

## SUPPORTING STATEMENT

**Part B: Statistical Methodology:**

B.1. The specifics of the survey design described here (e.g., strata definitions, sample sizes) were based on data collected in the 2019 Urban Rate Survey and serve as the general template for future Urban Rate Surveys. The survey design for the voice survey remains the same as the past Urban Rate Surveys.

We propose to further stratify for the broadband survey and therefore, the minimum sufficient sample size for the broadband survey increases to 2000 sampling units. The rate variation within each stratum has been increasing based on the past Urban Rate Surveys. The increase in the number of service plans offered and survey responses (the rapid changes in the rate plans offered in the consumer market for fixed broadband services as described below) and the wider range of the rate offerings from 2017-2019 demonstrate that the current design is insufficient to capture rates for all possible service plans. In addition, because the Commission has determined that it must calculate Alaska-specific benchmarks, we must collect a sufficient number of rate samples from the Alaska providers in order to produce high precision rate estimates for Alaska.

The respondent universe is providers of fixed voice or fixed broadband services in urban census tracts of the 50 United States, the District of Columbia, and Puerto Rico. We estimate the respondent universe as 694 providers of fixed voice services and 1,344 providers of fixed broadband services in 58,000 urban census tracts. Each (service provider, census tract) pair will be assigned a “measure of size” reflecting the number of potential subscribers offered service by the provider in the census tract. This number of potential subscribers will be calculated as:

$$\text{Number of Potential Subscribers} = \text{Provider Presence Ratio} \times (\text{households in the census tract})$$

where

$$\text{Provider Presence Ratio} = 1/(1 + 10^{-Y}),$$

$$Y = 2.289 + 0.776 \text{Log}_{10}(X/(1-X)) + b_n * \text{state}_n^1, \text{ and}$$

$$X = \text{residential subscribers for provider in the tract} / \text{households in the tract.}^2$$

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<sup>1</sup> The  $b_n$  is the coefficient for  $n_{\text{th}}$  state.

<sup>2</sup> We used a regression model to estimate the proportion of the census tract’s households to which a service provider offers service. The regression was developed from data relating broadband provider presence to broadband provider subscription. Linear regression was used to regress  $\text{Log}_{10}(p/(1-p))$  on  $\text{Log}_{10}(s/(1-s))$ , where  $p$  is the fraction of housing units covered by the broadband provider in the census tract and  $s$  is the provider’s broadband subscriber fraction of households in the tract. This assumes that the relationship of voice provider presence to voice subscribership is similar to that of broadband provider presence to broadband subscribership.

The survey will collect a sample of urban rates for voice services and a separate sample of urban rates for broadband services. In both cases, the sampling unit will be a (service provider, census tract) pair, and the sampling frame will be constructed from FCC Form 477.

For the voice survey, we will implement a Stratified Probability Proportional to Size (PPS) sampling, where the selection probability is a function of measure of size. Measure of size is the number of potential subscribers from a provider in a given census tract, as described earlier.

The sampling units will be divided into two strata depending on whether the service provider is an incumbent local exchange carrier (ILEC) or Non-ILEC. The total number of samples is 500. The sample size allocation between ILEC and Non-ILEC will be a proportionate allocation, where the sample size in each stratum is proportional to that of the total number of potential subscribers. A sample of 217 ILEC and 283 Non-ILEC sampling units will be selected randomly from their respective strata.

For the broadband survey, as with the voice survey, we will implement a Stratified PPS sampling, where the selection probability is a function of the number of potential subscribers from a provider in a given tract. The sampling units will be divided into 39 strata. The total number of samples is 2000.

Past Urban Rate Surveys demonstrated that for some service providers (particularly the large national service providers), the rates offered for broadband services did not vary across adjacent census tracts. Carrier-specific stratification will allow us to reduce the number of survey responses requested in such cases while still capturing the offered rates in accordance with their estimated effect on the reasonable comparability benchmark. The terrestrial fixed wireless providers exhibit high price variations and their number of potential customers in a service area is limited by geographic constraints (line of sight). A terrestrial fixed wireless stratum will allow us to produce more precise price estimates. The Alaska strata will allow us to develop Alaska-specific benchmarks. The varying bandwidth strata will allow us to develop benchmarks for service plans for various download bandwidth up to 1 Gbps.

