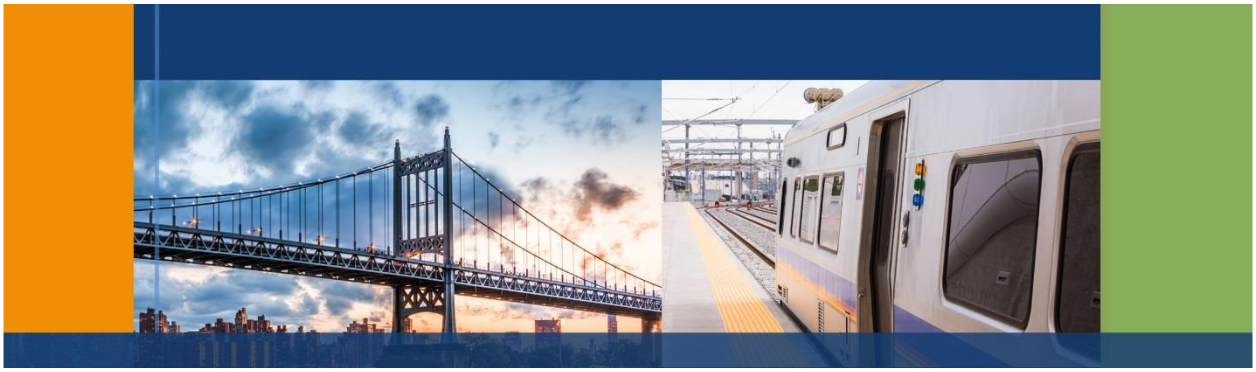


CHAPTER 4: Mobility and Access

Mobility and Access – Highways

Transportation infrastructure, such as highways, bridges, bicyclist and pedestrian facilities, and public transportation, provides lasting economic benefits to the Nation and its citizens over decades through improved mobility. Mobility increases productivity through enhanced employment opportunities, lower business costs, and faster product deliveries, which are essential drivers of business expansion and economic growth. In addition, consumers benefit from the increase in available product variety and the convenience of product delivery.

In urban areas, congestion, along with the lack of congestion-independent alternatives, is often the biggest impediment to maintaining transportation mobility. Despite past capacity expansions on highways, the urban transportation system has had difficulties keeping up with rising mobility demands and thus congestion has worsened over time. This deficiency in transportation capacity and reliability—and underutilization of mechanisms to manage highway demand, such as congestion pricing—has adversely affected the American economy and resulted in loss of time, fuel, and missed opportunities.

Another critical component to mobility is system access. Access to destinations refers to the ability of people to reach employment destinations and essential services, such as health care, education, transit, and recreation, among others, through a diverse transportation network. Accessibility refers to the provision of facilities that are accessible to and usable by individuals with mobility, visual, hearing, and other disabilities.

KEY TAKEAWAYS

- For the 52 largest metropolitan areas with populations over 1 million, the Travel Time Index (TTI) for Interstate highways averaged 1.34 in 2016, meaning that the average peak-period trip took 34 percent longer than the same trip under free-flow traffic conditions.
- For Interstate highways in the same metropolitan areas, the Planning Time Index (PTI) averaged 2.49 for Interstate highways in 2016, meaning that ensuring on-time arrival 95 percent of the time required planning for 2.49 times the travel time under free-flow traffic conditions.
- Congestion is worse in large urban areas with high population than it is in medium and small urban areas.
- The average speed on the Interstate Highway System was 56.8 mph in 2016. The average observed speed was 60.3 mph on rural Interstate highways, and 53.8 mph on urban Interstate highways.
- Speed had the highest variability on urban Interstates during morning peak hours.
- Congestion grew persistently worse from 2006 to 2016. The average delay for an individual commuter rose from 42 hours in 2006 to 53 hours in 2016. Total delay reached 8.6 billion hours and fuel waste reached 3.3 billion gallons in 2016, leading to a total cost of $171 billion.

This section focusses on highway mobility and access issues relating to personal travel. Freight-specific mobility issues are addressed in Part III. Information on operational performance of public transit is presented later in this chapter.

Congestion

Congestion on highways and bridges occurs when traffic demand approaches or exceeds the available capacity of the system. "Recurring" congestion refers to congestion routinely taking place at roughly the same places and times. Although typically associated with peak traffic periods, recurring congestion may extend beyond traditional peak traffic windows and create delays at other times of day.

"Nonrecurring" congestion refers to less predictable congestion occurring due to factors such as accidents, construction, inclement weather, and surging demand associated with special events. Such disruptions can take away part of the roadway from use and dramatically reduce the available capacity and/or reliability of the entire transportation system. About half of total highway congestion is recurring, and the other half nonrecurring.

No definition or measurement of exactly what constitutes congestion has been universally accepted. Transportation professionals examine congestion from several perspectives, such as average delays and variability. This report examines congestion through indicators of duration and severity, including travel time indices, congestion hours, and planning time indices.

Congestion Measures

The National Performance Management Research Data Set (NPMRDS) is the Federal Highway Administration's (FHWA's) official data source for measuring congestion, and is provided monthly to States and metropolitan planning organizations (MPOs) for their performance measurement activities. (See the discussion of Transportation Performance Management in the Introduction to Part I of this report.) The NPMRDS is a compilation of vehicle probe-based data on observed travel times, date/time, direction, and location for freight, passenger, and other traffic. The data are collected from a variety of sources, including mobile devices, connected autos, portable navigation devices, GPS on commercial trucks, and sensors. The NPMRDS provides historical average travel times in 5-minute intervals by traffic segment in both rural and urban areas on the National Highway System, as well as over 25 key Canadian and Mexican border crossings. Using data from the NPMRDS, FHWA produces quarterly Urban Congestion Reports that estimate mobility, congestion, and reliability on Interstate highways and other limited-access highways in the 52 largest metropolitan areas. (https://ops.fhwa.dot.gov/perf_measurement/ucr/index.htm).

Although the NPMRDS is a rich source of information on congestion, it has not existed long enough to provide a 10-year time series. Data are available starting in 2012 for the Interstate highways and starting in mid-2013 for roads functionally classified as "Other Freeway and Expressway." (See Chapter 1 for a description of functional classes.)

Different Methodologies in The *Urban Congestion Reports and the Urban Mobility Report*

The *Urban Congestion Reports* and the *Urban Mobility Report* both report traffic system performance indicators such as the TTI, congested hours, and the PTI, and use vehicle miles traveled (VMT) as weights to aggregate values. However, these two reports differ in their data coverage, definition of free-flow speed or peak hours, and estimation methodology, resulting in different estimations and interpretations of the same congestion indicators.

In the *Urban Congestion Reports* based on NPMRDS, the peak period includes the a.m. peak period (6 a.m. to 9 a.m.) and p.m. peak period (4 p.m. to 7 p.m.) on weekdays. For purposes of computing free-flow speed, the off-peak period is defined as 9 a.m. to 4 p.m. and 7 p.m. to 10 p.m. on weekdays, as well as 6 a.m. to 10 p.m. on weekends. The free-flow speed is calculated as the 85th percentile of off-peak speeds based on the previous 12 months of data. The boundaries of the 52 metropolitan areas used in the *Urban Congestion Reports* are based on metropolitan statistical areas with populations above 1,000,000 in 2010.

The 2019 *Urban Mobility Report* assigned peak hours as 6 a.m. to 10 a.m. and 3 p.m. to 7 p.m. on weekdays. Free-flow travel speed is calculated during a set window of light traffic hours (for example, 10 p.m. to 5 a.m.). Congestion occurs if traveling speed is below a congestion threshold, usually defined as the lower value of either the free-flow speed or the speed limit (65 mph on the freeways). The 2019 Urban Mobility Report includes data for 494 urbanized areas (defined by the U.S. Census Bureau as an urban area of 50,000 or more people).

An alternative source of congestion measures is the Urban Mobility Report developed by the Texas Transportation Institute; the most recent edition released in August 2019 included data for 1982 through 2017. The 2019 Urban Mobility Report's estimated congestion trends were based on speed data provided by INRIX®, which contains historical traffic information on freeways and other major roads and streets. Data of traffic speed were collected from more than 1.5 million GPS-enabled vehicles and mobile devices for each section of road for every 15-minute period every day for all major U.S. metropolitan areas.

