Developing a Statistically Valid and Principal Method to Compute Bus and Truck Occupancy Data

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16. Abstract

This project used publicly available data to compute bus and truck occupancies for each state and the District of Columbia. As part of this study, data from the Census Bureau, data from the National Transit Database, data from other public sources, and information from school boards were used to develop bus occupancies by school bus, transit bus, intercity, and charter bus. Data from the Highway Statistics Series tables VM-2 and VM-4 were used to obtain state level Vehicle Miles Traveled (VMT) by vehicle type to weigh the occupancy by VMT and obtain a single bus occupancy factor by state. To compute truck occupancy, data from the Fatality Analysis Reporting System (FARS) was used to obtain state level truck occupancy for single and combination unit trucks and it was weighted by the distribution of VMT to obtain truck occupancy at the state level. The methodology developed in this study allows for an easy to use approach with public data or publicly available data to compute state level bus and truck occupancies on an annual basis.

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List of Acronyms

ACS	The American Community Survey
CMAQ	Congestion Mitigation and Air Quality Improvement Program
DOT	Department of Transportation
FARS	Fatal Accident Reporting System
FAST	Fixing America's Surface Transportation
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FTA	Federal Transit Administration
GES	General Estimates System
GTFS	General Transit Feed Specification
HOV	High-occupancy vehicle
HSS	Highway Statistics Series
ISTEA	Intermodal Surface Transportation Efficiency Act
MAP-21	Moving Ahead for Progress in the 21st Century
NHS	National Highway System
NHTS	National Household Travel Survey
NHTSA	National Highway Traffic Safety Administration
NTD	National Transit Database
SOV	Single-occupancy vehicle
TOD	Time of Day
VMT	Vehicle miles traveled
VOF	vehicle occupancy factors
VRM	vehicle revenue miles

1.0 Introduction and Background

As important travel characteristics, vehicle occupancy factors for buses and trucks provide greater understanding of the movement of people and goods and of multimodal travel. These factors are useful from both a planning and an operations standpoint, supporting travel demand modeling, travel behavior analysis, and performance measurement. This project was undertaken to explore bus and truck vehicle occupancy factors and determine cost effective methods for computing them on an annual basis.

Vehicle occupancy factors have significant uses for a variety of site-specific, subregional, areawide, and even national purposes. Vehicle occupancy factors are used to calculate personal mobility measures such as person-delay, person-miles traveled, etc., which are often used to set policies for high-occupancy vehicle (HOV) and managed lanes. Transit occupancy factors can be used to identify high ridership routes and allow for efficient expansion of services. Through Federal legislation beginning with the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, vehicle occupancy factors have received increased attention due to the emphasis on person movements rather than vehicle movements. The Moving Ahead for Progress in the 21st Century Act (MAP-21) initiated and the Fixing America's Surface Transportation Act (FAST Act) has advanced reforms to the Federal-Aid Highway Program by establishing new requirements for performance management to foster more efficient investment of Federal transportation funds.

Accordingly, the Federal Highway Administration (FHWA) established a set of performance metrics and measures to consistently assess the performance of the National Highway System (NHS), freight movement on the Interstate system, and the Congestion Mitigation and Air Quality Improvement Program (CMAQ). Three of the seven measures established by FHWA—1) percent of the person-miles traveled on the Interstate that are reliable, 2) percent of the person-miles traveled on the non-Interstate NHS that are reliable, 3) annual hours of peak hour excessive delay—depend upon the use of some form of vehicle occupancy factors. In addition, a fourth measure, percentage of non-single-occupancy vehicle (SOV) travel, could potentially benefit from the availability of refined bus vehicle occupancy factors.

Past research on vehicle occupancy has identified that vehicle occupancy factors vary significantly by time of day, day of week, and month of year, as well as by trip purpose. Data on personal vehicle occupancy factors has historically been obtained from the National Household Travel Survey (NHTS) Program which has a non-fixed six- to eight-year cycle, but there is a need to obtain these factors on an annual basis. Sources such as cellphone data coupled with survey data that provide contextual information have been explored as potential data sources to obtain a continuous annual dataset that provides insights into travel behavior and trip making characteristics of households and persons. Knowing bus and truck occupancy factors on a consistent basis could ultimately help lead to improved resource allocation and conditions across various modes of transportation.

The objective of this study is to develop bus and truck occupancy factors on an annual basis using mainly publicly available data and within a budget of $25,000 each year. This study is aimed towards fulfilling that objective and the remainder of the report is structured as follows. Chapter 2 details the data sources used for the development of bus and truck occupancy factors, including data sources that were considered but not used. Chapter 3 focuses on the development of individual components of the bus occupancy factor (school bus, transit, and intercity bus) and the methodology for developing a single bus occupancy factor. Chapter 4 details the development of the truck occupancy factors.

2.0 Data Sources

In this section, we outline the data sources used to estimate the vehicle occupancy factors (VOF) for buses and trucks. Each data source may be used for one or more purposes. We give a brief description of each data source and what it will be used for.

Occupancy and Travel Information

School Enrollment and Bus Database

Since no such database previously existed, the project team compiled school enrollment data by scouring each State's department of education website to obtain elementary, middle, and high school enrollment at the school district level. The number of buses for each school district was also compiled. This information was readily available only for California (not updated since 2012) and Florida. For the other States, the number of buses at a statewide level was compiled from schoolbusfleet.com.

American Community Survey

The American Community Survey (ACS) is collected on an ongoing basis by the U.S. Census Bureau. The survey includes a range of questions, including addressing household, socioeconomic, and commute travel characteristics. The ACS was used as a source for variables for computing school bus occupancy.

Fatal Accident Reporting System

The National Highway Transportation Safety Administration (NHTSA) collects and maintains the Fatal Accident Reporting System (FARS), which is a census of all U.S. vehicle accidents from 1975 to 2016 that resulted in a fatal injury within 30 days of the accident. While it only contains accidents that resulted in fatal injuries and therefore may not be fully representative of the driving population, this dataset was used to estimate truck occupancy (with adjustments for potential bias applied based on data in other datasets).

National Transit Database

The Federal Transit Administration (FTA) collects and maintains the National Transit Database (NTD), which contains data on all transit systems that receive funding from the FTA. Information on passenger trips is useful for calculating the percent of non-single occupancy travel and the passenger miles and passenger trips are used for vehicle occupancy factors.

National Automotive Sampling System General Estimates System

The General Estimates System (GES) is maintained by NHTSA and contains a nationally representative sample of 50,000 police accident reports per year that resulted in property damage, injury, or death. However, the reports are coded to one of four geographic regions in the U.S. rather than containing detailed geographic information (such as State) which would be necessary for our purposes. Therefore we did not pursue use of the GES in our analysis.

Federal Highway Administration Highway Statistics Series

The FHWA Highway Statistics Series (HSS) consists of annual reports containing analyzed statistical information on motor fuel, motor vehicle registrations, driver licenses, highway user taxation, highway mileage, travel, and highway finance. Data from the HSS was used to correct biases in the FARS dataset.

3.0 Bus Occupancy

This chapter details the methodology used to develop school, intercity, and transit bus occupancy factors.

School Bus Occupancy

As a first step, the school enrollment database was used to compute the school bus occupancy. Except for Florida and California, most other States did not report school bus ridership down to the school district level in a manner that was publicly accessible. Some States, like Virginia, publish school financial efficiency reports but these data are not consistently updated and some counties report data from 2005 or 2006.

The **initial** methodology used to obtain school bus ridership was as follows. Using school district/county enrollment data and statewide total enrollment, ridership, and number of buses, the county/school district share of total enrollment, bus ridership, and number of buses were computed. This information was then used to compute students per bus. Figure 1, figure 2, and figure 3 shows the total enrollment, percent transported by bus, and bus occupancy respectively from the methodology described above.

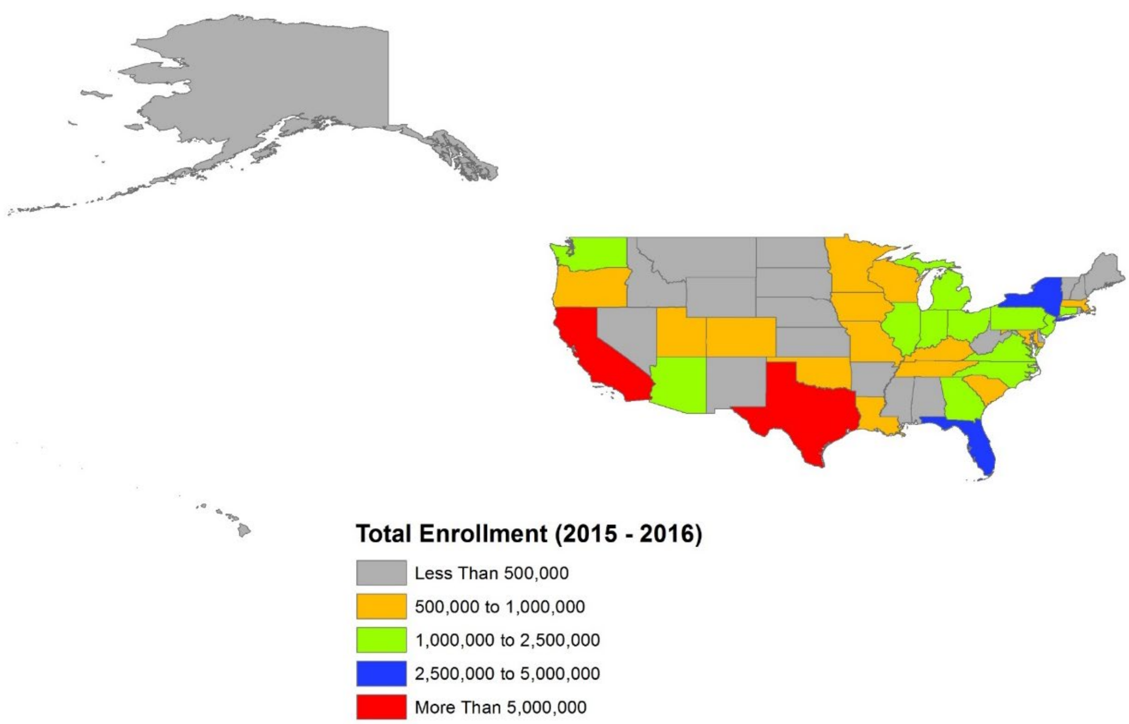

Figure 1. Map. Total enrollment.

(Source: Data Analysis.)

