Costs

17. Annual capital cost refers to the annual cost of using the network, and is measured by the WACC multiplied by plant investment plus annual depreciation expense. Calculation of annual price changes can be conducted either on a post-tax or pre-tax basis. However, the approach must be applied consistently. For example, use of a post-tax WACC should be accompanied by use of post-tax opex. We use a pre-tax WACC to be consistent with the pre-tax opex inputs provided in the CACM source data.

18. Annual depreciation is calculated as the reciprocal of the weighted average economic life, shown to be 24.89 years in Table 5. The annual depreciation for total plant investment is thus \( \frac{1}{24.89} = 4.02\% \).

\[
\text{Table 5: Weighted Average Economic Life of Plant Investment}
\]

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Cost Share</th>
<th>Economic Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1] Labor</td>
<td>59.60%</td>
<td>25.08</td>
</tr>
<tr>
<td>Fiber</td>
<td>2.90%</td>
<td>25.00</td>
</tr>
<tr>
<td>Poles</td>
<td>1.20%</td>
<td>25.00</td>
</tr>
<tr>
<td>Conduit</td>
<td>2.20%</td>
<td>50.00</td>
</tr>
<tr>
<td>Drop</td>
<td>1.40%</td>
<td>25.00</td>
</tr>
<tr>
<td>ONT</td>
<td>9.10%</td>
<td>12.00</td>
</tr>
<tr>
<td>Fiber pedestals</td>
<td>2.70%</td>
<td>25.00</td>
</tr>
<tr>
<td>Splitters</td>
<td>5.70%</td>
<td>25.00</td>
</tr>
<tr>
<td>Electronics</td>
<td>6.40%</td>
<td>12.00</td>
</tr>
<tr>
<td>Land/Buildings</td>
<td>8.70%</td>
<td>40.00</td>
</tr>
<tr>
<td>Total Plant Investment</td>
<td></td>
<td>24.89</td>
</tr>
</tbody>
</table>

Sources and Notes:
[1]: *BDS Order & FNPRM*, Appendix C, Table 2
[2]: Workbook ACF8 50 V6

19. The total annual expense associated with capital invested in the network plant is 17.09%, which is the sum of the annual depreciation expense (4.02%) and the pre-tax cost of
capital (13.08%).

IV. Economic Life Adjustment for Annual Price Changes

20. Annual price changes for three of the categories (capital cost, plant-specific opex, and plant-non-specific opex) depend on annual changes in the underlying total plant investment, which is based on a portfolio of long-lived assets. Price changes for each asset are realized only when capex is incurred. Therefore, calculating the annual price changes for these cost areas requires adjusting the annual price changes of the underlying investments (that were shown in Table 1) to reflect the economic life of each investment. Table 6 shows the calculated annualized changes in input prices associated with each asset type, adjusted for its economic life (low and high estimates are shown in columns [6] and [7], respectively).

21. In addition to the annualized price changes for each asset type, Table 6 provides weighted average annualized price changes for the identified asset types. The first weighted average (row [k]) employs weights that reflect an asset’s share of total plant investment (column [1]). The resulting combined annualized price changes of -1.27% and +0.10%

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12 In the CACM, annual capital costs (i.e., cost of capital and depreciation) are caused by total investment in the network, as is plant-non-specific opex (i.e., expenses directly associated with operating and/or maintaining the plant in general, but not specifically caused by a particular asset category). Plant-specific opex is caused by operating and maintaining specific asset groups that make up the network.

13 We assume straight-line depreciation for each asset type and a constant WACC across asset types. Consequently, the change in capital cost for each asset type will reflect changes in the replacement costs of the asset type as it is replaced over time. If an asset remains functional for exactly its economic life (L), then it will be replaced only a fraction of times over the course of the operational life of the network (N). Given an annual change in the price of the asset of r, a constant annual price growth rate can be calculated over the course of the operational life of the network. This annual growth rate is \((1 + r)^{(N-L)}/N – 1\). This value is equivalent to the annualized rate of change of capital costs from the first period of operation until the end of the operational life of the network.
represent the range of estimated annual price changes for capital costs.

Table 6: Derivation of Annual Price Changes for Capital Cost and Plant-Specific Opex