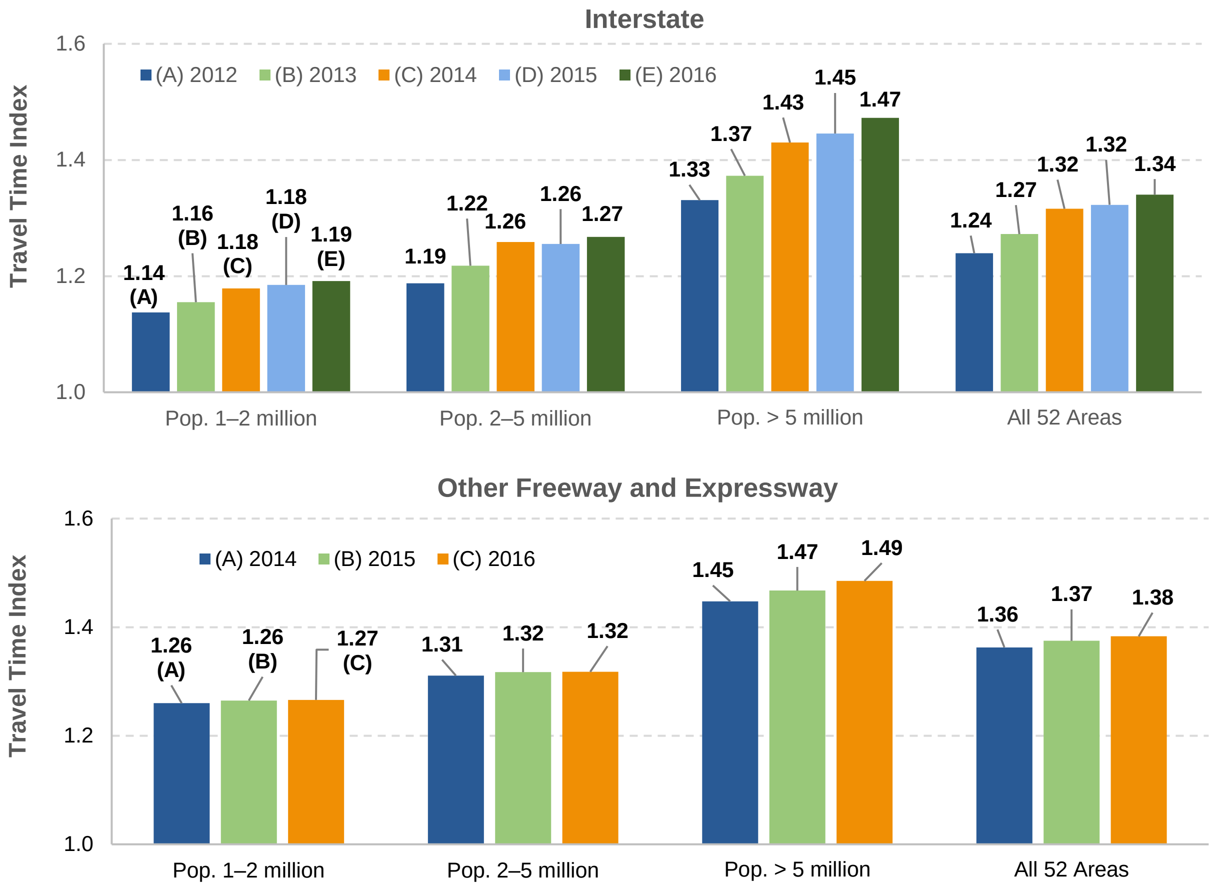
Travel Time Index

The TTI measures the average intensity of congestion. This index is calculated as the ratio of the peak-period travel time to the free-flow travel time for the a.m. and p.m. peak period on weekdays. The value of the TTI is always greater than or equal to 1, with a higher value indicating more severe congestion. For example, a value of 1.30 indicates that a 60-minute trip on a road that is not congested would typically take 78 minutes (30 percent longer) during the period of peak congestion.

Exhibit 4-1 shows the TTI for the 52 largest metropolitan areas was 1.34 in 2016, which indicates that the average driver spent roughly one-third more time during the congested peak time compared with traveling the same distance during the non-congested period. Congestion became more pronounced over time, as TTI climbed continuously from 2012 to 2016. The TTI increased from 1.24 in 2012 to 1.34 in 2016 on Interstate highways, meaning that an average trip on Interstate highways that would have taken 60 minutes during the off-peak period took 74.4 minutes (24 percent longer) during the peak period in 2012, and took 80.4 minutes (34 percent longer) during the peak period in 2016. The TTI rose from 1.36 in 2014 to 1.38 in 2016 for other freeways and expressways, indicating average congestion has become more severe on these types of facilities as well.

Residents in the largest metropolitan areas tend to experience more severe congestion, and those with more moderate populations usually report better mobility. In 2016, the average TTI was 1.47 for Interstate highways in metropolitan areas with populations over 5 million, so that a 60-minute off-peak trip took an average of 88.4 minutes during the peak period (60 minutes times 1.47). The average TTI for Interstate highways in metropolitan areas with populations between 2 and 5 million was 1.27, so that the same length of off-peak trip took 76.1 minutes during the peak. For metropolitan areas with populations between 1 and 2 million the TTI was 1.27 in 2016, so that the same length of off-peak trip took 71.5 minutes during the peak. In 2016, TTI was 1.49, 1.28, and 1.27 on other freeways and expressways in metropolitan areas with populations above 5 million, between 2 and 5 million, and between 1 and 2 million, respectively.

Exhibit 4-1 ■ Travel Time Index for the 52 Largest Metropolitan Areas, 2012–2016



Note: Travel time index is averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

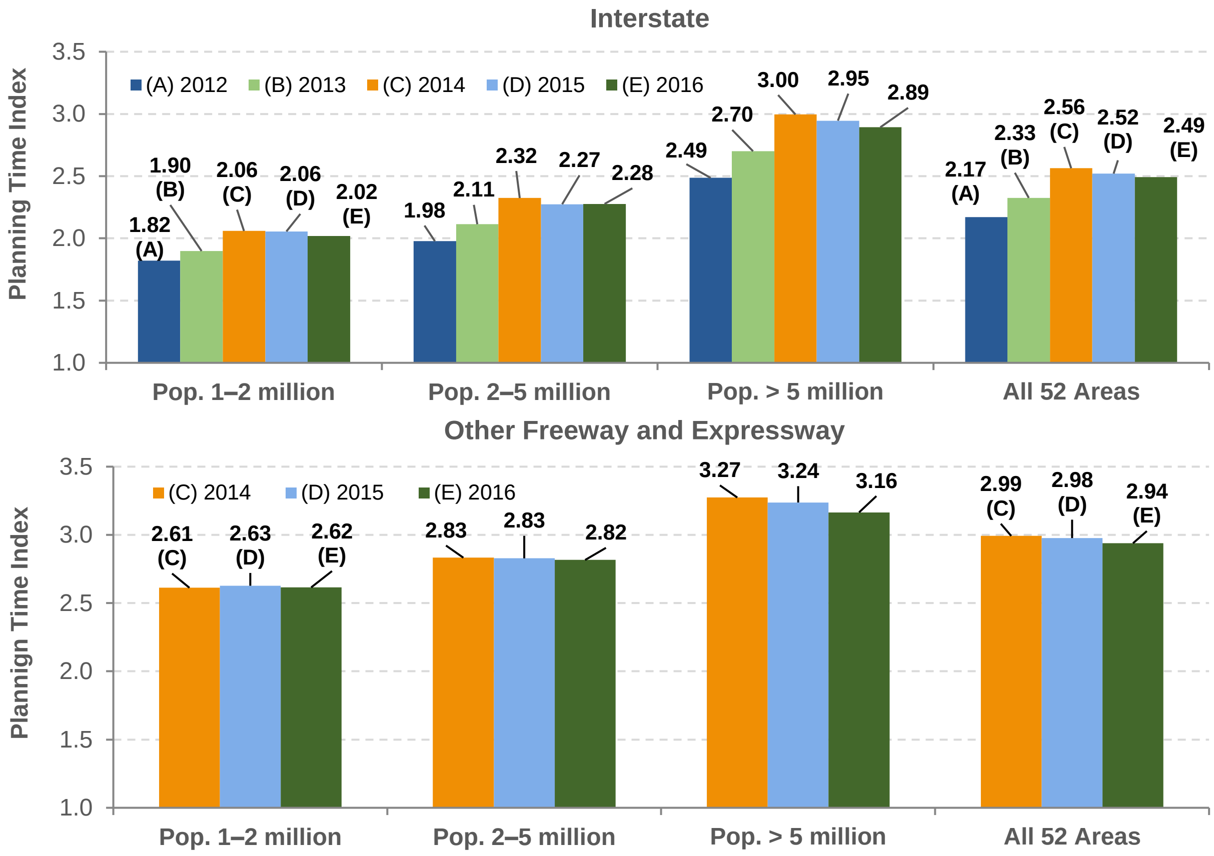
Planning Time Index

Most travelers are less tolerant of unexpected delays than of everyday congestion. Although drivers dislike everyday congestion, they may have an option to alter their schedules to accommodate it, or are otherwise able to factor it into their travel and residential location choices. Unexpected delays, however, often have larger consequences and cause more disruptions in business operation and people’s lives. Travelers also tend to better remember spending more time in traffic due to unanticipated disruptions, rather than the average time required for a trip throughout the year. From an economic perspective, low travel time reliability requires travelers to budget extra time in planning trips or to suffer the consequences of being delayed. Hence, travel time reliability influences travel decisions.

Transportation reliability measures typically compare high-delay days with average-delay days, which provides a different perspective of traffic condition beyond a simple average travel delay. The simplest methods usually identify days that exceed the 95th percentile in terms of travel times and estimate the severity of delay on specific routes during the heaviest traffic days of each year. (These days could be spread over the course of a year or could also be concentrated in the same month or week, such as a week with severe weather). The PTI, used to measure travel time reliability in this report, is defined as the ratio of the 95th percentile of travel time during the a.m. and p.m. peak periods to the free-flow travel time. For example, a PTI of 1.60 means that, for a trip that takes 60 minutes in light traffic, a traveler should budget a total of 96 (60 × 1.60) minutes to ensure on-time arrival for 19 out of 20 trips (95 percent of the trips).