The following 39 strata will be used:

- Carrier-specific strata (each is further divided into two strata: service download bandwidth < 500 Mbps and service download bandwidth >= 500 Mbps)
  - AT&T (AT&T Services, Inc.)
  - CenturyLink (CenturyLink, Inc., CenturyLink Communications, LLC)
  - Charter (Charter Communications, Inc.)
  - Comcast (Comcast Cable Communications, INC.)
  - Cox (Cox Communications)
  - CSC Holdings (CSC Holdings LLC)
  - Frontier (Frontier Communications Corporation)
  - Verizon (Verizon New York Inc., Verizon Pennsylvania LLC, Verizon New Jersey Inc., Verizon California Inc., Verizon New England Inc., Verizon Virginia LLC, Verizon Maryland LLC, Verizon Florida LLC, Verizon Delaware LLC, GTE Southwest Incorporated dba Verizon Southwest, Verizon Washington, DC Inc.)
  - WideOpenWest (Knology, WideOpenWest, and Wiregrass Telcom) Windstream (service providers identifying Windstream as their holding company)

- Continental US (excluding Terrestrial Fixed Wireless)
  - Download bandwidth: 2 – 36 Mbps
  - Download bandwidth: 40 – 75 Mbps
  - Download bandwidth: 80 – 115 Mbps
  - Download bandwidth: 120 – 155 Mbps
  - Download bandwidth: 180 – 250 Mbps
  - Download bandwidth: 300 – 350 Mbps
  - Download bandwidth: 400 Mbps
  - Download bandwidth: 500 – 750 Mbps
  - Download bandwidth: 1 Gbps
- Terrestrial Fixed Wireless
  - Download bandwidth: 2 – 36 Mbps
  - Download bandwidth: 40 – 75 Mbps
  - Download bandwidth: 80 – 155 Mbps
  - Download bandwidth: 180 – 750 Mbps
  - Download bandwidth: 1 Gbps
- Alaska
  - Download bandwidth: 2 – 36 Mbps
  - Download bandwidth: 40 – 75 Mbps
  - Download bandwidth: 80 – 155 Mbps
  - Download bandwidth: 180 – 750 Mbps
  - Download bandwidth: 1 Gbps

For each sampling unit, except for the Terrestrial Fixed Wireless providers, the number of potential subscribers is calculated as:

$$\text{Number of Potential Subscribers} = \text{Provider Presence Ratio} \times (\text{Number of households in the sampling unit's census tract})$$

For each sampling unit of the Terrestrial Fixed Wireless providers, the number of potential subscribers is calculated as:

$$\text{Number of Potential Subscribers} = 2 \times (\text{Number of residential subscribers})$$

Provider Presence Ratio is calculated as the fraction of housing units in the census tract for which the provider offered fixed broadband service.

Sample size allocation will be an optimum allocation with fixed cost, where the sample size for each stratum is proportional to the standard deviation of the distribution of the rates. This allocation is designed to minimize possible sampling variance. The sample size is calculated as:

$$n_h = n * ( N_h * \sigma_h * w_i ) / [ \sum ( N_h * \sigma_i * w_i ) ]$$

where  $n_h$  is the sample size for stratum  $h$ ,  $n$  is total sample size,  $N_h$  is the population size for stratum  $h$ ,  $\sigma_h$  is the Stratum standard deviation (SD) of stratum  $h$ , and  $w_i$  is the square root of number of potential

subscribers per unit for stratum  $h$ . The purpose of  $w_i$  is to give extra weight to those units with larger number of potential subscribers in the census tract.  $N_h$  and  $w_i$  are derived from the frame data.

Stratum SD ( $\sigma_h$ ) is an estimate of the standard deviation of rates by service plan for the service providers in the stratum. Stratum SD is based on fixed broadband service rates provided in last year's Urban Rate Survey. The Stratum SDs are calculated based on service plans with download bandwidths greater than or equal to 2 Mbps.

For a particular stratum identified with a service provider, all service rates are partitioned by service plan according to download bandwidth, upload bandwidth, and usage allowance. The variance of rates is calculated for each service plan. The Stratum SD is calculated as the square root of the average of these variances.<sup>3</sup> For the varying bandwidth strata, the standard deviation is calculated by applying the above procedure to all service plans, assigned to the current bandwidth strata, from the last year's broadband Urban Rate Survey.

Once each sample is selected, the survey will be organized by provider so that each provider surveyed is given a list of census tracts for which the appropriate urban service rate is to be provided.

We anticipate the high response rates from the voice and broadband surveys will continue. We contact directly any provider that is sent a survey notification that does not complete the online survey form within 30 days. Because compliance is mandatory, failure to comply may lead to enforcement action, including forfeiture penalties, pursuant to the Communications Act of 1934, as amended, and other applicable law.

## B.2.

The survey will collect a sample of urban rates for voice services and a separate sample of urban rates for broadband services. In both cases, the sampling unit will be a (service provider, census tract) pair.