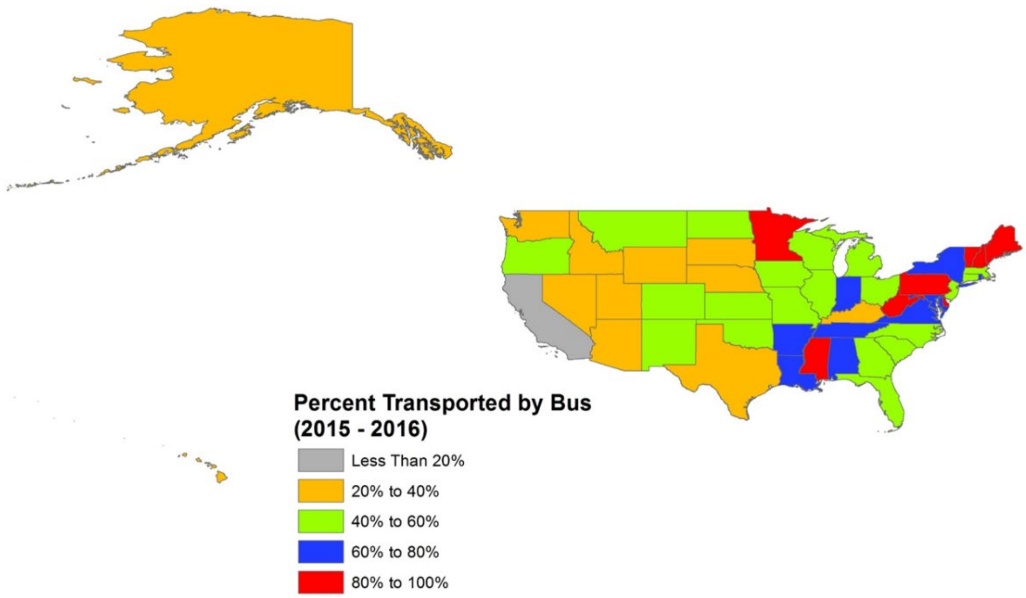

Figure 2. Map. Percent transported by bus.

(Source: Data Analysis.)

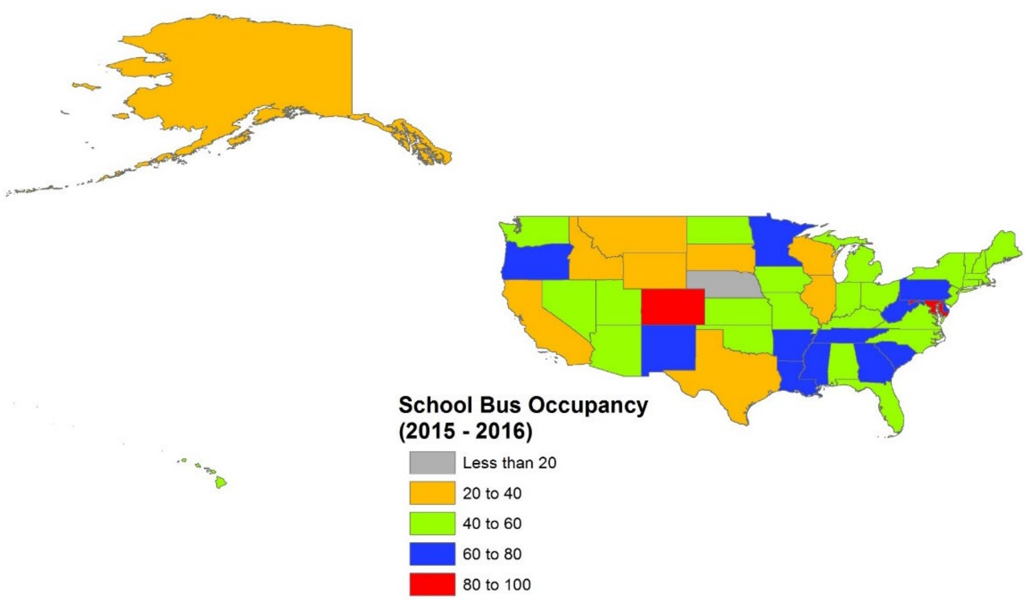

Figure 3. Map. School bus occupancy.

(Source: Data Analysis.)

As figure 3 shows, most of the States have a bus ridership between 40 to 60 students per bus. However, there are outliers like Colorado and Maryland which have bus ridership over 80. NHTSA does not publish any guidance on the capacity per school bus but in perusing various school district websites, most have an average capacity of 72 passengers per bus with 3 per seat for K to 6th grade and two per seat for 7th to 12th grade. Ultimately, the level of uncertainty with this methodology was deemed unacceptable.

The **final** methodology used to determine school bus occupancy at various geographies was a modeling based methodology. Based on a review of the data and bus ridership, a set of variables were found to influence school bus ridership (figure 4)—population density, median income, household income less than $25,000, and zero car households. As the figure shows, the more dense the area and lower the income of its residents, the higher the propensity for school bus travel. Using these variables as the starting point, multiple specifications were tried and the final specification is shown in table 1.

The dependent variable for the model is bus share. As the regression results show, households with higher income have a lesser propensity for school bus travel. All the other variables show a positive direction in the estimates, indicating that bus share increases as there is an increase in the percentage of people who live in a primary city, go to work between 6 and 8 a.m., have children, commute for more than 30 minutes, and have fewer vehicles. A review of the fit diagnostics (figure 5) indicates that the model well-explains bus share. The residuals are randomly distributed based on the predicted value, the observed versus predicted bus shares are linear, the residuals have a normal distribution, and the fact that the height of the fit-mean is taller than residual indicates that the variables in the model explain a lot of the variation in the response (dependent) variable.

Table 1. Regression estimates.

Variable	Description	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	Intercept	-0.779	0.131	0.279	35.48	<.0001
PriCity	Percentage of individuals living in a Principal City	0.074	0.033	0.040	5.13	0.025
GTW68	Percentage of workers go to work between 6:00 AM and 8:00 AM	0.880	0.253	0.095	12.08	0.001
tt30more	Percentage of workers who commute more than 30 minutes	0.269	0.102	0.055	6.96	0.009
IncG75k	Percentage of households with income greater than $75,000	-0.643	0.106	0.292	37.07	<.0001
owner	Percentage of homeowner households with school-age children	1.252	0.113	0.961	122.13	<.0001
PopDen	Number of persons per sq. miles	0.000	0.000	0.053	6.78	0.010
nlcar	Percentage households with a vehicle imparity (workers > vehicles)	0.975	0.368	0.055	7.02	0.009

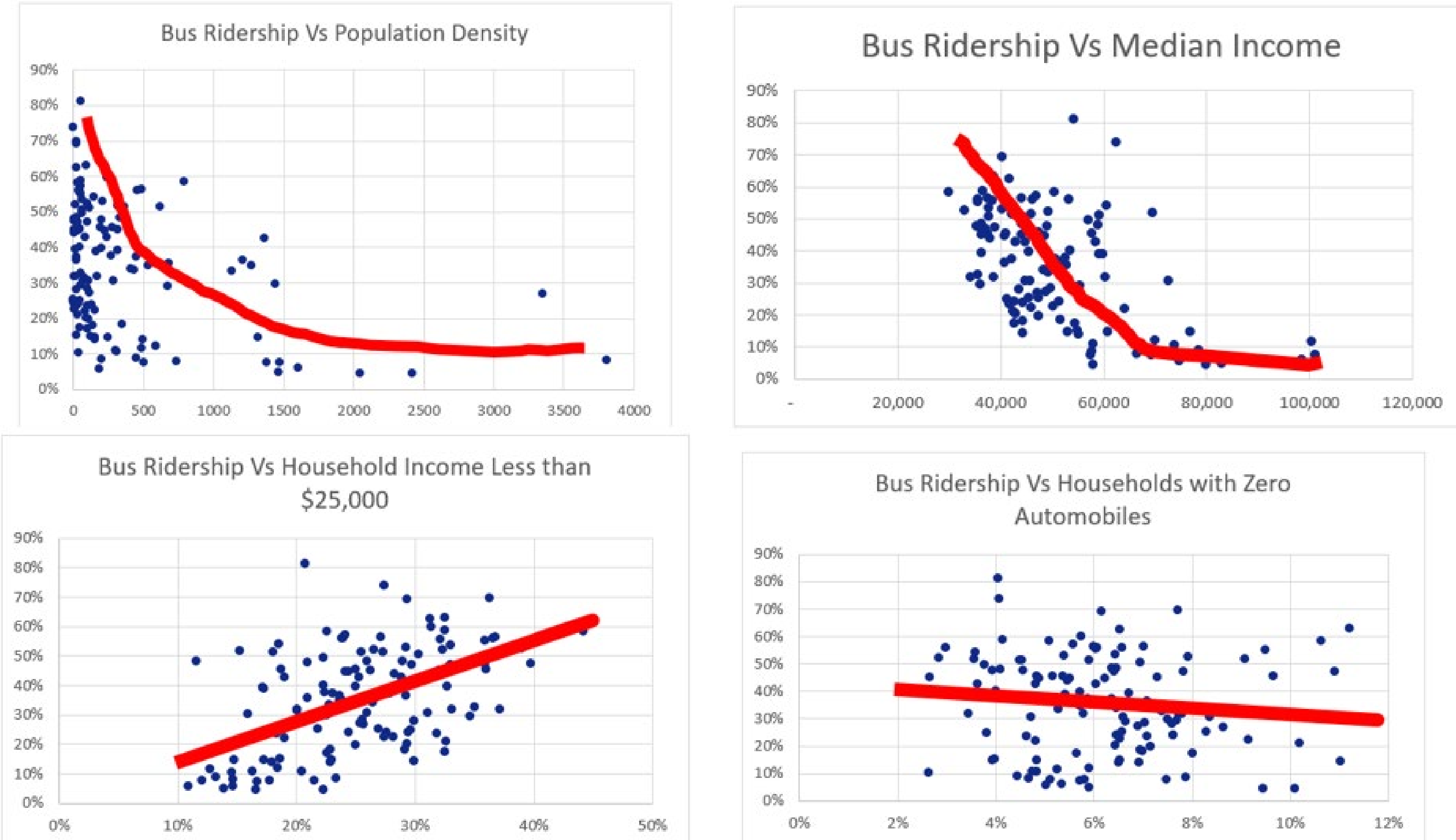

Figure 4. Variables that influence school bus ridership.

(Source: Data Analysis.)