Exhibit 4-2 indicates the average PTI was 2.49 for Interstate highways in the 52 largest metropolitan areas in 2016, meaning that travelers would need to plan on a 60-minute off-peak trip requiring up to 150 minutes (2.49 × 60 minutes) in the peak period to ensure on-time arrival 95 percent of the time. The PTI for other freeways and expressways was 2.94 in 2016, meaning that travelers would need to plan on a trip of the same length taking up to 176 minutes 19 times out of 20 for on-time arrival. The PTI rose in 2012–2014 before tailing back off to lower levels in 2016.

Exhibit 4-2 ▪ Planning Time Index for the 52 Largest Metropolitan Areas, 2012–2016



Note: Planning time index is averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

As was the case for the TTI, the PTI was consistently higher in larger metropolitan areas than smaller ones. In 2016, the average PTI was 2.89 on Interstate highways in metropolitan areas with more than 5 million residents, 27 percent higher than the PTI of 2.28 observed in areas with populations between 2 million and 5 million, and 43 percent higher than the PTI of 2.02 in areas with populations between 1 million and 2 million. The PTI in 2016 showed a similar pattern for other freeways and expressways; the average PTI was 3.16 in metropolitan areas over 5 million in population, 2.82 in metropolitan areas with populations between 2 and 5 million, and 2.62 in metropolitan areas with between 1 and 2 million.

Transportation Performance Management (TPM) Reliability Measures

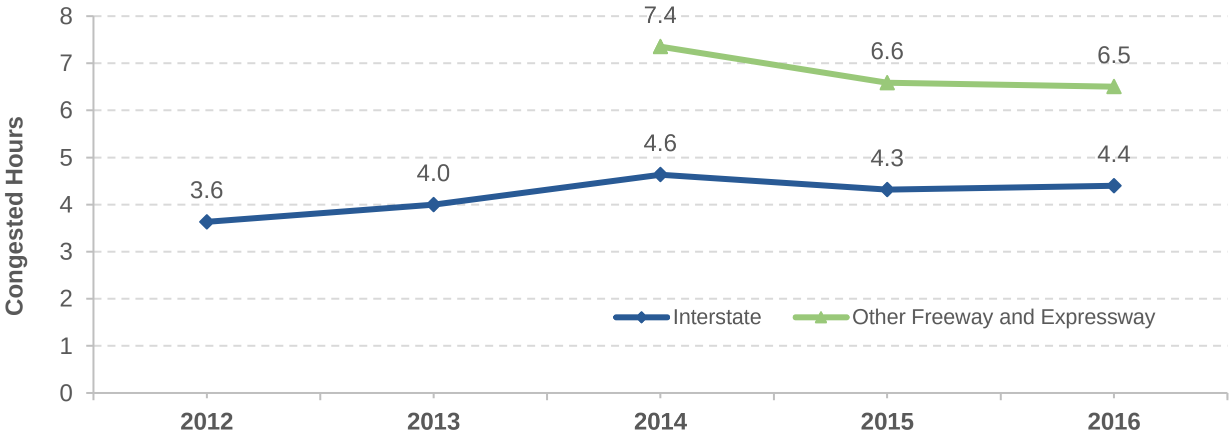
The TPM described in Introduction to Part I establishes specific national performance measures related to travel time reliability, which is defined as the consistency or dependability of travel times from day to day or across different times of the day. These are several travel time based reliability measures, two for carrying out the National Highway Performance Program (NHPP) and one to assess the freight movement:

- Percent of the person-miles traveled on the Interstate that are Reliable;
- Percent of person-miles traveled on the non-Interstate National Highway System (NHS) that are Reliable;
- Truck Travel Time Reliability Index.

Congested Hours

Congested hours is another performance indicator computed from NPMRDS for the 52 largest metropolitan areas in the United States. It is calculated as the average number of hours when road sections are congested from 6 a.m. to 10 p.m. on weekdays. As shown in *Exhibit 4-3*, on average, highways were congested for 4.4 hours per day on Interstate highways in 2016 and 6.5 hours per day on other freeways and expressways.

Exhibit 4-3 ■ Average Congested Hours for the 52 Largest Metropolitan Areas, 2012–2016



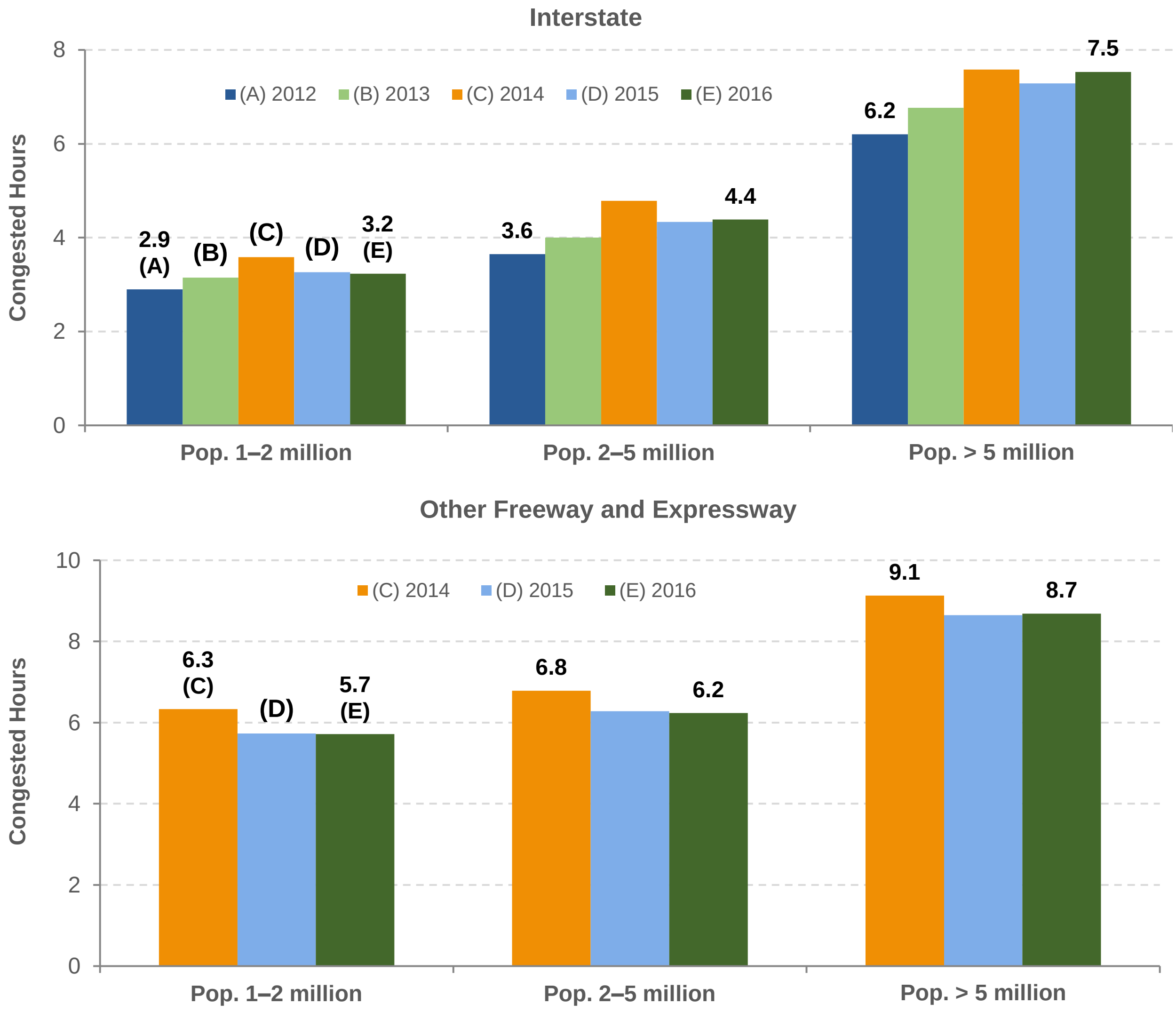
Note: Congested hours are averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

For both Interstate highways and other freeways and expressways, congested hours per day peaked in 2014. For the 52 largest metropolitan areas combined, congested hours per day rose from 3.6 in 2012 to 4.6 in 2014, before tailing off to 4.3 hours in 2015 and rebounding to 4.4 hours in 2016. The trend was similar for other freeways and expressways, with daily congested hours tailing off from 7.4 hours in 2014 to 6.5 hours in 2016.

Exhibit 4-4 shows that for both Interstate highways and other freeways and expressways, the values for different-sized metropolitan areas tended to move in tandem.

Exhibit 4-4 ■ Congested Hours for the 52 Largest Metropolitan Areas, 2012–2016



Note: Congested hours are averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

Similar to the trend for the TTI and PTI, congestion duration is higher on average in larger metropolitan areas. In areas with a population above 5 million, average congested hours reached 7.5 per day on Interstate highways and 8.7 per day on other freeways and expressways in 2016. In metropolitan areas with population between 2 and 5 million, road congestion eased to 4.4 hours and 6.2 hours per day on Interstate highways and on other freeways and expressways, respectively. Residents in metropolitan areas with population between 1 and 2 million experienced the lowest number of congested hours, averaging 3.2 hours on Interstate highways and 5.7 hours on other freeways and expressways in 2016.