<table>
<thead>
<tr>
<th>Cost category</th>
<th>% of total</th>
<th>Plant-Specific OpEx</th>
<th>Low estimate</th>
<th>High estimate</th>
<th>Economic Life</th>
<th>Low estimate</th>
<th>High estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor [a]</td>
<td>59.60%</td>
<td>1.61%</td>
<td>2.47%</td>
<td>2.77%</td>
<td>25.08</td>
<td>1.84%</td>
<td>2.07%</td>
</tr>
<tr>
<td>Fiber [b]</td>
<td>2.90%</td>
<td>0.07%</td>
<td>-5.00%</td>
<td>-5.00%</td>
<td>25.00</td>
<td>-3.77%</td>
<td>-3.77%</td>
</tr>
<tr>
<td>Poles [c]</td>
<td>1.20%</td>
<td>0.03%</td>
<td>2.00%</td>
<td>2.00%</td>
<td>25.00</td>
<td>1.50%</td>
<td>1.50%</td>
</tr>
<tr>
<td>Conduit [d]</td>
<td>2.20%</td>
<td>0.01%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>50.00</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Drop [e]</td>
<td>1.40%</td>
<td>0.04%</td>
<td>-2.00%</td>
<td>-2.00%</td>
<td>25.00</td>
<td>-1.50%</td>
<td>-1.50%</td>
</tr>
<tr>
<td>ONT [f]</td>
<td>9.10%</td>
<td>0.25%</td>
<td>-5.00%</td>
<td>-5.00%</td>
<td>12.00</td>
<td>-4.41%</td>
<td>-4.41%</td>
</tr>
<tr>
<td>Fiber pedestals [g]</td>
<td>2.70%</td>
<td>0.07%</td>
<td>-5.00%</td>
<td>-5.00%</td>
<td>25.00</td>
<td>-3.77%</td>
<td>-3.77%</td>
</tr>
<tr>
<td>Splitters [h]</td>
<td>5.70%</td>
<td>0.15%</td>
<td>-5.00%</td>
<td>-5.00%</td>
<td>25.00</td>
<td>-3.77%</td>
<td>-3.77%</td>
</tr>
<tr>
<td>Electronics [i]</td>
<td>6.40%</td>
<td>0.54%</td>
<td>-30.00%</td>
<td>-10.00%</td>
<td>12.00</td>
<td>-26.94%</td>
<td>-8.85%</td>
</tr>
<tr>
<td>Land/Buildings [j]</td>
<td>8.70%</td>
<td>0.00%</td>
<td>3.56%</td>
<td>5.07%</td>
<td>40.00</td>
<td>2.12%</td>
<td>3.01%</td>
</tr>
<tr>
<td>Capital Cost [k]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-1.27%</td>
<td>0.10%</td>
</tr>
<tr>
<td>Plant-Specific OpEx [l]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-5.00%</td>
<td>-1.34%</td>
</tr>
</tbody>
</table>

Sources and Notes:
[1][a]-[j]: BDS Order & FNPRM, Appendix C, Table 2
[2]: See Table 4, Materials-based Opex and Labor-based Opex
[3]-[4][a]: BDS Order & FNPRM, Appendix C, Table 3
[3]-[4][b]-[i]: Response to Professor Hogendorn at 3
[3]-[4][j]: BDS Order & FNPRM, Appendix C, Table 4
[5]: See Table 5, based on Workbook ACF8 50 V6
[6]: (1 + [3])^( (100 - [5]) / 100) - 1
[7]: (1 + [4])^( (100 - [5]) / 100) - 1
[k]: Sum([1] x [6]) / sum([1]), Sum([1] x [7]) / sum([1])
[l]: Sum([2] x [6]) / sum([2]), Sum([2] x [7]) / sum([2])

22. The second weighted average annualized price change in Table 6 (row [l]) corresponds to the combined annual price change for plant-specific opex. As shown in Table 4, the annual expenses associated with operating and managing the cable and wire, circuit equipment/transport, and switching elements of a wireline network constitute 2.78% of total network capex. This figure has two components: materials-based opex (accounting for 1.16% of total network capex) and labor-based opex (accounting for 1.61% of total network capex).
Table 7 identifies by asset type the components of the plant-specific opex value of 2.78% of total network capex. Labor-based opex (1.61% from column [6] in Table 4) is assigned to the labor cost component. The corresponding percentages for poles (0.03%), conduit (0.01%), ONT (0.25%), and electronics (0.54%) reflect data from column [4] in Table 4. Table 4 also shows the component parts for fiber-optic-based opex (i.e., buried, aerial, and underground), which total 0.33%. We allocate this value (for total fiber-optic opex) to the four fiber-optic related cost categories specified in Table 1 (i.e., fiber, drop, pedestal, and splitter) in proportion to the CACM capex input cost shares, as shown in columns [3] and [4] in Table 7.