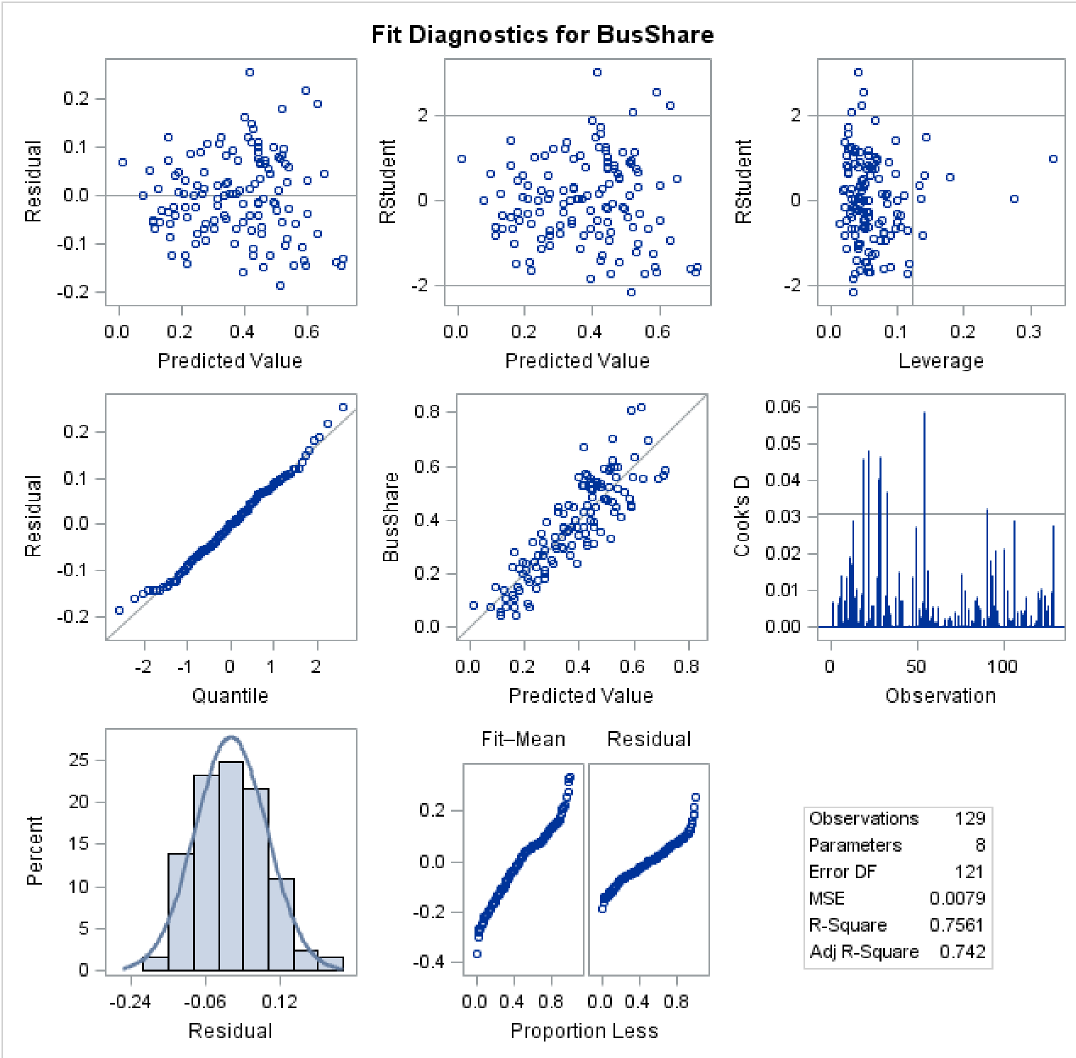

Figure 5. Fit diagnostics for bus share.

(Source: Data Analysis.)

School Bus Vehicle Miles Traveled

The American School Bus Council estimates that the vehicle miles traveled (VMT) by school buses is 5,760,000,000. [1]

1 https://web.archive.org/web/20181008040737/http://www.americanschoolbuscouncil.org/issues/environmental-benefits Accessed original website (http://www.americanschoolbuscouncil.org/issues/environmental-benefits) in October- 2018.

Transit Bus

Two methodologies for determining vehicle revenue miles (VRM) were explored. One methodology relied on the NTD database. The other methodology utilized the General Transit Feed Specification (GTFS).

National Transit Database Methodology

The NTD database TS2.2TimeSeriesSysWideOpexpSvc_4 was accessed and the "master" file and the VRM monthly statistics were extracted for 2016 as of February 2018. Reporting year 2016 was selected as the most recent complete year available since 2017 was at the time incomplete. The VRM file was subsequently inverted to allow the row summation of the monthly data, corresponding to the annual passenger mile data in the "master" file, allowing computation of passenger miles per vehicle revenue mile (PMperVRM), functionally passenger occupancy.

This allowed the direct calculation of passenger miles per vehicle revenue mile for 2016, by agency and mode. Three NTD categories were modes of interest: Commuter Bus (CB), Motor Bus (MB), and Rapid Bus (RB). Table 2 summarizes the findings.

Table 2. National Transit Database data summary.

Mode	Passenger Miles (PM)	Vehicle Revenue Miles (VRM)	PM/VRM
MB Only	18,504,494,448	1,789,143,894	10.34
MB, CB, RB	20,951,007,667	1,924,006,871	10.89
All NTD Modes	57,001,945,470	4,110,075,422	13.87

(Source: NTD.)

General Transit Feed Specification Methodology

In the GTFS methodology, GTFS data were used to calculate the number of revenue vehicle trips per time period to see variability by Time of Day (TOD). The intent was to attribute revenue miles to time periods proportional to the number of vehicle trips in each time period, with the assumption that the PMperVRM would vary across time periods and this disaggregation would possibly provide a more accurate estimation of occupancy (PMperVRM) than that achieved using NTD data. GTFS data were provided by service hour for 30 transit authorities in Florida, New York, Texas, and the District of Columbia.

Unfortunately, we found that the ratio of passenger miles to vehicle revenue miles were identical across time periods. The anticipated additional disaggregation was not there. It appears that the time period passenger estimates in GTFS were derived from each system's annual occupancy factors (presumably PMperVRM ratios).

Since the GTFS data was not disaggregated by time period, there were no unique time period specific PMperVRM factors available. This is illustrated by the GTFS based PMperVRM by time period for Florida transit systems provided in appendix A.

Consequently, GTFS data were used to confirm the NTD databased estimates of PMperVRM. While valuable, this basic verification was limited by two aspects of the data. GTFS data were for 2017, whereas the NTD data were for 2016. This limited the verification to a reasonableness check rather than a replication. Secondly, GTFS data were only available for a subset of the transit agencies and, for those agencies, only for motor bus (NTD category MB). The verification using GTFS data is shown below for Florida, New York, Texas and the District of Columbia. The individual agency and State PMperVRMs for 2016 and 2017 are almost identical, as would be expected (table 3).

Table 3. 2016 NTD PMperVRM versus 2017 General Transit Feed Specification PMperVRM.

Transit Agency ID	State	PMperVRM (2016 NTD)	PMperVRM (2017 TOD)
20002	NY	7.23	7.45
20004	NY	9.18	9.21
20018	NY	8.19	8.11
20113	NY	10.34	10.25
20188	NY	13.63	13.83
	NY	11.18	11.28
30030	DC	10.02	10.32
	DC	10.02	10.32
40026	FL	5.12	5.53
40027	FL	6.72	6.87
40030	FL	7.03	6.9
40034	FL	12.61	12.82
40035	FL	8.43	8.35
40036	FL	5.39	5.55
40037	FL	8	8.07
40038	FL	5.83	5.56
40040	FL	7.84	7.63
40041	FL	9.03	9.43
40046	FL	4.13	4.14
40063	FL	7.5	7.25
40120	FL	4.56	4.63

Transit Agency ID	State	PMperVRM (2016 NTD)	PMperVRM (2017 TOD)
40128	FL	1.53	1.67
40185	FL	4.76	4.92
	FL	9.07	9.31
60006	TX	8.58	8.63
60007	TX	4.42	3.89
60011	TX	7.22	7.19
60048	TX	8.02	7.93
60051	TX	5.41	4.96
60056	TX	5.24	5.35
60114	TX	0.48	0.33
	TX	6.57	7.11

Selected Methodology

Given the findings using GTFS data, the quality and long-standing credibility of the NTD data, and the ultimate objective of generating a very aggregate annual occupancy factor, we believe occupancy as estimated by the PMperVRM calculated from existing NTD data is appropriate for estimating aggregate occupancy. PMperVRM based on NTD data for the three bus modes for 2016 is provided in appendix B.

Intercity Bus

Intercity bus occupancy is measured by compiling occupancy estimates for carriers using predominately single deck buses (using data from Greyhound/Boltbus) and those predominately using double-deck buses (using data from Megabus). Region-specific estimates will be made by weighting these two categories based on their differing prevalence throughout the United States.

Single Deck Carrier Occupancy Estimate

A typical single-deck bus has 55 seats. The average occupancy of single-deck buses is determined by using publicly available data on the Greyhound Lines' official website, official data provided in the annual report of its parent company, First Group, Ltd., and submissions to the Federal Motor Carrier Safety Administration (FMCSA). This information encompasses both Greyhound and Boltbus (which are both owned by First Group and reported together as "Greyhound'). Based on research by Schwieterman et al., these two companies comprise around 30 percent of all scheduled intercity seat miles in the United States.

The research team considered a variety of other approaches to measure single-deck bus occupancy, including creating a formula based on the number of sold-out buses (which can be monitored online) and trends in revenue relative to average ticket prices. However, the approach detailed below was determined to be most effective, to require fewer assumptions, and to be administratively more straightforward.

The process encompasses five steps. The first three (Steps 1–2) involve measuring passenger miles. Step 3 measures bus miles. In the final step (Step 4), seat miles is divided by passenger miles to determine average passenger occupancy, and one person is added to the result to account for the driver. An Excel spreadsheet will automatically make these calculations when data are entered in the appropriate cells:

- **Step 1. Obtain passenger miles reported on Greyhound.com website for its North American operations.** This figure is available on greyhound.com under the "About" tab, and then the "Facts and Figures" subsection. The number provided (5.03 billion at the time of this writing) is updated periodically but apparently not on a fixed schedule. The estimate includes all North America mileage, necessitating the next step to take into account the share within the United States.

- **Step 2. Determine passenger miles that are in United States.** This is done by multiplying the total passenger mile number from Step 1 by the most recent estimate of the share of passenger miles in the U.S, which is available in the Greyhound section of the First Group Annual Report. It was last reported in the 2015 report as 79 percent. In the example above, the resulting passenger miles is 5,030,000 x.79 = 3,973,700,000. If the company provides a newer estimate of the U.S. share, the formula should be modified to reflect this.

- **Step 3. Compute U.S. bus miles for Greyhound/Boltbus.** U.S. bus miles were calculated by adding the mileages reported to FMCSA by each of its three operating units, Greyhound Lines, Greyhound Canada, and Greyhound Mexico. This information is available on the FMCSA website (see link below) and updated annually. Only U.S. mileage is included in this data, so no additional adjustments are needed. The current data is shown in table 4.

Table 4. U.S. bus miles.

Unit	Bus Miles
Greyhound Lines	143,295,106
Greyhound Canada	487,679
Greyhound Mexico	1,467,000
Total	**145,279,785**

- **Step 4. Compute occupancy.** U.S. passenger miles is divided by estimated U.S. bus miles and adding one for the driver. In the example above, that calculation would amount to 28.4: 3,973,700,000/145,279,785 = 27.4. 27.4 + 1 = 28.4. On a 56-seat bus, this represents a load factor of 49 percent.

The strength of this approach is that it relies entirely on publicly available data that is periodically updated by Greyhound. However, it does not consider Greyhound's propensity to occasionally hire other companies to provide its service, such as when there are equipment shortages. Moreover, it provides only a systemwide average of occupancy, without the possibility of determining State- or region-specific estimates. Nevertheless, Greyhound and Boltbus tend to provide service with their own equipment, and this equipment is largely the same throughout different regions of the United States, making any bias apparently quite small. Although the results should be regarded as only an approximation, they appear reasonable and consistent with expectations.

Double Deck Carrier Occupancy Estimate

A typical double-deck bus has 81 seats. Average occupancy for carriers predominately using double-deck equipment was extrapolated from observations of Megabus utilization. Megabus is deemed representative of all carriers predominately using double-deck operations. At present, only one other carrier predominately uses double-deckers, Flixbus, and it is confined to a handful of routes in the West Coast region.