Congestion in 52 Metropolitan Areas

The average congestion measures in metropolitan areas by population size do not reflect the variations within each group. For example, both Los Angeles and Philadelphia are metropolitan areas with population exceeding 5 million, but their congestion measures differed substantially in 2016. *Exhibits 4-5*, *4-6*, and *4-7* present estimated TTI, PTI, and congested hours by area size of the 52 largest metropolitan areas to provide more details about various dimensions of congestion. Six metropolitan areas did not have sufficient data coverage on the other freeway and expressway functional class to allow computation of these measures.

Among major metropolitan areas with populations above 5 million, the highest Interstate TTI values were observed in Los Angeles (1.7) and Washington DC (1.5), where 50 percent or more additional time was needed to travel during peak hours than off-peak hours (*Exhibit 4-5*). Los Angeles (3.5), and Dallas/Fort Worth (3.0) experienced the highest Interstate PTI values; Interstate highway travelers in these areas would need to depart early enough to allow for peak-period travel time to be at least triple that during off-peak hours to ensure on-time arrival 95 percent of the time.

Exhibit 4-5 ■ Travel Time Index, Planning Time Index, and Congested Hours in Metropolitan Areas with Population Above 5 Million, 2016

Metropolitan Area	Travel Time Index		Planning Time Index		Congested Hours	
	Interstate	Other Freeway and Expressway	Interstate	Other Freeway and Expressway	Interstate	Other Freeway and Expressway
Atlanta	1.3	1.4	2.3	3.1	4.2	6.6
Chicago	1.4	1.2	2.4	2.2	7.7	8.2
Dallas/Ft Worth	1.4	N/A	3.0	N/A	6.2	N/A
Houston	1.4	N/A	2.9	N/A	5.8	N/A
Los Angeles	1.7	1.6	3.5	3.5	9.6	8.6
Miami	1.3	1.4	2.5	2.9	5.2	6.5
New York	1.3	1.4	2.3	2.9	7.7	10.2
Philadelphia	1.3	1.1	2.2	1.9	6.4	4.5
Washington, DC	1.5	1.4	2.9	3.6	7.3	9.4

Note: Travel time index and Planning time index are averaged across road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System in the 9 metropolitan areas with population above 5 million. Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

Los Angeles experienced the longest average congested Interstate hours (9.6) during the 16-hour period between 6 a.m. and 10 p.m. on a weekday. New York and Chicago also had relatively long congested time of 7.7 hours per weekday on Interstate highways. New York experienced average congested hours of 10.2 per weekday on other freeways and expressways.

Exhibit 4-6 shows that three of the four highest Interstate TTI values among metropolitan areas with populations between 2 and 5 million were located on the West Coast: Portland (1.5), San Francisco (1.5), and Seattle (1.5). The highest Interstate PTI values were observed in Portland (3.2) and San Francisco (3.2), as well as in San Juan (3.3). The PTI for other freeways and expressways in Charlotte was 4.0, indicating that drivers in that area would need to account for peak period trips taking quadruple the time of off-peak trips to arrive on time 19 days out of every 20.

Roads were classified as congested for more than 7 hours per weekday on Interstate highways of Denver, Orlando, Portland, San Francisco, and Seattle. In most areas with between 2 and 5 million in population, other freeways and expressways usually remained congested for a longer period than Interstate highways, with more than 9 hours of daily congestion observed in Charlotte (9.6), Portland (9.8), and Seattle (9.8).

Exhibit 4-6 ■ Travel Time Index, Planning Time Index, and Congested Hours in Metropolitan Areas with Population 2–5 Million, 2016

Metropolitan Area	Travel Time Index		Planning Time Index		Congested Hours	
	Interstate	Other Freeway and Expressway	Interstate	Other Freeway and Expressway	Interstate	Other Freeway and Expressway
Baltimore	1.3	1.3	2.2	2.7	5.1	7.8
Boston	1.4	1.3	2.8	2.5	6.2	6.5
Charlotte	1.2	1.3	2.1	4.0	3.4	9.6
Cincinnati	1.2	1.1	1.9	2.3	2.8	5.6
Cleveland	1.1	1.1	1.9	2.1	2.5	3.7
Denver	1.4	1.2	2.8	2.8	7.1	6.4
Detroit	1.2	1.2	2.3	2.8	4.1	5.3
Kansas City	1.1	1.2	1.7	2.3	2.3	5.6
Minneapolis	1.3	1.4	2.3	2.9	5.1	7.7
Orlando	1.4	1.1	2.6	1.6	7.5	1.6
Phoenix	1.3	1.2	2.3	2.5	3.3	3.6
Pittsburgh	1.2	1.2	1.8	2.6	3.1	8.7
Portland	1.5	1.5	3.2	3.9	7.7	9.8
Riverside	1.2	1.4	1.8	2.8	4.7	7.1
Sacramento	1.2	1.4	1.9	2.7	3.9	5.3
St Louis	1.2	1.2	2.0	3.3	3.1	6.2
San Antonio	1.2	N/A	2.2	N/A	3.6	N/A
San Diego	1.3	1.3	2.5	3.0	3.7	5.6
San Francisco	1.5	1.5	3.2	3.4	7.5	7.6
San Juan	1.5	N/A	3.3	N/A	3.7	N/A
Seattle	1.5	1.3	2.8	2.9	7.1	9.8
Tampa	1.2	1.2	2.2	2.3	3.0	0.0

Note: Travel time index and planning time index are averaged across road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System in the 22 metropolitan areas with populations of 2–5 million. Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

Congestion also affected smaller metropolitan areas with populations between 1 and 2 million (*Exhibit 4-7*). Interstate TTI values generally fell between 1.0 and 1.2 in areas of this size, except for Austin (1.4) and San Jose (1.5). Cleveland reported one of the lowest congestion measures in TTI, PTI, and congested hours. The highest Interstate PTI value was 3.3 in San Jose. The highest PTI value for other freeways and expressways among the 52 largest metropolitan areas reflected in the NPMRDS was observed in New Orleans (5.3), suggesting atypically low travel time reliability in this area.

Congestion Management in Cleveland, Ohio

The Ohio Department of Transportation and the Northeast Ohio Areawide Coordinating Agency (NOACA, the MPO for the Cleveland area) have jointly committed to managing congestion through incorporating system management and operation strategies into their planning processes. Working together, they are establishing policies on congestion management and prioritizing congestion mitigation strategies such as adding capacity to the transportation system, operating existing capacity with higher efficiency, and encouraging congestion-reducing strategies.

NOACA evaluates future operating conditions of all roadways on the NOACA Congestion Management Process (CMP) network using projected year 2035 traffic forecasts to highlight the worst congested roadway segments on the network. The NOACA CMP examines 2,400 segments in the network to support decision makers in identifying and funding projects that will help alleviate traffic congestion. For example, the I-480 corridor has the longest continuous segment of congestion in the system under existing and forecast traffic conditions. Widening roads to address increasing traffic demand is not cost-effective, and congestion management strategies need to be considered.

Reducing Congestion in Birmingham, Alabama

The Regional Planning Commission of Greater Birmingham (RPCGB) outlines five strategies to reduce congestion in the order they should be considered for each project:

1. Decrease the need for trip making;
2. Increase the use of transit over other modes;
3. Increase HOV use;
4. Enhance operations on existing roadway facilities; and
5. Increase roadway capacity through additional infrastructure.

Highway projects are evaluated against these five strategies to produce an evaluation matrix containing multiple congestion mitigation strategies.

The RPCGB completed many projects between 2006 and 2016 that helped reduce congestion in the Birmingham urbanized area. The majority of congestion mitigation projects involve capacity expansion, such as adding additional lanes on I-65 from CR-52 to CR-17 (Valleydale Road) and building new roads on SR-4 (Corridor-X, I-22) From CR-105 (Cherry Avenue) to East of I-65. Several projects improved intersections by adding a continuous center turn lane.

The RPCGB also undertook projects to improve operation efficiency. For example, a project was completed on 9.1 miles of SR-38 (US 280) from Hollywood Boulevard to Doug Baker Boulevard to improve access management such as reconfiguring and/or closing intersections. The project also upgraded traffic signal systems on this corridor and installed adaptive signal controls.