**Table 7: Derivation of Plant-Specific Opex Component Cost Breakdown**

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Labor-based Opex</th>
<th>Non-Fiber-Optic Material-based Opex</th>
<th>Fiber-Optic Cost-Shares</th>
<th>Fiber-Optic-based Opex</th>
<th>Plant-Specific Opex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>1.61%</td>
<td></td>
<td></td>
<td></td>
<td>1.61%</td>
</tr>
<tr>
<td>Fiber</td>
<td></td>
<td>2.90%</td>
<td>0.07%</td>
<td>0.07%</td>
<td></td>
</tr>
<tr>
<td>Poles</td>
<td>0.03%</td>
<td></td>
<td></td>
<td></td>
<td>0.03%</td>
</tr>
<tr>
<td>Conduit</td>
<td></td>
<td>0.01%</td>
<td></td>
<td></td>
<td>0.01%</td>
</tr>
<tr>
<td>Drop</td>
<td></td>
<td>1.40%</td>
<td>0.04%</td>
<td>0.04%</td>
<td></td>
</tr>
<tr>
<td>ONT</td>
<td>0.25%</td>
<td></td>
<td></td>
<td></td>
<td>0.25%</td>
</tr>
<tr>
<td>Fiber pedestals</td>
<td></td>
<td>2.70%</td>
<td>0.07%</td>
<td>0.07%</td>
<td></td>
</tr>
<tr>
<td>Splitters</td>
<td></td>
<td>5.70%</td>
<td>0.15%</td>
<td>0.15%</td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>0.54%</td>
<td></td>
<td></td>
<td></td>
<td>0.54%</td>
</tr>
<tr>
<td>Land/Buildings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1.61%</td>
<td>0.84%</td>
<td>12.70%</td>
<td>0.33%</td>
<td>2.78%</td>
</tr>
</tbody>
</table>

Sources and Notes:
[1]: See Table 4, Labor-based Opex
[2]: See Table 4, Materials-based Opex
[3]: *BDS Order & FNPRM*, Appendix C, Table 2
[4]: See Table 4, Materials-based Opex
[5]: See Table 4, Materials-based Opex and Labor-based Opex
24. Plant-specific opex was then derived by summing labor-specific opex, material-based opex, and fiber-based opex for each cost category. In total, plant-specific opex is 2.78% of total plant investment.

25. The plant-specific opex percentages of total capex shown in Table 7 are used as the weights that are applied to the annual price increases (columns [6] and [7]) in Table 6 to determine the combined plant-specific opex annualized price changes. The resulting estimated annualized price changes range from -5.00% to -1.34%, as indicated in row [l] in Table 6.

26. **Plant-Non-Specific Opex.** As described earlier, plant-non-specific operating expenses in the CACM are driven by total plant investment. Consequently, the annual price changes for these expenses move in tandem with the value of current investment, and are taken to be equivalent to the annualized price change values for the cost of capital and depreciation (ranging from -1.27% to +0.10%, as shown in row [k] in Table 6).

V. **Annual Price Changes for Non-Plant-Based Opex**

27. Non-plant-based opex cover expenses associated with customer operations, sales and marketing, and general and administrative functions, which are primarily labor-related. We therefore set the annual price changes for non-plant-based operating expenses equal to the annual price changes for labor, ranging from 2.47% to 2.77% annually (as shown in Table 1).

VI. **Combined Annual Input Price Changes**

28. The combined annualized input price change for the CACM information is a weighted average of the annualized price changes for each of the four cost areas: capital cost, plant-specific operating expense, plant-non-specific operating expense, and non-plant-based
operating expense. As shown in Table 8, the weight for each cost area reflects its annual operating expense as a share of total network investment. Table 8 indicates that the combined annualized price changes associated with providing services over the modeled wireline network ranges from -0.76% to +0.58%.

Table 8: Calculation of Annual Input Price Change
CACM - Adjusted for Asset Economic Life and Operating Expenses

<table>
<thead>
<tr>
<th>Cost Area</th>
<th>Annual Expense</th>
<th>Low estimate</th>
<th>High estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>[a] 17.09%</td>
<td>-1.27%</td>
<td>0.10%</td>
</tr>
<tr>
<td>Plant-Specific Opex</td>
<td>[b] 2.78%</td>
<td>-5.00%</td>
<td>-1.34%</td>
</tr>
<tr>
<td>Plant-Non-Specific Opex</td>
<td>[c] 3.77%</td>
<td>-1.27%</td>
<td>0.10%</td>
</tr>
<tr>
<td>Non-plant-Based Opex</td>
<td>[d] 6.97%</td>
<td>2.47%</td>
<td>2.77%</td>
</tr>
<tr>
<td>Combined Annual Expenses</td>
<td>[e] 30.60%</td>
<td>-0.76%</td>
<td>0.58%</td>
</tr>
</tbody>
</table>

Sources and Notes:
[1][a]: Paragraph 19 of this technical appendix; [1][b]: Table 4
[1][c]: Sum of plant-based, investment driven values in Workbook Opex V8.xlsx
[1][d]: See paragraph 15 of this technical appendix
[1][e]: Sum([1][a]-[d])
[2]-[3][a]-[c]: Table 6
[2]-[3][d]: Labor rate of price changes; See Table 6
[2][e]: Sum([1] x [2]) / [1][e]
[3][e]: Sum([1] x [3]) / [1][e]
I declare under penalty of perjury under the laws of the United States of America that the
foregoing is true and correct to the best of my knowledge and belief.

Executed on August 31, 2016

[Signature]
Chris Fretrup
I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct to the best of my knowledge and belief.

Executed on August 31, 2016

____________________________________
David Sappington