The data collection involved manually tracking the number of available seats on buses within four hours of departure and applying a formula that makes an adjustment for expected "close-in" bookings (i.e., those bookings made after the data is collected, relatively close to the departure time) and no-show rates. The formula was developed based on one set of research observations involving a sample of 100 buses. A set of regional double-deck occupancy factors were then developed using another set of research observations involving random samples of 70 buses across five data collection days. These observations could be refreshed annually to update occupancy factors.

Using Time to Departure to Estimate Number of Boarding Passengers

The data team undertook directional observation of reservation growth on 100 buses within four hours of departure. This data was collected using a random sampling technique during the summer and early autumn of 2018. The number of passengers with reservations was determined by subtracting the number of available seats from the bus capacity.

This showed that reservations (bookings) grow by 12.5 percent from four hours before departure to the "booking cutoff," which is around 20 minutes before departure. The analysis showed that bookings tend to occur relatively steadily across this four-hour period—bookings grow at a compounding rate of 0.0511 percent per minute until the booking cutoff.

The research team determined that, on average, 91 percent of the passengers with reservations before the cutoff point board the bus. To compute this statistic, the number of reservations at the cutoff point was compared with the number of passengers boarding 20 buses in Chicago between June and September 2018. The "no show" rate (9 percent) reflects the tendency of passengers to make speculative bookings that are not ultimately used, change their reservations at the last moment (which can be done at modest cost), or simply miss the bus.

A formula was created to estimate occupancy by computing the number of additional bookings that occur before the booking cutoff and then factoring in the no-show rate. One person is added in this estimate to account for the driver:

Total Occupancy = $[Reservations_x ((1 +.000511)^{\wedge x}) * 0.91] + 1$

where:

$Reservation_x$ is the number of reservations at time x

x is number of minutes until the online booking cutoff (20 minutes before departure)

0.00511 is the rate at which bookings grow per minute, and 0.91 is the share of passengers expected to board the bus.

For example, if a bus had 50 reservations 180 minutes prior to the booking cutoff, the formula predicts that there will be 49.9 boarding passengers. (The additional bookings in the 180 minutes are essentially offset by the no-shows. The number of new bookings will more than offset no-shows:

$= \quad [50 (1 +.000511)^{\wedge 180}) * 0.91] + 1 = 49.9 + 1 = 50.9$ including driver

Another bus having 50 reservations 20 minutes before the cutoff is projected to have 46.0 passengers on board. The equation estimates that, within this 20-minute period, there will be fewer new reservations than no shows.

$= \quad [50 (1 +.000511)^{\wedge 20}) * 0.91] + 1 = 46.0 + 1 = 47$ including driver

Another way to look at these estimates is shown in figure 6, plotting the number of passengers expected to board the bus as a share of the number of reservations at different intervals before the booking cutoff (which is 20 minutes before departure). The chart reflects the phenomenon of no-shows, as explained above. At longer intervals before the booking cutoff, the ratio of bookings to boarding is higher, since more new bookings are made relative to the no-shows that occur. For example, passenger boardings will be about 101.5 percent of bookings that exist 200 minutes before the cutoff.

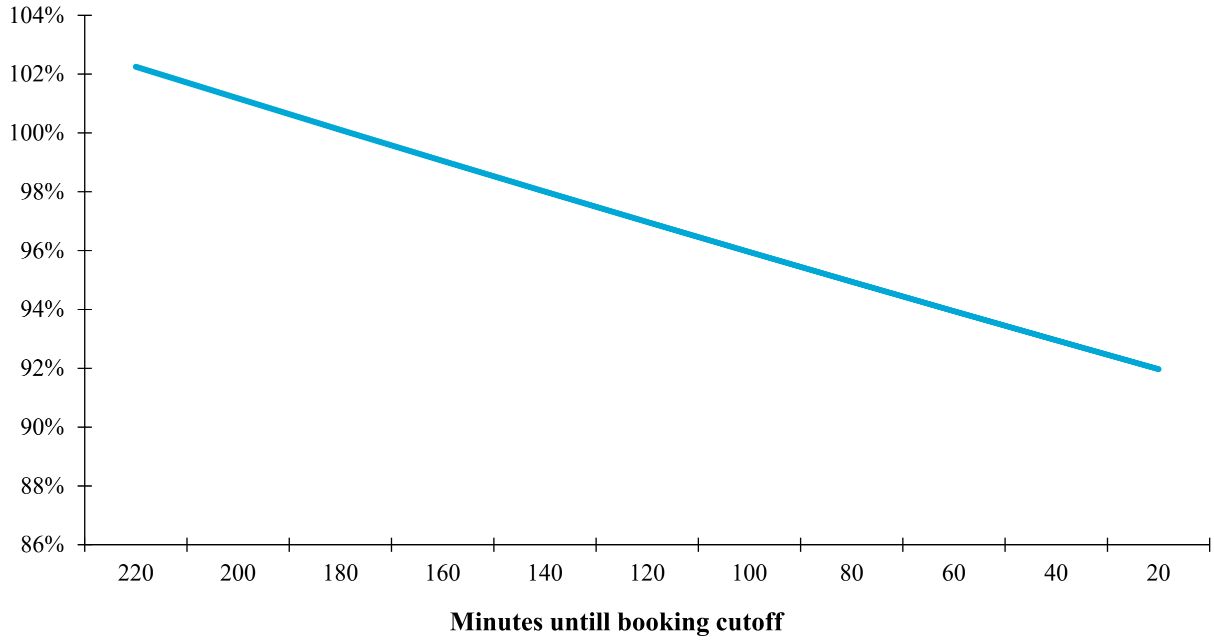

Figure 6. Expected boardings as a share of reservations.

(Source: Data Analysis.)

Collecting a Sample of Occupancy Observations

The understanding developed above of how a single observation of seats remaining for booking at any point within four hours of departure relates to the ultimate expected number of boarding passengers at departure, enabled an unobtrusive single check of seats remaining for any route to suffice in assembling an occupancy database. Indeed, collecting a sample set of 350 observations spread over five separate selected days, each involving different days of the week and times of the year (70 buses sampled per data collection session), required only about two person days of analyst time in total.

The resulting database provided a mix of peak season (August and early September) and off-peak season (e.g., October) departures and provided a stratified sample of 25 departures in the Northeast, 15 in the Southeast, and 10 in the Midwest, South Central, and West Coast region, allowing average double-deck bus occupancies to be calculated. As necessary, this data collection can be repeated in future years to obtain updated estimates of double-deck bus occupancy.

Occupancy Calculations

Using the separate occupancy estimates for single-deck and double-deck bus occupancy, a spreadsheet was developed to automatically tabulate average occupancy. The spreadsheet develops regional averages for bus occupancy by a formula that takes into account the approximate market share of predominately single-deck and predominately double-deck carriers in each region (figure 7). The weightings (table 5) are based on research by Schwieterman (2016). [2] For example, in the Northeast, occupancy is tabulated based on a 92 percent single-deck and 8 percent double-deck weighting. In the Midwest, the ratio between these categories is 90 percent to 10 percent. Presently, no carriers operating in the Mountain region predominantly use double-deck equipment, so that category has a zero weighting.

Table 5. Regional weighting.

Region	Single Deck (Weighting)	Double Deck (Weighting)	Hypothetical Average Occupancy if Single Deck Estimate is 28.4 and Double Deck is 41.1 (Includes Driver)
Northeast	0.92	0.08	29.9
Southeast	0.91	0.09	30.0
Midwest	0.90	0.10	30.0
South Central	0.92	0.08	29.9
Mountain	1.00	0.00	28.4
West	0.91	0.09	30.0
National Average	0.92	0.08	29.9

2 Joseph P. Schwieterman and Brian Antolin, 2016. “2015 Year in Review of Intercity Bus Service in the United States,” Chaddick Institute Policy Series, DePaul University.

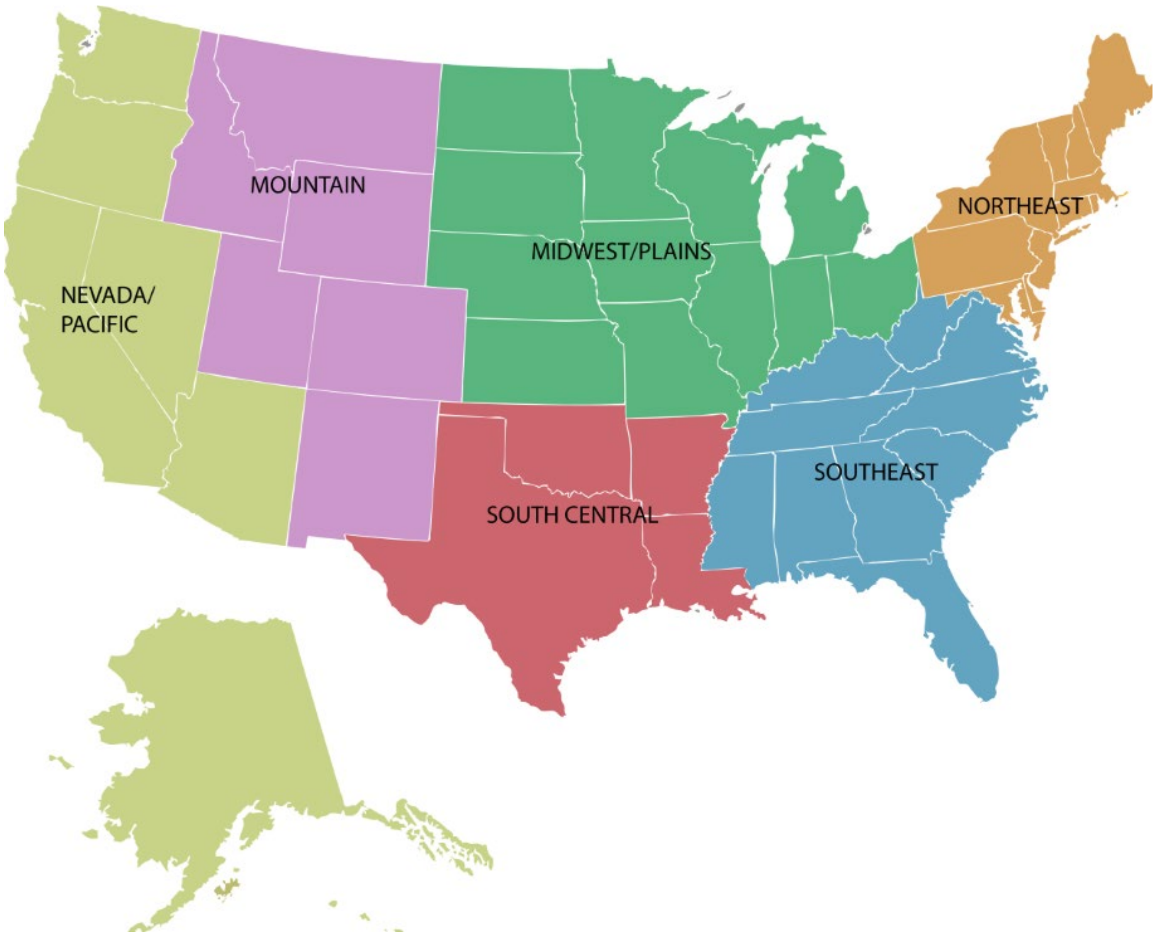

Figure 7. Map of regions for intercity bus occupancy estimates.