Exhibit 4-7 ■ Travel Time Index, Planning Time Index, and Congested Hours in Metropolitan Areas with Population 1–2 Million, 2016

Metropolitan Area	Travel Time Index		Planning Time Index		Congested Hours	
	Interstate	Other Freeway and Expressway	Interstate	Other Freeway and Expressway	Interstate	Other Freeway and Expressway
Austin	1.4	N/A	2.8	N/A	5.2	N/A
Birmingham	1.0	N/A	1.3	N/A	0.6	N/A
Buffalo	1.1	1.2	1.8	2.3	4.3	9.1
Columbus	1.1	1.2	1.8	2.3	2.7	4.5
Hartford	1.2	1.1	1.9	2.0	2.7	3.8
Indianapolis	1.1	1.2	1.6	2.8	2.8	12.5
Jacksonville	1.2	1.3	2.0	3.5	2.7	9.0
Las Vegas	1.2	1.2	2.0	2.1	3.7	4.7
Louisville	1.1	1.2	2.0	3.5	3.0	4.8
Memphis	1.2	1.2	1.9	2.4	4.1	5.3
Milwaukee	1.2	1.2	2.2	1.9	4.3	3.3
Nashville	1.2	1.2	2.0	2.2	2.7	5.3
New Orleans	1.1	1.5	2.0	5.3	2.9	12.2
Oklahoma City	1.1	1.1	1.7	2.1	2.2	2.7
Providence	1.2	1.2	1.9	2.2	4.0	7.5
Raleigh	1.2	1.1	1.9	2.1	2.5	2.7
Richmond	1.1	1.1	1.4	1.8	1.5	5.2
Rochester	1.1	1.2	1.6	2.1	2.4	6.3
Salt Lake City	1.2	1.2	1.9	2.2	3.0	6.1
San Jose	1.5	1.4	3.3	3.2	6.0	5.5
Virginia Beach	1.2	1.2	2.5	2.7	5.5	8.1

Note: Travel time index and planning time index are averaged across road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 21 metropolitan areas with populations of 1–2 million. Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

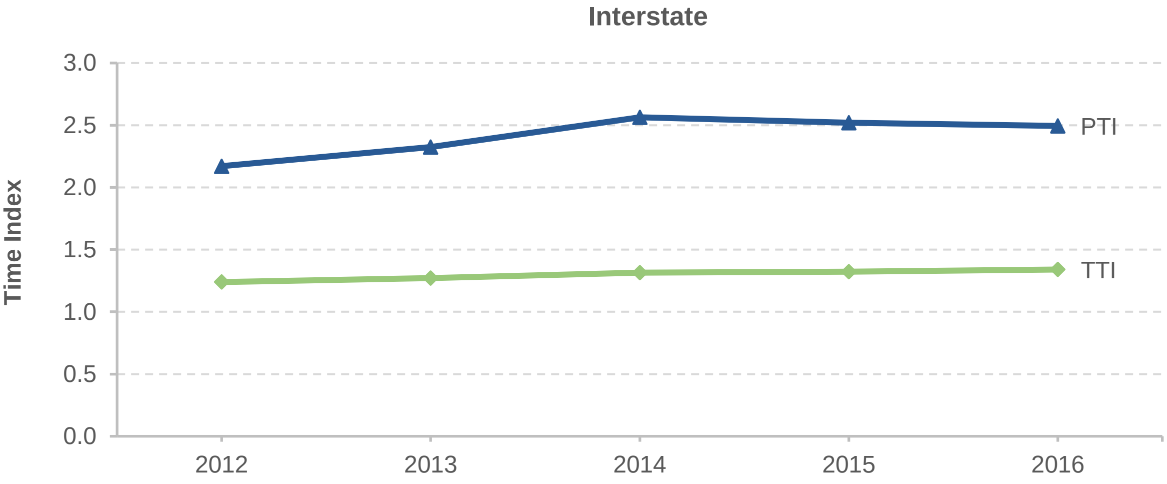
Source: FHWA staff calculation from the National Performance Management Research Data Set.

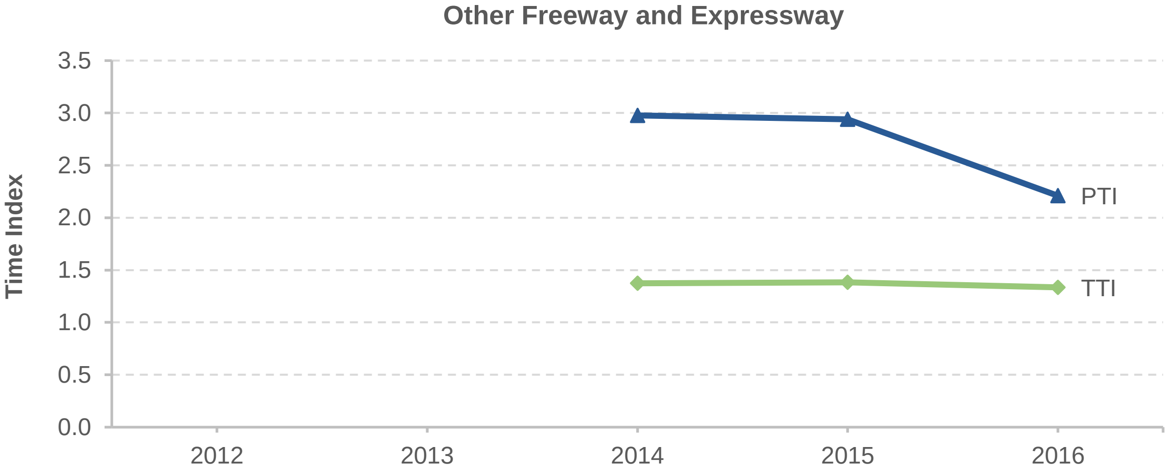
Correlation Between TTI and PTI

Exhibit 4-8 demonstrates that the average PTI has been consistently above the average TTI among the 52 largest metropolitan areas covered in the NPMRDS.

The relationship between TTI and PTI is also reflected in *Exhibit 4-9*, which compares 2016 PTI and TTI values for metropolitan areas of different sizes. Like *Exhibit 4-8*, *Exhibit 4-9* shows that the values of PTI are consistently higher than the values of TTI.

Exhibit 4-8 ■ Average Travel Time Index and Planning Time Index in the 52 Largest Metropolitan Areas, 2012–2016



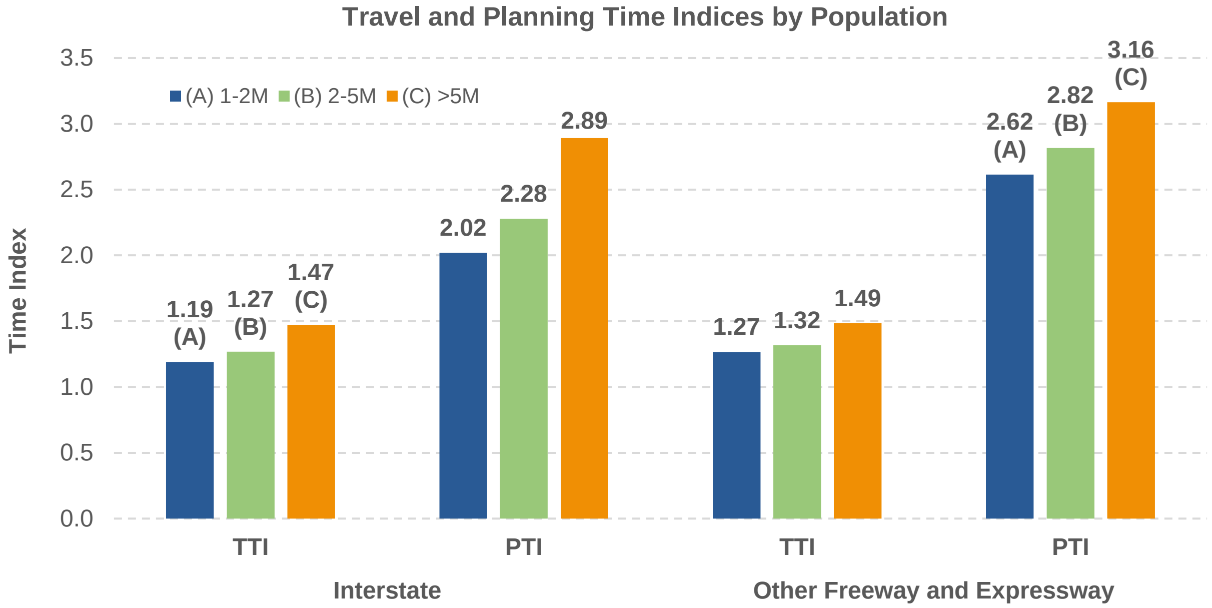


Note: Travel time index and planning time index are averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

Drivers living in more populated urban areas tended to spend more travel time during peak hours than those living in less populated urban areas. The PTI difference between areas of different sizes was much larger than the TTI difference. This is particularly the case on Interstate highways, where PTI was 2.89 in metropolitan areas with populations above 5 million, compared with 2.02 in metropolitan areas with populations between 1 and 2 million, a difference of 0.87. In contrast, the Interstate TTI of 1.47 in metropolitan areas over 5 million in population differed from those with populations between 1 and 2 million by only 0.28.