For the voice survey, the sampling units will be divided into two strata depending on whether the service provider is an incumbent local exchange carrier (ILEC) or Non-ILEC. The total number of samples is 500. The sample size allocation between ILEC and Non-ILEC will be a proportionate allocation, where the sample size in each stratum is proportional to that of the total number of potential subscribers. A sample of 217 ILEC and 283 Non-ILEC sampling units will be selected randomly from their respective strata.

For the broadband survey, the sampling units will be divided into 39 strata. The total number of samples is 2000. Past Urban Rate Surveys demonstrated that for many of the service providers (particularly the large national service providers), the rates offered for broadband services did not vary across census tracts. Stratification will allow us to reduce the number of survey responses requested in such cases while still capturing the offered rates in accordance with their estimated effect on the reasonable comparability benchmark. The terrestrial fixed wireless providers exhibit high price variations and their number of potential customers in a service area is limited by geographic constraints (line of sight). A terrestrial fixed wireless stratum will allow us to produce more precise price estimates. The Alaska strata will allow us to develop Alaska-specific benchmarks. The varying bandwidth strata will allow us to develop benchmarks for service plans for various download bandwidth up to 1 Gbps.

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<sup>3</sup> Service plans with only one rate are ignored in the calculation.

The following 39 strata will be used:

- Carrier-specific strata (separately by service download bandwidth < 500 Mbps and service download bandwidth >= 500 Mbps)
  - AT&T (AT&T Services, Inc.)
  - CenturyLink (CenturyLink, Inc., CenturyLink Communications, LLC)
  - Charter (Charter Communications, Inc.)
  - Comcast (Comcast Cable Communications, INC.)
  - Cox (Cox Communications)
  - CSC Holdings (CSC Holdings LLC)
  - Frontier (Frontier Communications Corporation)
  - Verizon (Verizon New York Inc., Verizon Pennsylvania LLC, Verizon New Jersey Inc., Verizon California Inc., Verizon New England Inc., Verizon Virginia LLC, Verizon Maryland LLC, Verizon Florida LLC, Verizon Delaware LLC, GTE Southwest Incorporated dba Verizon Southwest, Verizon Washington, DC Inc.)
  - WideOpenWest (Knology, WideOpenWest, and Wiregrass Telcom) Windstream (service providers identifying Windstream as their holding company)
- Continental US (excluding Terrestrial Fixed Wireless)
  - Download bandwidth: 2 – 36 Mbps
  - Download bandwidth: 40 – 75 Mbps
  - Download bandwidth: 80 – 115 Mbps
  - Download bandwidth: 120 – 155 Mbps
  - Download bandwidth: 180 – 250 Mbps
  - Download bandwidth: 300 – 350 Mbps
  - Download bandwidth: 400 Mbps
  - Download bandwidth: 500 – 750 Mbps
  - Download bandwidth: 1 Gbps
- Terrestrial Fixed Wireless
  - Download bandwidth: 2 – 36 Mbps
  - Download bandwidth: 40 – 75 Mbps
  - Download bandwidth: 80 – 155 Mbps
  - Download bandwidth: 180 – 750 Mbps
  - Download bandwidth: 1 Gbps
- Alaska
  - Download bandwidth: 2 – 36 Mbps
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  - Download bandwidth: 80 – 155 Mbps
  - Download bandwidth: 180 – 750 Mbps
  - Download bandwidth: 1 Gbps

For each sampling unit, except for the Terrestrial Fixed Wireless providers, the number of potential subscribers is calculated as:

Number of Potential Subscribers = Provider Presence Ratio x (Number of households in the sampling unit's census tract)

For each sampling unit of the Terrestrial Fixed Wireless providers, the number of potential subscribers is calculated as:

Number of Potential Subscribers = 2 x (Number of residential subscribers)

Provider Presence Ratio is calculated as the fraction of housing units in the census tract for which the provider offered fixed broadband service.

Sample size allocation will be an optimum allocation with fixed cost, where the sample size for each stratum is proportional to the standard deviation of the distribution of the rates. This allocation is designed to minimize possible sampling variance. The sample size is calculated as:

$$n_h = n * ( N_h * \sigma_h * w_i ) / [ \Sigma ( N_h * \sigma_i * w_i ) ]$$

where  $n_h$  is the sample size for stratum  $h$ ,  $n$  is total sample size,  $N_h$  is the population size for stratum  $h$ ,  $\sigma_h$  is the Stratum standard deviation (SD) of stratum  $h$ , and  $w_i$  is the square root of number of potential subscribers per unit for stratum  $h$ . The purpose of  $w_i$  is to give extra weight to those units with more number of potential subscribers in the census tract.  $N_h$  and  $w_i$  are derived from the frame data.