(Source: Data Analysis.)

Overall Bus Occupancy

The overall bus occupancy is computed as a weighted average of the occupancy by the individual bus components and the VMT for each. Table 6 shows the overall average bus occupancy.

Table 6. Overall bus occupancy.

Mode	Occupancy	VMT	Weighted Average
School Bus	49.75	5,760,000,000	
Transit Bus	10.89	2,050,607,489	
Intercity Bus	29.9	1,963,813,700*	
Charter Bus	37.5[1]	1,963,813,700*	
Overall			**37.59**

([1] ABA Motorcoach Census, 2015.)

4.0 Truck Occupancy

The 2016 FARS database was used to determine the number of persons occupying the vehicles that were involved in fatal crashes. Using the reported Body Type of those vehicles, the occupancies of those vehicles were computed.

It is assumed that the occupancies of vehicles involved in fatal crashes is an unbiased simple of all vehicles by body type. The assumption that involvement in crashes is an unbiased sample at the State level has been used by several State DOTs in processing their own required submittals of vehicle occupancies.

The FARS person and vehicle tables were joined based on the common key field of State case number (ST_CASE). The "person" table file contains records for each of the Motor Vehicle Occupants in those accidents. Pedestrians, bicyclists and other persons not in motor vehicles are reported in a different file.

The body type in FARS is entered as a numeric code. The name associated with that body (e.g., BODY_TYP 1= "Convertible, excludes sun-roof, t-bar") as well as the grouping of body types (e.g., "Utility Vehicles" which consist of Body Types 14,15,16 and 18) were obtained from the FARS User's Manual available on the NHTSA website. [3]

To compute the truck occupancy factors, the "Medium/Heavy Vehicles" category was disaggregated into Combination Unit/CU trucks, Single Unit/SU trucks and Unknown Body Type trucks. These new body type groupings were used to compute the truck occupancies shown in table 7. Also shown in table 7 is the vehicle observations for each Body Type Group in the 2016 FARS database.

Table 7. Truck occupancy factors.

Vehicle Type	Observations	Occupancy
Trucks	4,213	1.16
Single Unit	1,334	1.25
Combination	2,817	1.11
Unknown Truck Type	62	1.34

Given that the FARS data is a much smaller sample size and because it only contains accidents that resulted in fatal injuries, it may be less representative of the overall population.

Table 8 shows the proportion of vehicle miles that were driven by each truck type in 2016, as estimated by the Highway Statistical Series (HSS), as well as the proportion of fatal accidents in 2016, as reported

[3] "2016 FARS / CRSS Coding and Validation Manual," National Highway Traffic Safety Administration, October 2017 accessed at ftp://ftp.nhtsa.dot.gov/FARS/FARS-DOC/Coding and Validation Manual/2016 FARS CRSS Coding and Validation Manual-812449.pdf on January 31, 2018.

in FARS. It also shows the derivation of the vehicle occupancy factor for trucks. There is a greater prevalence of combination trucks involved in fatal accidents (recorded by FARS) than in terms of VMT (recorded by HSS). Since the occupancy factor is greater for single unit trucks (1.25) than for combination trucks (1.11), the vehicle occupancy estimate from FARS is weighted using the HSS prevalence to avoid this potential bias, arriving at the adjusted truck occupancy factor of 1.17 (i.e., 39% * 1.25 + 61% * 1.11 = 1.17).

Table 8. Adjusted truck occupancy factors.

Truck Type	Proportion in 2016 FARS	Proportion of 2016 VMT (HSS)	Vehicle Occupancy (2016 FARS)	Adjusted Truck Occupancy Factor
Single Unit	32%	39%	1.25	1.17
Combination	68%	61%	1.11	

5.0 Apply Methodology to States

One of the key requirements of this task is to apply the methodology developed in sections 3 and 4 to individual states. This is done to ensure that the performance measures that are derived using these occupancy factors will be more relevant to the particular state. The process used to develop the individual state level estimates is detailed below. First, the application of the methodology for bus occupancy to states is detailed followed by application of the truck methodology to individual states.

Bus Occupancy

School Bus Occupancy

Using information from the Census along with the developed enrollment and bus availability data obtained from each state as part of this study, the state level school bus occupancy is developed. The regression equations developed in Table 1 are used to derive the share of school bus ridership. This estimated share is multiplied by the general school enrollment in the state to obtain the number of school children transported by bus. Dividing this number by the number of school buses in the state provides the school bus occupancy for the state. For states where the regression estimates exceed the threshold of 60 students/bus, the estimate for that state is capped at the national estimate of 49.75 (Table 6). Appendix C shows the individual state level school bus occupancy.

Transit Bus Occupancy

In order to apply transit bus occupancy to the individual states, NTD data is applied by aggregating the individual agency PMT and VRM to the state level and obtaining the transit bus occupancy. Appendix C shows the individual state level transit bus occupancy based on the 2016 NTD data.

Intercity Bus Occupancy

In order to apply the intercity bus occupancy, the regional estimates obtained from Table 5 is applied to each state in the region. Appendix C shows the individual state level intercity bus occupancy. For charter buses, the overall estimate of occupancy from the ABA is used to uniformly across all states because information at the state level is not available.

VMT Calculations

The estimates obtained do not account for VMT and need to be weighted to obtain the proper overall bus occupancy by VMT. This is achieved through the following steps.

Step 1. Obtain individual bus category VMT. HSS table VM-4 provides the distribution of annual distance traveled by vehicle type. However, for buses, it does not break this information down by school, transit, intercity, and charter bus. Therefore, in order to obtain the VMT distribution by individual bus category, the national VMT shown in Table 6 is used to obtain the distribution of VMT by bus type.

Step 2. Obtain state level VMT by bus. HSS table VM-2 provides the VMT by functional system. Table VM-4 provides distribution of VMT by Interstate System, Other Arterials, and Other and VM-2 provides by Interstate, Other Freeways and Expressways, Other Principal Arterial, Minor Arterial, Major and Minor Collector, and Local. Therefore, Table 9 shows the crosswalk between the Functional System in VM-2 and VM-4 for the purposes of obtaining state level VMT by vehicle type.

Table 9. VM-2 and VM-4 Crosswalk.

VM -2 Functional System	VM-4 Functional System
Interstate	Interstate
Other Freeways and Expressways	Other Arterials
Other Principal Arterial	Other Arterials
Minor Arterial	Other
Major Collector	Other
Minor Collector	Other
Local	Other

Step 3. Calculate Individual Bus Type VMT. After computing the bus VMT from HSS tables VM-4 and VM-2, apply the factors obtained from Step 1 and obtain state level VMT by bus type.

Step 4. Calculate Overall Bus Occupancy by State. Once the state level bus type VMTs are obtained, use these VMT information along with the state level bus type occupancy to obtain the overall occupancy by state.

The overall bus occupancy is shown in Table 10.

Table 10. Overall Bus Occupancy.

STATE	Overall Bus Occupancy
Alabama	37.1
Alaska	33.7
Arizona	40.3
Arkansas	39.2
California	41.7
Colorado	37.1

STATE	Overall Bus Occupancy
Connecticut	27.2
Delaware	30.0
District of Columbia	31.8
Florida	36.2
Georgia	38.3
Hawaii	38.1
Idaho	35.8
Illinois	32.8
Indiana	32.6
Iowa	36.6
Kansas	36.4
Kentucky	36.6
Louisiana	40.2
Maine	30.6
Maryland	39.8
Massachusetts	39.3
Michigan	37.8
Minnesota	32.6
Mississippi	36.3
Missouri	33.3
Montana	23.6
Nebraska	23.0
Nevada	31.1
New Hampshire	26.6
New Jersey	31.5

STATE	Overall Bus Occupancy
New Mexico	36.8
New York	33.5
North Carolina	39.8
North Dakota	36.3
Ohio	38.3
Oklahoma	32.2
Oregon	42.5
Pennsylvania	37.8
Rhode Island	27.8
South Carolina	36.3
South Dakota	30.9
Tennessee	39.0
Texas	37.1
Utah	37.3
Vermont	33.3
Virginia	28.8
Washington	41.2
West Virginia	37.4
Wisconsin	29.1
Wyoming	25.0

Truck Occupancy

Applying the methodology in Section 4 to each state gives Truck Occupancy (weighted by VMT) for each state and is shown in Table 11.

Table 11. Overall Truck Occupancy.

STATE	Overall Truck Occupancy
Alabama	1.19
Alaska	1.50
Arizona	1.31
Arkansas	1.21
California	1.14
Colorado	1.21
Connecticut	1.17
Delaware	1.21
District of Columbia	1.17
Florida	1.18
Georgia	1.12
Hawaii	1.00
Idaho	1.25
Illinois	1.12
Indiana	1.04
Iowa	1.12
Kansas	1.17
Kentucky	1.12
Louisiana	1.20
Maine	1.10
Maryland	1.19
Massachusetts	1.09
Michigan	1.04
Minnesota	1.20

STATE	Overall Truck Occupancy
Mississippi	1.18
Missouri	1.16
Montana	1.16
Nebraska	1.06
Nevada	1.19
New Hampshire	1.46
New Jersey	1.12
New Mexico	1.23
New York	1.16
North Carolina	1.14
North Dakota	1.21
Ohio	1.14
Oklahoma	1.22
Oregon	1.25
Pennsylvania	1.13
Rhode Island	1.00
South Carolina	1.12
South Dakota	1.00
Tennessee	1.18
Texas	1.22
Utah	1.58
Vermont	1.00
Virginia	1.07
Washington	1.19
West Virginia	1.21