Exhibit 4-9 ■ Travel Time Index and Planning Time Index by Population in the 52 Largest Metropolitan Areas, 2016



Note: Travel time index and planning time index are averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

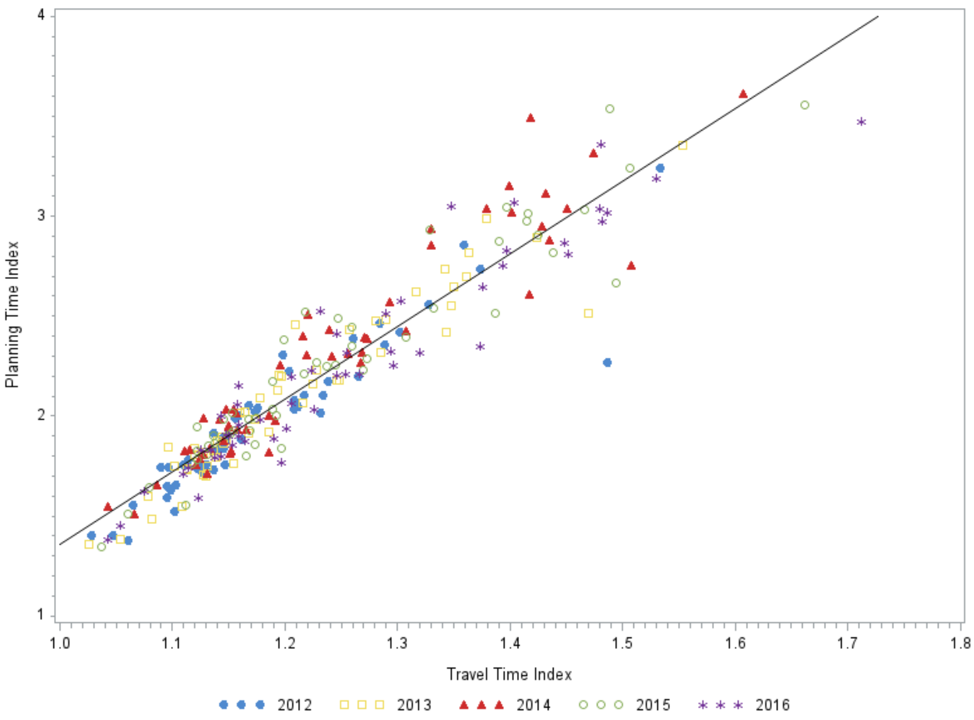
Source: FHWA staff calculation from the National Performance Management Research Data Set.

The PTI not only is consistently higher than the TTI, it is also correlated with the TTI. *Exhibit 4-10* presents the scatterplot of PTI values for individual metropolitan areas against TTI values, with different colors used to differentiate years. There is a clear linear correlation between TTI and PTI on Interstate highways, represented by the solid line in the graph. The scatterplot indicates that for TTI values between 1.0 and 1.4, where the majority of observations are concentrated, higher TTI values are closely associated with higher PTI values. In other words, higher levels of recurring congestion are associated with higher levels of non-recurring congestion. However, on highly congested Interstate highways where TTI values are above 1.4, the relationship between TTI and PTI becomes more disperse with less linear correlation. For example, the highest Interstate TTI reflected in the NPMRDS was 1.71 in Los Angeles in 2016. The Interstate PTI value for 2016 was 3.47, resulting in a data point well below the solid (linear correlation) line.

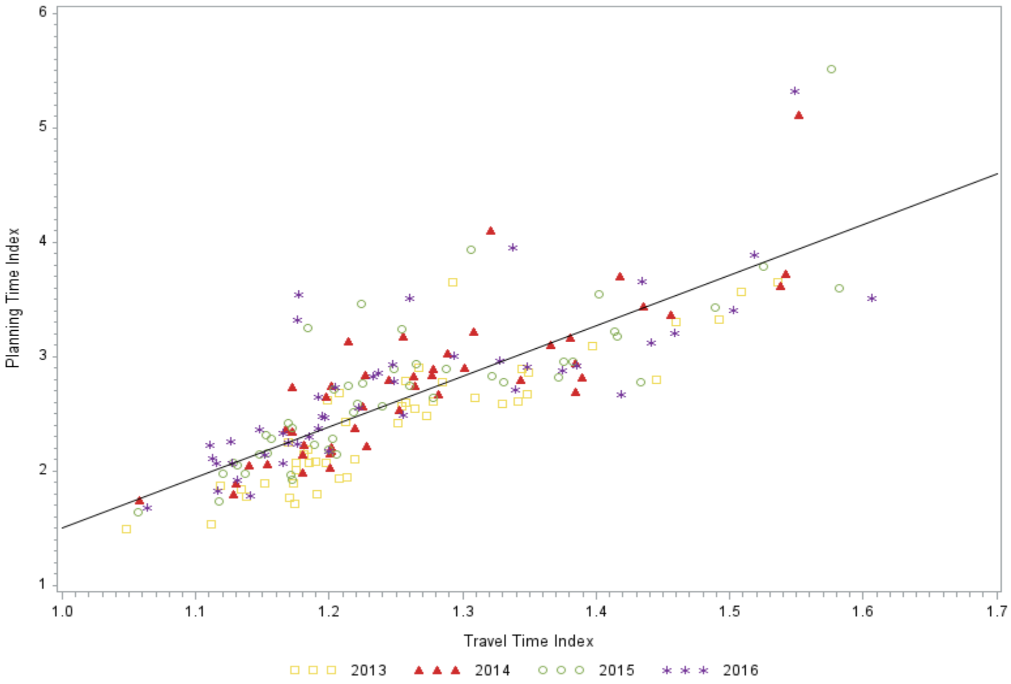
A comparison of the two charts in *Exhibit 4-10* reveals that PTI values showed a much larger variation relative to TTI values for other freeways and expressways than for Interstate highways. Additionally, there are more observed dots above the solid (linear regression) line, implying low travel reliability (high PTI) even in some cases where average travel time (TTI) is modest. This indicates that freeways that routinely experience severe congestion are also more vulnerable to extreme congestion when conditions deteriorate unexpectedly.

Exhibit 4-10 ■ Correlation Between Travel Time Index and Planning Time Index in the 52 Largest Metropolitan Areas, 2012–2016

Interstate



Other Freeway and Expressway



Note: Travel time index and planning time index are averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

The correlation coefficient between TTI and PTI was 0.947 on Interstate highways and 0.814 on other freeways and expressways. The high and positive values of correlation coefficients suggest a strong linear relationship between TTI and PTI, especially on Interstate highways. There appears to be no substantial year-to-year variation in the distribution of the ratios between PTI and TTI on the graphs.

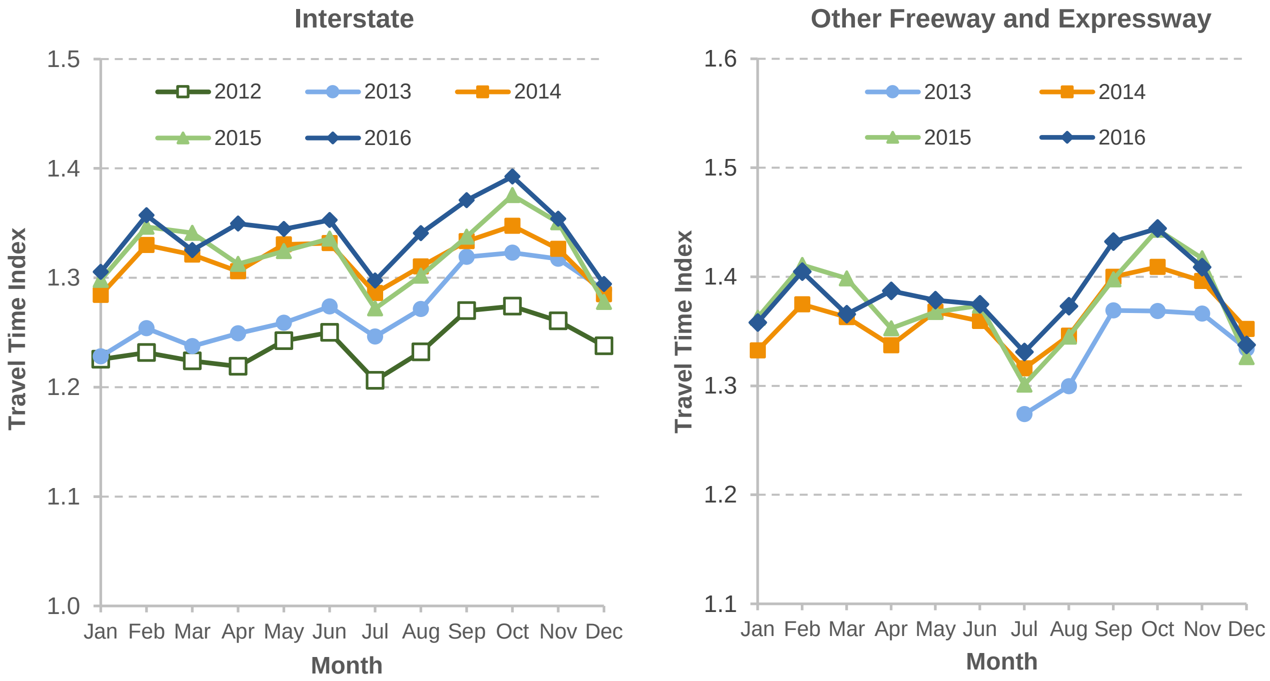
Seasonal Patterns in Congestion and Reliability

Road congestion varies over the course of a year. For each year from 2012 to 2016, the TTI stayed relatively flat in the first half of the year, dropped to a lower level in July, quickly rose to the highest yearly value in October, and dropped again in the last two months of the year (see *Exhibit 4-11*).