Stratum SD ( $\sigma_h$ ) is an estimate of the standard deviation of rates by service plan for the service providers in the stratum. Stratum SD is based on fixed broadband service rates provided in last year's Urban Rate Survey. The Stratum SDs are calculated based on service plans with download bandwidths greater than or equal to 2 Mbps.

For a particular stratum identified with a service provider, all service rates are partitioned by service plan according to download bandwidth, upload bandwidth, and usage allowance. The variance of rates is calculated for each service plan. The Stratum SD is calculated as the square root of the average of these variances. For the varying bandwidth strata, the standard deviation is calculated by applying the above procedure to all service plans, assigned to the current bandwidth strata, from the last year's broadband Urban Rate Survey.

Once each sample is selected, the survey will be organized by provider so that each provider surveyed is given a list of census tracts for which the appropriate urban service rate is to be provided.

The goal of the survey is to estimate the mean and standard deviation of the distribution of offered urban rates for a given service. These estimates will then be used to estimate upper and lower limits for carrier rates; for example, the mean plus twice the standard deviation is a possible upper limit based on the approximate 97.5 percentile of a normal distribution.

The estimate of the mean is

$$\widehat{R} = \frac{\sum_{j=1}^n K_j Y_j}{\sum_{j=1}^n K_j}$$

where  $Y_j$  is the rate and  $K_j$  is the weight of the  $j$ th sampled rate. Similarly, the estimate of the standard deviation is

$$\widehat{\sigma}_R = \sqrt{\frac{\sum_{j=1}^n K_j (Y_j - \widehat{R})^2}{\sum_{j=1}^n K_j}}$$

For both voice and broadband surveys, the sample will be selected based on probability proportional to the number of potential subscribers of each sampling unit.  $K_j$  will reflect the sampling weight which is the inverse of the selection probability for each sampling unit and the nonresponse weight to compensate for unit nonresponse in each stratum.

B.3. We anticipate the high response rates from the voice and broadband surveys will continue. We contact directly any provider that is sent a survey notification that does not complete the online survey form within 30 days. Because compliance is mandatory, failure to comply may lead to enforcement action, including forfeiture penalties, pursuant to the Communications Act of 1934, as amended, and other applicable law. Based on the sampling methodology described above and an anticipated high rate of compliance, the information collected should be both sufficiently accurate and reliable for the purpose of determine the rate floor and rate comparability benchmarks.

B.4. The total sample size for the voice survey will be similar to past years' Urban Rate Survey. The sample size allocation between two strata (ILEC and Non-ILEC) will be a proportionate allocation, where the sample size in each stratum is proportional to that of the total number of potential subscribers.

The total sample size for the broadband survey will be 2000 to adequately cover the fast-growing number of service plans and better estimate the variance in speed offerings. The sample size allocation for the broadband survey will be an optimum allocation with fixed cost, where the sample size for each stratum is proportional to the standard deviation of the distribution of the rates. This allocation is designed to minimize possible sampling variance. The sample size is calculated as:

$$n_h = n * (N_h * \sigma_h * w_i) / [ \sum (N_h * \sigma_i * w_i) ]$$

where  $n_h$  is the sample size for stratum  $h$ ,  $n$  is total sample size,  $N_h$  is the population size for stratum  $h$ ,  $\sigma_h$  is the Stratum standard deviation (SD) of stratum  $h$ , and  $w_i$  is the square root of number of potential subscribers per unit for stratum  $h$ . The purpose of  $w_i$  is to give extra weight to those units with a higher number of potential subscribers in the census tract.  $N_h$  and  $w_i$  are derived from the frame data.

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Survey. The Stratum SDs are calculated based on service plans with download bandwidths greater than or equal to 2 Mbps.

For a particular stratum identified with a service provider, all service rates are partitioned by service plan according to download bandwidth, upload bandwidth, and usage allowance. The variance of rates is calculated for each service plan. The Stratum SD is calculated as the square root of the average of these variances. For the varying bandwidth strata, the standard deviation is calculated by applying the above procedure to all service plans, assigned to the current bandwidth strata, from the last year's broadband Urban Rate Survey.

Finally, adjustments will be made to the sample sizes so that a minimum of 5 sampling units is in each stratum.

B.5. The individuals within the agency who consulted on the statistical aspects of the design are:

Craig Stroup, Industry Economist, 202-418-0989

Kenneth Lynch, Supervisory Industry Economist and Acting Division Chief, 202-418-7356

The survey data will be collected and analyzed by these same individuals and other Industry Analysis Division of the Office of Economics and Data staff. We do not anticipate seeking assistance from outside the agency unit.