STATE	Overall Truck Occupancy
Wisconsin	1.07
Wyoming	1.27

Appendix A. General Transit Feed Specification-Based TOD PMperVRM

Table 12. GTFS Based TOD PMperVRM

NTD ID	Mode	UZA Name	Time of Day	PM	VRM	PMperVRM
40036	MB	Tallahassee, FL	5:00 AM	52,193	9,402	5.55
40036	MB	Tallahassee, FL	6:00 AM	244,904	44,116	5.55
40036	MB	Tallahassee, FL	7:00 AM	678,503	122,222	5.55
40036	MB	Tallahassee, FL	8:00 AM	794,933	143,195	5.55
40036	MB	Tallahassee, FL	9:00 AM	794,933	143,195	5.55
40036	MB	Tallahassee, FL	10:00 AM	762,814	137,410	5.55
40036	MB	Tallahassee, FL	11:00 AM	802,963	144,642	5.55
40036	MB	Tallahassee, FL	12:00 PM	815,007	146,811	5.55
40036	MB	Tallahassee, FL	1:00 PM	815,007	146,811	5.55
40036	MB	Tallahassee, FL	2:00 PM	851,140	153,320	5.55
40036	MB	Tallahassee, FL	3:00 PM	871,214	156,936	5.55
40036	MB	Tallahassee, FL	4:00 PM	859,170	154,767	5.55
40036	MB	Tallahassee, FL	5:00 PM	758,800	136,687	5.55
40036	MB	Tallahassee, FL	6:00 PM	738,726	133,070	5.55
40036	MB	Tallahassee, FL	7:00 PM	449,659	80,999	5.55
40036	MB	Tallahassee, FL	8:00 PM	160,593	28,928	5.55
40036	MB	Tallahassee, FL	9:00 PM	128,474	23,143	5.55
40036	MB	Tallahassee, FL	10:00 PM	96,356	17,357	5.55
40036	MB	Tallahassee, FL	11:00 PM	64,237	11,571	5.55
40041	MB	Tampa-St. Petersburg, FL	4:00 AM	224,610	23,808	9.43
40041	MB	Tampa-St. Petersburg, FL	5:00 AM	1,369,050	145,116	9.43
40041	MB	Tampa-St. Petersburg, FL	6:00 AM	3,615,147	383,198	9.43
40041	MB	Tampa-St. Petersburg, FL	7:00 AM	4,342,455	460,291	9.43
40041	MB	Tampa-St. Petersburg, FL	8:00 AM	4,321,064	458,024	9.43
40041	MB	Tampa-St. Petersburg, FL	9:00 AM	4,267,585	452,355	9.43
40041	MB	Tampa-St. Petersburg, FL	10:00 AM	4,288,976	454,622	9.43
40041	MB	Tampa-St. Petersburg, FL	11:00 AM	4,481,499	475,029	9.43
40041	MB	Tampa-St. Petersburg, FL	12:00 PM	4,609,847	488,634	9.43
40041	MB	Tampa-St. Petersburg, FL	1:00 PM	4,609,847	488,634	9.43

NTD ID	Mode	UZA Name	Time of Day	PM	VRM	PMperVRM
40041	MB	Tampa-St. Petersburg, FL	2:00 PM	4,588,456	486,367	9.43
40041	MB	Tampa-St. Petersburg, FL	3:00 PM	4,631,239	490,902	9.43
40041	MB	Tampa-St. Petersburg, FL	4:00 PM	4,748,892	503,373	9.43
40041	MB	Tampa-St. Petersburg, FL	5:00 PM	4,738,196	502,239	9.43
40041	MB	Tampa-St. Petersburg, FL	6:00 PM	4,588,456	486,367	9.43
40041	MB	Tampa-St. Petersburg, FL	7:00 PM	4,395,933	465,960	9.43
40041	MB	Tampa-St. Petersburg, FL	8:00 PM	4,085,758	433,082	9.43
40041	MB	Tampa-St. Petersburg, FL	9:00 PM	3,764,887	399,070	9.43
40041	MB	Tampa-St. Petersburg, FL	10:00 PM	2,877,144	304,971	9.43
40041	MB	Tampa-St. Petersburg, FL	11:00 PM	1,005,396	106,570	9.43
40128	MB	Fort Walton Beach-Navarre-Wright, FL	5:00 PM	40,119	23,965	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	6:00 PM	28,319	16,917	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	7:00 PM	7,080	4,229	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	6:00 AM	7,080	4,229	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	7:00 AM	23,599	14,097	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	8:00 AM	35,399	21,146	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	9:00 AM	42,479	25,375	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	10:00 AM	37,759	22,556	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	11:00 AM	37,759	22,556	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	12:00 PM	40,119	23,965	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	1:00 PM	40,119	23,965	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	2:00 PM	37,759	22,556	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	3:00 PM	40,119	23,965	1.67
40128	MB	Fort Walton Beach-Navarre-Wright, FL	4:00 PM	35,399	21,146	1.67
40037	MB	Miami, FL	5:00 AM	626,719	77,644	8.07

NTD ID	Mode	UZA Name	Time of Day	PM	VRM	PMperVRM
40037	MB	Miami, FL	6:00 AM	2,101,351	260,334	8.07
40037	MB	Miami, FL	7:00 AM	3,391,655	420,189	8.07
40037	MB	Miami, FL	8:00 AM	4,006,085	496,310	8.07
40037	MB	Miami, FL	9:00 AM	4,350,166	538,938	8.07
40037	MB	Miami, FL	10:00 AM	4,423,898	548,072	8.07
40037	MB	Miami, FL	11:00 AM	4,423,898	548,072	8.07
40037	MB	Miami, FL	12:00 PM	4,473,052	554,162	8.07
40037	MB	Miami, FL	1:00 PM	4,485,341	555,685	8.07
40037	MB	Miami, FL	2:00 PM	4,595,938	569,386	8.07
40037	MB	Miami, FL	3:00 PM	4,681,959	580,043	8.07
40037	MB	Miami, FL	4:00 PM	4,608,227	570,909	8.07
40037	MB	Miami, FL	5:00 PM	4,116,683	510,012	8.07
40037	MB	Miami, FL	6:00 PM	3,391,655	420,189	8.07
40037	MB	Miami, FL	7:00 PM	2,236,526	277,081	8.07
40037	MB	Miami, FL	8:00 PM	1,425,478	176,601	8.07
40037	MB	Miami, FL	9:00 PM	712,739	88,301	8.07
40037	MB	Miami, FL	10:00 PM	98,309	12,179	8.07
40038	MB	Pensacola, FL-AL	5:00 AM	79,509	14,290	5.56
40038	MB	Pensacola, FL-AL	6:00 AM	304,784	54,779	5.56
40038	MB	Pensacola, FL-AL	7:00 AM	322,452	57,955	5.56
40038	MB	Pensacola, FL-AL	8:00 AM	397,544	71,451	5.56
40038	MB	Pensacola, FL-AL	9:00 AM	344,538	61,924	5.56
40038	MB	Pensacola, FL-AL	10:00 AM	375,458	67,482	5.56
40038	MB	Pensacola, FL-AL	11:00 AM	357,790	64,306	5.56
40038	MB	Pensacola, FL-AL	12:00 PM	401,961	72,245	5.56
40038	MB	Pensacola, FL-AL	1:00 PM	335,704	60,336	5.56
40038	MB	Pensacola, FL-AL	2:00 PM	401,961	72,245	5.56
40038	MB	Pensacola, FL-AL	3:00 PM	357,790	64,306	5.56
40038	MB	Pensacola, FL-AL	4:00 PM	415,213	74,627	5.56
40038	MB	Pensacola, FL-AL	5:00 PM	375,458	67,482	5.56
40038	MB	Pensacola, FL-AL	6:00 PM	265,029	47,634	5.56
40038	MB	Pensacola, FL-AL	7:00 PM	66,257	11,909	5.56
40038	MB	Pensacola, FL-AL	8:00 PM	44,172	7,939	5.56
40038	MB	Pensacola, FL-AL	9:00 PM	39,754	7,145	5.56

NTD ID	Mode	UZA Name	Time of Day	PM	VRM	PMperVRM
40038	MB	Pensacola, FL-AL	10:00 PM	13,251	2,382	5.56
40038	MB	Pensacola, FL-AL	11:00 PM	17,669	3,176	5.56
40027	MB	Tampa-St. Petersburg, FL	3:00 PM	4,022,479	585,335	6.87
40027	MB	Tampa-St. Petersburg, FL	4:00 PM	4,193,538	610,226	6.87
40027	MB	Tampa-St. Petersburg, FL	5:00 PM	4,089,866	595,141	6.87
40027	MB	Tampa-St. Petersburg, FL	6:00 PM	3,716,646	540,831	6.87
40027	MB	Tampa-St. Petersburg, FL	7:00 PM	2,923,555	425,424	6.87
40027	MB	Tampa-St. Petersburg, FL	8:00 PM	2,156,381	313,788	6.87
40027	MB	Tampa-St. Petersburg, FL	9:00 PM	1,466,961	213,466	6.87
40027	MB	Tampa-St. Petersburg, FL	10:00 PM	896,764	130,493	6.87
40027	MB	Tampa-St. Petersburg, FL	11:00 PM	450,974	65,624	6.87
40027	MB	Tampa-St. Petersburg, FL	4:00 AM	10,367	1,509	6.87
40027	MB	Tampa-St. Petersburg, FL	5:00 AM	1,041,905	151,614	6.87
40027	MB	Tampa-St. Petersburg, FL	6:00 AM	2,659,191	386,954	6.87
40027	MB	Tampa-St. Petersburg, FL	7:00 AM	3,618,158	526,499	6.87
40027	MB	Tampa-St. Petersburg, FL	8:00 AM	4,022,479	585,335	6.87
40027	MB	Tampa-St. Petersburg, FL	9:00 AM	4,043,214	588,352	6.87
40027	MB	Tampa-St. Petersburg, FL	10:00 AM	3,809,951	554,408	6.87
40027	MB	Tampa-St. Petersburg, FL	11:00 AM	3,784,033	550,637	6.87
40027	MB	Tampa-St. Petersburg, FL	12:00 PM	3,851,420	560,443	6.87
40027	MB	Tampa-St. Petersburg, FL	1:00 PM	3,866,971	562,706	6.87
40027	MB	Tampa-St. Petersburg, FL	2:00 PM	3,918,807	570,249	6.87
40046	MB	Sarasota-Bradenton, FL	5:00 AM	311,185	75,151	4.14
40046	MB	Sarasota-Bradenton, FL	6:00 AM	708,811	171,177	4.14
40046	MB	Sarasota-Bradenton, FL	7:00 AM	769,320	185,790	4.14
40046	MB	Sarasota-Bradenton, FL	8:00 AM	816,862	197,271	4.14
40046	MB	Sarasota-Bradenton, FL	9:00 AM	838,472	202,490	4.14
40046	MB	Sarasota-Bradenton, FL	10:00 AM	860,082	207,709	4.14
40046	MB	Sarasota-Bradenton, FL	11:00 AM	868,726	209,796	4.14
40046	MB	Sarasota-Bradenton, FL	12:00 PM	868,726	209,796	4.14
40046	MB	Sarasota-Bradenton, FL	1:00 PM	855,760	206,665	4.14
40046	MB	Sarasota-Bradenton, FL	2:00 PM	868,726	209,796	4.14
40046	MB	Sarasota-Bradenton, FL	3:00 PM	881,692	212,928	4.14
40046	MB	Sarasota-Bradenton, FL	4:00 PM	911,946	220,234	4.14