The TTI was consistently highest in October for all 5 years on both Interstates and other freeways and expressways. The month with the lowest TTI varied by year for Interstate highways: it was January in 2013, July in 2012 and 2015, and December in 2014 and 2016. On other freeways and expressways, the lowest TTI occurred consistently in July of each year.

Travel conditions tended to be stable in the first half of the year. Between July and October, peak-hour travel condition worsened substantially due to decreased speed and extended travel time. This is consistent with the public's perception of better travel conditions in summer during vacation season, with congestion rising in in September as schools are again in session.

Exhibit 4-11 ■ Monthly Travel Time Index in the 52 Largest Metropolitan Areas, 2012–2016



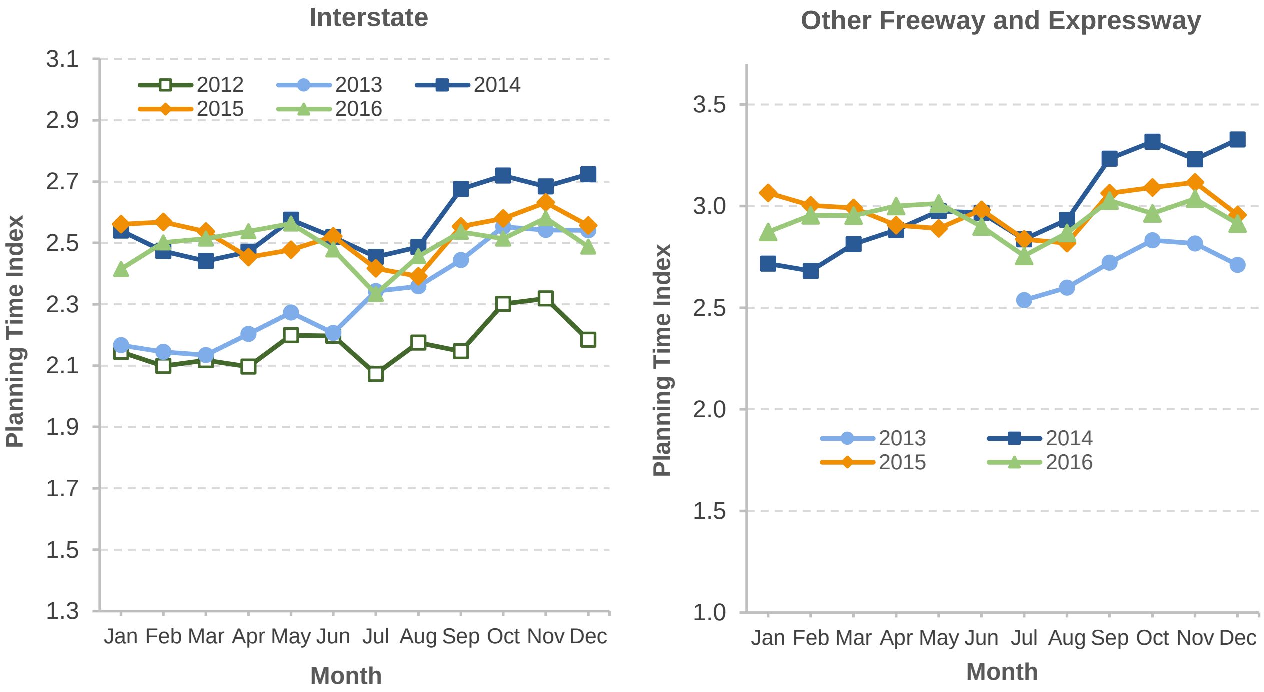
Note: Travel time index is averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

PTI generally fluctuated less in the first half of the year than the second, for each year from 2012 to 2016 on both Interstates and other freeways and expressways (See *Exhibit 4-12*). The month with the lowest PTI on highways varied by year: for Interstate highways it was March in 2013 and 2014, July in 2012 and 2016, and August in 2015; for other freeways and expressways it was February in 2014, August in 2015, and July in 2016.

The upward trend of PTI in the second half of the year implies that travel time reliability worsened in fall and winter. This seasonal pattern is more evident in the last quarter, where PTI consistently swelled to a yearly high. Travelers experienced the highest monthly PTI values in the last quarter of the year: for Interstate highways it was October in 2013 and 2014, November in 2012, 2015, and 2016; for other freeways and expressways it was December in 2014 and November in 2015 and 2016.

Exhibit 4-12 ■ Monthly Planning Time Index in the 52 Largest Metropolitan Areas, 2012–2016

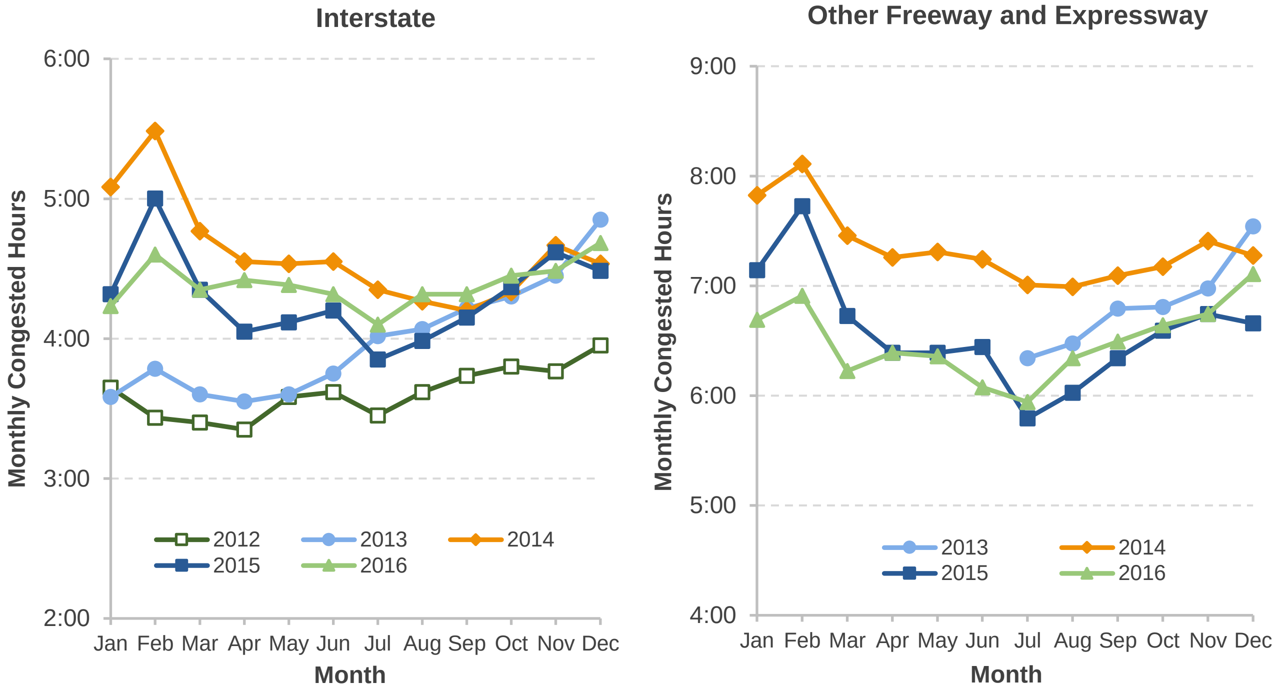


Note: Planning time index is averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

Congested hours revealed a different monthly pattern than those of TTI and PTI. High average daily congestion numbers were concentrated in winter months and shorter periods of congestion tended to occur in warmer months. The highest monthly congested hours values for the year occurred in February (2014 and 2015) and December (2012, 2013 and 2016) (see *Exhibit 4-13*). Other freeways and expressways experienced the shortest periods of congestion during the summer months of July 2015 and 2016 and August 2013. For Interstate highways, the months with the shortest periods of congestion on Interstate varied more, occurring in April (2012 and 2013), July (2015 and 2016), and September (2014).

Exhibit 4-13 ■ Monthly Congested Hours in the 52 Largest Metropolitan Areas, 2012–2016



Note: Congested hours are averaged across metropolitan areas, road sections, and periods weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System over the 52 largest metropolitan areas (populations greater than 1 million). Data cover all Interstate highways (Interstate functional class) and other limited-access highways (Other Freeway and Expressway functional class) in these areas. Data on Interstate highways start in 2012; full-year data on other freeways and expressways start in 2014. Population is from United States Census Bureau 2014 Metropolitan Statistical Areas Population Estimates for 2010.

Source: FHWA staff calculation from the National Performance Management Research Data Set.