NTD ID	Mode	UZA Name	Time of Day	PM	VRM	PMperVRM
40046	MB	Sarasota-Bradenton, FL	5:00 PM	894,658	216,059	4.14
40046	MB	Sarasota-Bradenton, FL	6:00 PM	847,116	204,578	4.14
40046	MB	Sarasota-Bradenton, FL	7:00 PM	626,693	151,346	4.14
40046	MB	Sarasota-Bradenton, FL	8:00 PM	371,694	89,764	4.14
40046	MB	Sarasota-Bradenton, FL	9:00 PM	254,999	61,582	4.14
40046	MB	Sarasota-Bradenton, FL	10:00 PM	116,695	28,182	4.14
40046	MB	Sarasota-Bradenton, FL	11:00 PM	8,644	2,088	4.14
40063	MB	Palm Bay-Melbourne, FL	5:00 AM	104,216	14,382	7.25
40063	MB	Palm Bay-Melbourne, FL	6:00 AM	416,866	57,529	7.25
40063	MB	Palm Bay-Melbourne, FL	7:00 AM	677,407	93,484	7.25
40063	MB	Palm Bay-Melbourne, FL	8:00 AM	964,002	133,035	7.25
40063	MB	Palm Bay-Melbourne, FL	9:00 AM	990,056	136,631	7.25
40063	MB	Palm Bay-Melbourne, FL	10:00 AM	990,056	136,631	7.25
40063	MB	Palm Bay-Melbourne, FL	11:00 AM	990,056	136,631	7.25
40063	MB	Palm Bay-Melbourne, FL	12:00 PM	781,623	107,866	7.25
40063	MB	Palm Bay-Melbourne, FL	1:00 PM	807,677	111,462	7.25
40063	MB	Palm Bay-Melbourne, FL	2:00 PM	1,016,110	140,226	7.25
40063	MB	Palm Bay-Melbourne, FL	3:00 PM	1,042,164	143,822	7.25
40063	MB	Palm Bay-Melbourne, FL	4:00 PM	1,068,218	147,417	7.25
40063	MB	Palm Bay-Melbourne, FL	5:00 PM	833,731	115,058	7.25
40063	MB	Palm Bay-Melbourne, FL	6:00 PM	338,703	46,742	7.25
40063	MB	Palm Bay-Melbourne, FL	7:00 PM	286,595	39,551	7.25
40063	MB	Palm Bay-Melbourne, FL	8:00 PM	234,487	32,360	7.25
40063	MB	Palm Bay-Melbourne, FL	9:00 PM	156,325	21,573	7.25
40063	MB	Palm Bay-Melbourne, FL	10:00 PM	52,108	7,191	7.25
40063	MB	Palm Bay-Melbourne, FL	11:00 PM	52,108	7,191	7.25

Appendix B. 2016 National Transit Database-Based Bus Occupancy Factors by Mode

Table 13. 2016 NTD Occupancy by Mode= CB

Mode=CB			
Obs	**ID5**	**Mode**	**PMperVRM**
1	00006	CB	7.82
2	00019	CB	7.90
3	00024	CB	11.45
4	00029	CB	29.47
5	00040	CB	22.16
6	00044	CB	9.06
7	00057	CB	6.58
8	10013	CB	16.63
9	10045	CB	5.71
10	10064	CB	19.61
11	10066	CB	8.01
12	10102	CB	12.62
13	10105	CB	27.44
14	20002	CB	16.14
15	20008	CB	17.20
16	20122	CB	20.27
17	20126	CB	21.14
18	20128	CB	27.26
19	20135	CB	23.06
20	20137	CB	25.46
21	20149	CB	18.08
22	20161	CB	16.04
23	20163	CB	25.83
24	20169	CB	22.01
25	20177	CB	16.30
26	20217	CB	26.11
27	30007	CB	8.72
28	30027	CB	5.69

Mode=CB

Obs	ID5	Mode	PMperVRM
29	30034	CB	25.52
30	30070	CB	21.41
31	30081	CB	26.68
32	30095	CB	4.31
33	30102	CB	30.17
34	30103	CB	23.14
35	40004	CB	9.69
36	40008	CB	10.49
37	40027	CB	2.98
38	40034	CB	17.64
39	40035	CB	3.37
40	40046	CB	4.41
41	40078	CB	14.60
42	40100	CB	8.92
43	40110	CB	12.17
44	40135	CB	14.79
45	40138	CB	15.88
46	40159	CB	19.46
47	40173	CB	8.37
48	40192	CB	0.46
49	40928	CB	12.42
50	50006	CB	6.84
51	50010	CB	10.72
52	50028	CB	7.89
53	50040	CB	8.29
54	50096	CB	9.23
55	50117	CB	13.64
56	50148	CB	4.90
57	50157	CB	1.92
58	50159	CB	2.35
59	50160	CB	13.21
60	50161	CB	11.51

Mode=CB			
Obs	**ID5**	**Mode**	**PMperVRM**
61	50183	CB	26.40
62	60008	CB	18.37
63	60014	CB	5.91
64	60048	CB	11.96
65	60090	CB	1.11
66	60103	CB	8.06
67	60111	CB	3.26
68	60114	CB	2.14
69	60134	CB	22.30
70	70035	CB	7.92
71	80001	CB	12.94
72	90001	CB	6.75
73	90006	CB	14.41
74	90012	CB	15.11
75	90014	CB	22.31
76	90026	CB	20.06
77	90031	CB	4.69
78	90036	CB	8.68
79	90061	CB	17.61
80	90062	CB	3.87
81	90088	CB	5.05
82	90091	CB	1.11
83	90092	CB	7.07
84	90121	CB	22.16
85	90147	CB	14.21
86	90148	CB	9.32
87	90159	CB	12.53
88	90164	CB	5.72
89	90171	CB	9.93
90	90196	CB	17.56
91	90205	CB	14.27
92	90229	CB	19.50

Mode=CB

Obs	ID5	Mode	PMperVRM
93	90232	CB	7.58
94	90241	CB	29.82

Table 14. 2016 NTD Occupancy by Mode= MB

Mode=MB

Obs	ID5	Mode	PMperVRM
95	00001	MB	14.41
96	00002	MB	7.07
97	00003	MB	7.69
98	00005	MB	5.94
99	00006	MB	4.93
100	00007	MB	9.97
101	00008	MB	13.34
102	00011	MB	6.47
103	00012	MB	9.00
104	00016	MB	4.51
105	00018	MB	4.62
106	00019	MB	6.17
107	00020	MB	6.63
108	00021	MB	7.49
109	00024	MB	7.14
110	00025	MB	4.78
111	00029	MB	6.42
112	00034	MB	8.96
113	00043	MB	6.81
114	00044	MB	3.38
115	00047	MB	8.33
116	00057	MB	3.16
117	10001	MB	8.71
118	10003	MB	13.17
119	10004	MB	13.88
120	10005	MB	5.13

Mode=MB

Obs	ID5	Mode	PMperVRM
121	10006	MB	9.62
122	10007	MB	3.37
123	10008	MB	8.40
124	10013	MB	6.22
125	10014	MB	6.67
126	10016	MB	7.46
127	10040	MB	6.04
128	10045	MB	5.12
129	10048	MB	9.35
130	10049	MB	2.27
131	10050	MB	8.82
132	10051	MB	5.99
133	10053	MB	4.25
134	10055	MB	7.36
135	10056	MB	7.85
136	10057	MB	5.29
137	10061	MB	4.74
138	10063	MB	5.59
139	10064	MB	2.72
140	10066	MB	5.06
141	10086	MB	5.71
142	10087	MB	4.97
143	10098	MB	1.35
144	10105	MB	6.49
145	10107	MB	5.31
146	10118	MB	2.64
147	10128	MB	6.49
148	10130	MB	4.97
149	10183	MB	33.47
150	20002	MB	7.23
151	20003	MB	6.25
152	20004	MB	9.18

Mode=MB

Obs	ID5	Mode	PMperVRM
153	20006	MB	1.31
154	20008	MB	17.89
155	20010	MB	3.12
156	20018	MB	8.19
157	20071	MB	1.70
158	20072	MB	4.33
159	20076	MB	18.59
160	20078	MB	0.78
161	20080	MB	14.58
162	20082	MB	14.91
163	20084	MB	7.73
164	20096	MB	2.16
165	20113	MB	10.34
166	20145	MB	6.43
167	20166	MB	12.32
168	20175	MB	23.40
169	20178	MB	4.27
170	20188	MB	13.63
171	20190	MB	7.94
172	20192	MB	3.62
173	20196	MB	6.27
174	20206	MB	16.26
175	20209	MB	6.88
176	30001	MB	3.70
177	30002	MB	4.91
178	30006	MB	7.77
179	30007	MB	9.15
180	30008	MB	6.81
181	30010	MB	8.44
182	30011	MB	3.47
183	30012	MB	4.08
184	30013	MB	5.46

Mode=MB			
Obs	**ID5**	**Mode**	**PMperVRM**
185	30014	MB	8.92
186	30015	MB	4.33
187	30018	MB	11.28
188	30019	MB	14.92
189	30022	MB	10.92
190	30023	MB	12.58
191	30024	MB	16.33
192	30025	MB	4.21
193	30026	MB	7.39
194	30027	MB	4.70
195	30030	MB	10.02
196	30034	MB	14.02
197	30035	MB	1.84
198	30044	MB	7.57
199	30048	MB	6.82
200	30051	MB	6.80
201	30054	MB	9.36
202	30058	MB	5.08
203	30061	MB	5.98
204	30068	MB	4.43
205	30070	MB	10.30
206	30071	MB	4.20
207	30072	MB	4.56
208	30075	MB	4.74
209	30076	MB	4.66
210	30077	MB	1.04
211	30080	MB	3.46
212	30081	MB	4.47
213	30083	MB	6.00
214	30085	MB	8.52
215	30087	MB	2.67
216	30088	MB	4.70

Mode=MB			
Obs	**ID5**	**Mode**	**PMperVRM**
217	30091	MB	8.26
218	30094	MB	8.71
219	30095	MB	4.02
220	30096	MB	6.82
221	30111	MB	3.33
222	30112	MB	4.75
223	30129	MB	5.01
224	30137	MB	3.79
225	30201	MB	15.00
226	40001	MB	3.83
227	40002	MB	3.18
228	40003	MB	7.27
229	40004	MB	7.22
230	40005	MB	7.47
231	40006	MB	3.15
232	40007	MB	7.83
233	40008	MB	8.29
234	40009	MB	5.55
235	40012	MB	4.58
236	40014	MB	6.33
237	40015	MB	1.08
238	40017	MB	10.59
239	40018	MB	7.38
240	40019	MB	7.53
241	40021	MB	4.80
242	40022	MB	10.02
243	40023	MB	4.33
244	40025	MB	3.81
245	40026	MB	5.12
246	40027	MB	6.72
247	40028	MB	5.77
248	40029	MB	10.17

Mode=MB			
Obs	**ID5**	**Mode**	**PMperVRM**
249	40030	MB	7.03
250	40031	MB	6.01
251	40032	MB	4.97
252	40034	MB	12.61
253	40035	MB	8.43
254	40036	MB	5.39
255	40037	MB	8.00
256	40038	MB	5.83
257	40040	MB	7.84
258	40041	MB	9.03
259	40042	MB	5.17
260	40043	MB	5.61
261	40044	MB	3.29
262	40046	MB	4.13
263	40047	MB	6.73
264	40051	MB	6.70
265	40053	MB	5.62
266	40057	MB	4.63
267	40058	MB	10.51
268	40063	MB	7.50
269	40071	MB	5.76
270	40074	MB	3.36
271	40077	MB	5.29
272	40078	MB	5.23
273	40086	MB	13.40
274	40087	MB	7.35
275	40093	MB	4.03
276	40094	MB	2.47
277	40097	MB	6.25
278	40100	MB	0.79
279	40104	MB	5.67
280	40108	MB	6.59

Mode=MB

Obs	ID5	Mode	PMperVRM
281	40110	MB	7.47
282	40120	MB	4.56
283	40128	MB	1.53
284	40138	MB	6.24
285	40140	MB	5.46
286	40141	MB	2.59
287	40147	MB	8.92
288	40158	MB	3.68
289	40172	MB	3.11
290	40180	MB	4.62
291	40185	MB	4.76
292	40191	MB	17.68
293	40192	MB	1.34
294	40208	MB	7.48
295	40224	MB	2.38
296	40245	MB	3.00
297	40258	MB	1.26
298	40259	MB	3.99
299	44929	MB	4.79
300	50001	MB	4.27
301	50002	MB	3.18
302	50003	MB	5.18
303	50004	MB	3.86
304	50005	MB	9.20
305	50006	MB	3.82
306	50008	MB	8.26
307	50009	MB	4.99
308	50010	MB	4.36
309	50011	MB	8.31
310	50012	MB	8.65
311	50015	MB	9.42
312	50016	MB	5.78

Mode=MB			
Obs	**ID5**	**Mode**	**PMperVRM**
313	50017	MB	7.28
314	50021	MB	4.30
315	50022	MB	4.14
316	50024	MB	3.92
317	50025	MB	6.52
318	50026	MB	4.18
319	50027	MB	10.49
320	50028	MB	5.62
321	50029	MB	3.66
322	50031	MB	8.01
323	50032	MB	8.84
324	50033	MB	6.34
325	50034	MB	4.11
326	50035	MB	3.89
327	50036	MB	9.50
328	50040	MB	7.00
329	50042	MB	1.89
330	50043	MB	5.45
331	50044	MB	4.22
332	50045	MB	1.21
333	50047	MB	5.69
334	50050	MB	5.79
335	50051	MB	6.54
336	50052	MB	3.76
337	50053	MB	1.00
338	50054	MB	6.16
339	50056	MB	8.13
340	50057	MB	4.16
341	50058	MB	5.60
342	50059	MB	3.79
343	50060	MB	7.04
344	50061	MB	3.81

Mode=MB			
Obs	**ID5**	**Mode**	**PMperVRM**
345	50066	MB	12.11
346	50088	MB	2.43
347	50092	MB	5.45
348	50096	MB	3.70
349	50099	MB	3.11
350	50110	MB	7.20
351	50113	MB	8.28
352	50117	MB	2.73
353	50119	MB	12.40
354	50143	MB	1.37
355	50145	MB	11.99
356	50146	MB	4.38
357	50148	MB	7.58
358	50149	MB	4.01
359	50154	MB	6.40
360	50157	MB	2.53
361	50158	MB	15.04
362	50159	MB	6.41
363	50166	MB	5.75
364	50183	MB	2.57
365	50184	MB	3.26
366	50198	MB	0.98
367	50199	MB	3.42
368	50204	MB	2.73
369	50211	MB	3.07
370	50515	MB	0.99
371	50516	MB	10.13
372	50517	MB	4.37
373	50518	MB	22.19
374	50519	MB	5.08
375	60006	MB	8.58
376	60007	MB	4.42

Mode=MB

Obs	ID5	Mode	PMperVRM
377	60008	MB	8.38
378	60009	MB	5.60
379	60010	MB	4.50
380	60011	MB	7.22
381	60012	MB	7.70
382	60014	MB	10.03
383	60016	MB	2.00
384	60017	MB	5.98
385	60018	MB	5.66
386	60019	MB	6.94
387	60022	MB	4.62
388	60024	MB	6.24
389	60032	MB	7.67
390	60033	MB	5.72
391	60038	MB	11.35
392	60041	MB	3.02
393	60048	MB	8.02
394	60051	MB	5.41
395	60056	MB	5.24
396	60072	MB	2.36
397	60077	MB	4.63
398	60082	MB	2.25
399	60088	MB	7.71
400	60090	MB	2.27
401	60091	MB	4.67
402	60101	MB	4.11
403	60102	MB	3.77
404	60103	MB	0.50
405	60111	MB	1.14
406	60114	MB	0.48
407	60134	MB	4.01
408	70001	MB	3.78

Mode=MB

Obs	ID5	Mode	PMperVRM
409	70002	MB	3.30
410	70003	MB	5.43
411	70005	MB	6.41
412	70006	MB	7.41
413	70008	MB	5.92
414	70010	MB	6.38
415	70012	MB	6.59
416	70014	MB	5.94
417	70015	MB	4.63
418	70016	MB	4.28
419	70018	MB	4.75
420	70019	MB	8.61
421	70030	MB	7.62
422	70035	MB	6.30
423	70041	MB	8.21
424	70044	MB	3.32
425	70045	MB	0.48
426	70048	MB	3.51
427	70049	MB	1.17
428	80001	MB	5.66
429	80002	MB	4.93
430	80003	MB	5.54
431	80004	MB	3.33
432	80005	MB	5.79
433	80006	MB	9.21
434	80008	MB	3.09
435	80009	MB	4.73
436	80011	MB	8.03
437	80012	MB	2.87
438	80025	MB	3.43
439	80028	MB	6.99
440	80107	MB	6.33

Mode=MB			
Obs	**ID5**	**Mode**	**PMperVRM**
441	90001	MB	8.08
442	90002	MB	19.78
443	90004	MB	4.76
444	90006	MB	8.16
445	90007	MB	5.99
446	90008	MB	10.23
447	90009	MB	9.23
448	90010	MB	8.32
449	90012	MB	6.67
450	90013	MB	12.10
451	90014	MB	9.95
452	90015	MB	16.04
453	90016	MB	14.95
454	90017	MB	8.49
455	90019	MB	7.10
456	90020	MB	12.15
457	90022	MB	6.60
458	90023	MB	11.70
459	90026	MB	10.12
460	90027	MB	6.47
461	90029	MB	7.32
462	90030	MB	6.77
463	90031	MB	6.47
464	90032	MB	7.28
465	90033	MB	9.69
466	90034	MB	1.81
467	90035	MB	7.14
468	90036	MB	7.92
469	90039	MB	12.24
470	90041	MB	9.67
471	90042	MB	7.79
472	90043	MB	5.79

Mode=MB

Obs	ID5	Mode	PMperVRM
473	90045	MB	14.52
474	90061	MB	4.95
475	90062	MB	6.64
476	90078	MB	6.58
477	90079	MB	9.01
478	90087	MB	4.09
479	90088	MB	7.02
480	90089	MB	6.39
481	90090	MB	7.16
482	90091	MB	5.12
483	90092	MB	2.29
484	90093	MB	6.15
485	90119	MB	6.45
486	90121	MB	18.32
487	90131	MB	1.01
488	90134	MB	4.59
489	90136	MB	6.04
490	90142	MB	10.20
491	90144	MB	4.08
492	90146	MB	8.56
493	90147	MB	5.07
494	90148	MB	4.09
495	90154	MB	17.53
496	90156	MB	8.17
497	90159	MB	6.67
498	90162	MB	9.14
499	90164	MB	2.18
500	90171	MB	5.70
501	90173	MB	2.85
502	90196	MB	3.59
503	90200	MB	5.18
504	90201	MB	2.34

Mode=MB			
Obs	**ID5**	**Mode**	**PMperVRM**
505	90205	MB	3.32
506	90206	MB	9.48
507	90208	MB	5.51
508	90211	MB	12.94
509	90213	MB	2.97
510	90214	MB	3.93
511	90219	MB	7.87
512	90226	MB	8.76
513	90232	MB	3.51
514	90233	MB	5.65
515	90234	MB	5.48
516	90241	MB	12.20
517	90244	MB	2.41
518	99423	MB	5.69

Table 15. 2016 NTD Occupancy by Mode= RB.

Mode=RB			
Obs	**ID5**	**Mode**	**PMperVRM**
519	00007	RB	16.83
520	10003	RB	19.70
521	10048	RB	10.04
522	20008	RB	18.28
523	40035	RB	5.91
524	50015	RB	19.54
525	50033	RB	6.91
526	70005	RB	6.84
527	80011	RB	14.36
528	90045	RB	16.60
529	90154	RB	26.36

Appendix C. Unweighted Bus Occupancy

Table 16. Unweighted Bus Occupancy.

State	Region	School Bus	Transit	Intercity	Charter
Alabama	Southeast	51.1	3.4	30	37.5
Alaska	West	42.6	7.8	30	37.5
Arizona	West	56.3	7.2	30	37.5
Arkansas	South Central	55.7	2.8	29.9	37.5
California	West	57.2	12.8	30	37.5
Colorado	Mountain	49.75	8.8	28.4	37.5
Connecticut	Northeast	29.8	6.5	29.9	37.5
Delaware	Northeast	36.8	3.1	29.9	37.5
Florida	Southeast	48	7.0	30	37.5
Georgia	Southeast	50.8	11.1	30	37.5
Hawaii	West	49.75	13.5	30	37.5
Idaho	Mountain	49.3	2.8	28.4	37.5
Illinois	Midwest	38.1	15.4	30	37.5
Indiana	Midwest	40.7	7.2	30	37.5
Iowa	Midwest	49.75	4.5	30	37.5
Kansas	Midwest	49.75	3.3	30	37.5
Kentucky	Southeast	49.75	4.5	30	37.5
Louisiana	South Central	56.8	5.4	29.9	37.5
Maine	Northeast	36.2	8.1	29.9	37.5
Maryland	Northeast	54.1	11.0	29.9	37.5
Massachusetts	Northeast	51.5	15.0	29.9	37.5
Michigan	Midwest	51.7	5.6	30	37.5
Minnesota	Midwest	40.6	7.1	30	37.5
Mississippi	Southeast	49.1	4.6	30	37.5
Missouri	Midwest	42	7.2	30	37.5
Montana	Mountain	24	3.6	28.4	37.5
Nebraska	Midwest	22.4	2.9	30	37.5
Nevada	West	37.2	8.5	30	37.5
New Hampshire	Northeast	30.3	1.5	29.9	37.5
New Jersey	Northeast	33.8	20.5	29.9	37.5
New Mexico	Mountain	49.75	7.2	28.4	37.5
New York	Northeast	36.4	24.9	29.9	37.5
North Carolina	Southeast	56.2	4.4	30	37.5

State	Region	School Bus	Transit	Intercity	Charter
North Dakota	Midwest	50	2.2	30	37.5
Ohio	Midwest	52.9	5.6	30	37.5
Oklahoma	South Central	41	3.9	29.9	37.5
Oregon	West	59.8	9.9	30	37.5
Pennsylvania	Northeast	49.2	12.9	29.9	37.5
Rhode Island	Northeast	31	6.8	29.9	37.5
South Carolina	Southeast	49.75	2.9	30	37.5
South Dakota	Midwest	38.8	2.4	30	37.5
Tennessee	Southeast	55	3.6	30	37.5
Texas	South Central	50.1	6.6	29.9	37.5
Utah	Mountain	50	9.7	28.4	37.5
Vermont	Northeast	42.4	6.3	29.9	37.5
Virginia	Southeast	32.7	7.8	30	37.5
Washington	West	56.7	11.2	30	37.5
West Virginia	Southeast	52	2.6	30	37.5
Wisconsin	Midwest	34	5.5	30	37.5

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Office of Policy and Governmental Affairs
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