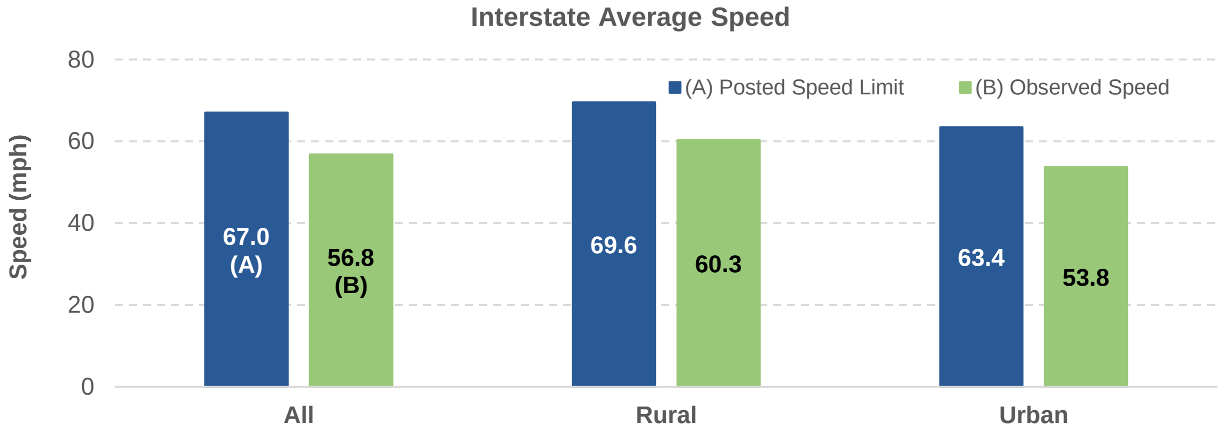
Mobility on Rural and Urban Interstates

In addition to estimating congestion on both Interstates and other freeways and expressways in urban areas, an FHWA study used NPMRDS, conflated with the 2013 Highway Performance Monitoring System (HPMS) geospatial network, to examine travel time and speed of the Interstate System for the entire Nation by urban/rural (see *Interstate Speed Profiles* at https://doi.org/10.1177/0361198118755713 for details on conflation methodology).

Average Speed on Interstates

The average speed of the entire Interstate Highway System in 2016 was 56.8 mph, including peak and off-peak travel, compared with an average speed limit of 67.0 mph (*Exhibit 4-14*). The average observed speed was 60.3 mph on rural Interstates, 6.5 mph higher than on urban Interstates (53.8 mph). The observed average speeds were about 10 mph lower than the average of posted speed limits on both rural and urban Interstates. The delays occur on Interstates for many road conditions that could slow traffic, such as regular congestion, adverse weather, work zones, incidents, special events, and traffic congestion.

Exhibit 4-14 ■ Average Observed Speed and Posted Speed Limit on Interstate, 2016



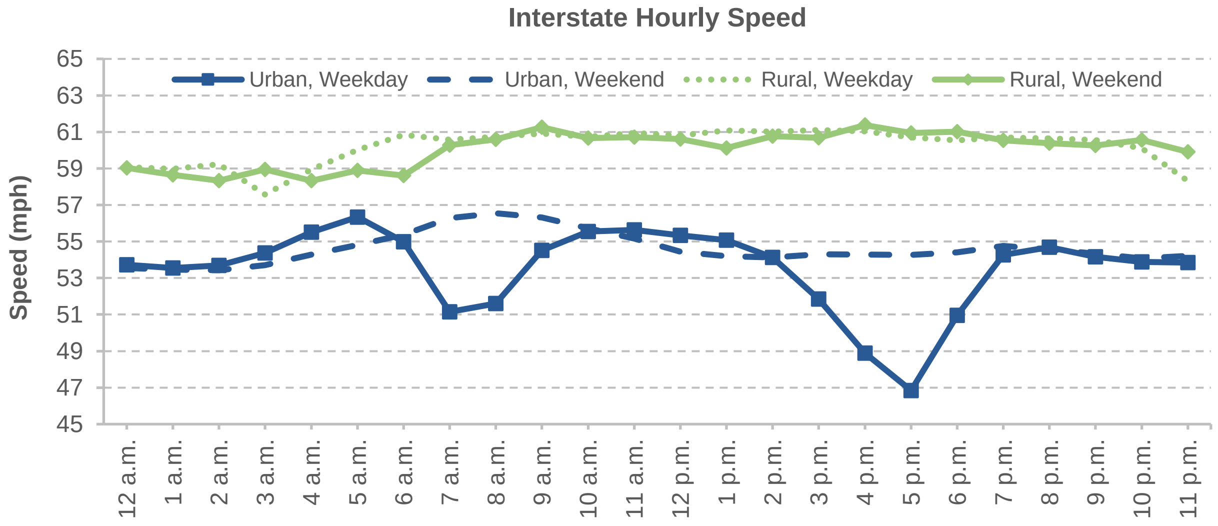
Note: Posted speed and observed speed are averaged over mainline Interstate highways.

Source: FHWA staff calculation from the National Performance Management Research Data Set and Highway Performance Monitoring System.

Speed by Hour of the Day on Rural and Urban Interstates

Traffic conditions generally vary by time of day, especially in urban areas where demand could exceed supply during peak travel times and along major commuter routes, causing congestion. *Exhibit 4-15* depicts the annual average speed by hour of the day on the Interstate System by urban/rural areas and weekday/weekend.

Exhibit 4-15 ■ Hourly Speed on Interstate, 2016



Note: Observed speed are averaged over mainline Interstate highways.

Source: FHWA staff calculation from the National Performance Management Research Data Set and Highway Performance Monitoring System.

Not surprisingly, the time-of-day speed variations for Interstate highways were larger on weekdays in urban areas than on weekends or in rural areas. The NPMRDS data clearly identified two weekday troughs on urban Interstate highways where average speed dropped substantially: the a.m. peak hour, approximately between 7:00 and 8:00 a.m., and the p.m. peak hour, between 5:00 and 6:00 p.m. Speed reduction is more noticeable during the p.m. peak hour, when average speed fell to 47 mph at 5 p.m., about 8 mph lower than that of weekend at the same time. On weekends, urban Interstate highways observed slightly higher speeds in the morning than in the afternoon, with no significant slowdowns throughout the day.

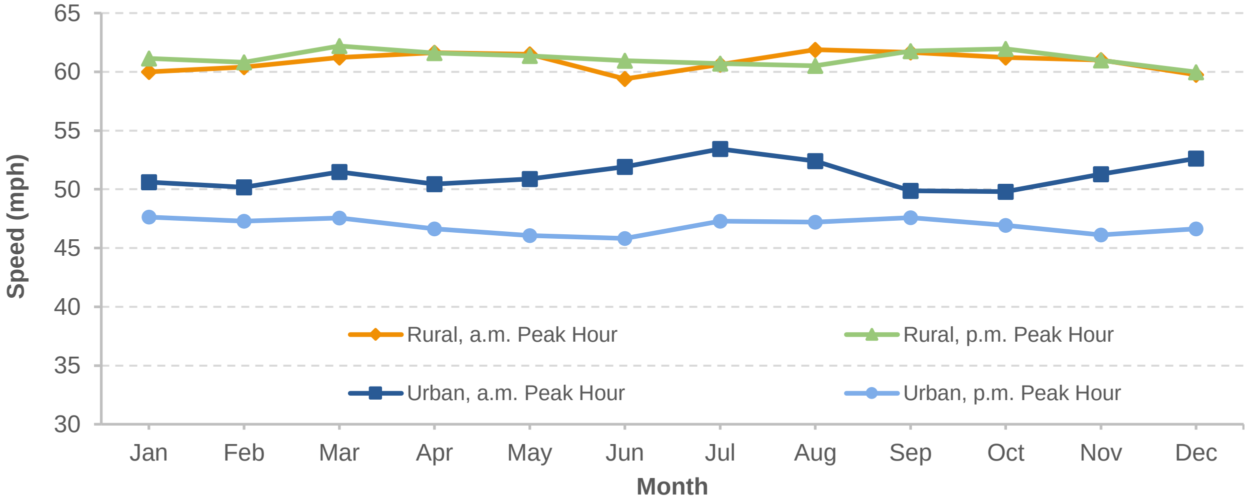
Unlike urban Interstate highways, rural Interstate highways operated at relatively consistent speeds. Average speed on rural Interstate highways was about 61 mph during the day, and dropped to about 59 mph during the overnight hours, possibly due to lack of street lights.

The lines of average weekend speeds were smoother for both rural and urban Interstates, implying relatively consistent speed. On urban Interstate highways, weekend drivers experienced higher speed than on weekdays at the same peak hours. For instance, the average speed at 8 a.m. was 56.5 mph on weekends, 4.9 miles higher than the speed at the same time on weekdays. The speed difference between weekday and weekend was even more evident at 5 p.m. on urban Interstates, where the average speed was 46.8 mph on weekdays but 7.5 miles higher on weekends. There were largely no significant speed differences between weekdays and weekends on rural Interstates.

Speed by Month on Rural and Urban Interstates

Exhibit 4-16 presents morning and afternoon peak hour travel speeds on both urban and rural Interstate highways. Average travel speed varies by month, with more noticeable variations on urban Interstate highways.

Exhibit 4-16 ▪ Peak Hour Speed by Month on Interstate, 2016



Note: Observed speed is averaged over mainline Interstate highways.

Source: FHWA staff calculation from the National Performance Management Research Data Set and Highway Performance Monitoring System.

On urban Interstate highways, the a.m. peak hour average speeds in summer months from June to August were higher than the average speeds of other months, which is possibly related to fewer urban commuters and students traveling during summer vacation. The a.m. peak-hour speed picked up in November and December, reaching average speeds comparable to those of summer months, which might be associated with more long-distance Interstate travel around the winter holidays. The lowest a.m. peak hour average speeds occurred in April, September, and October.

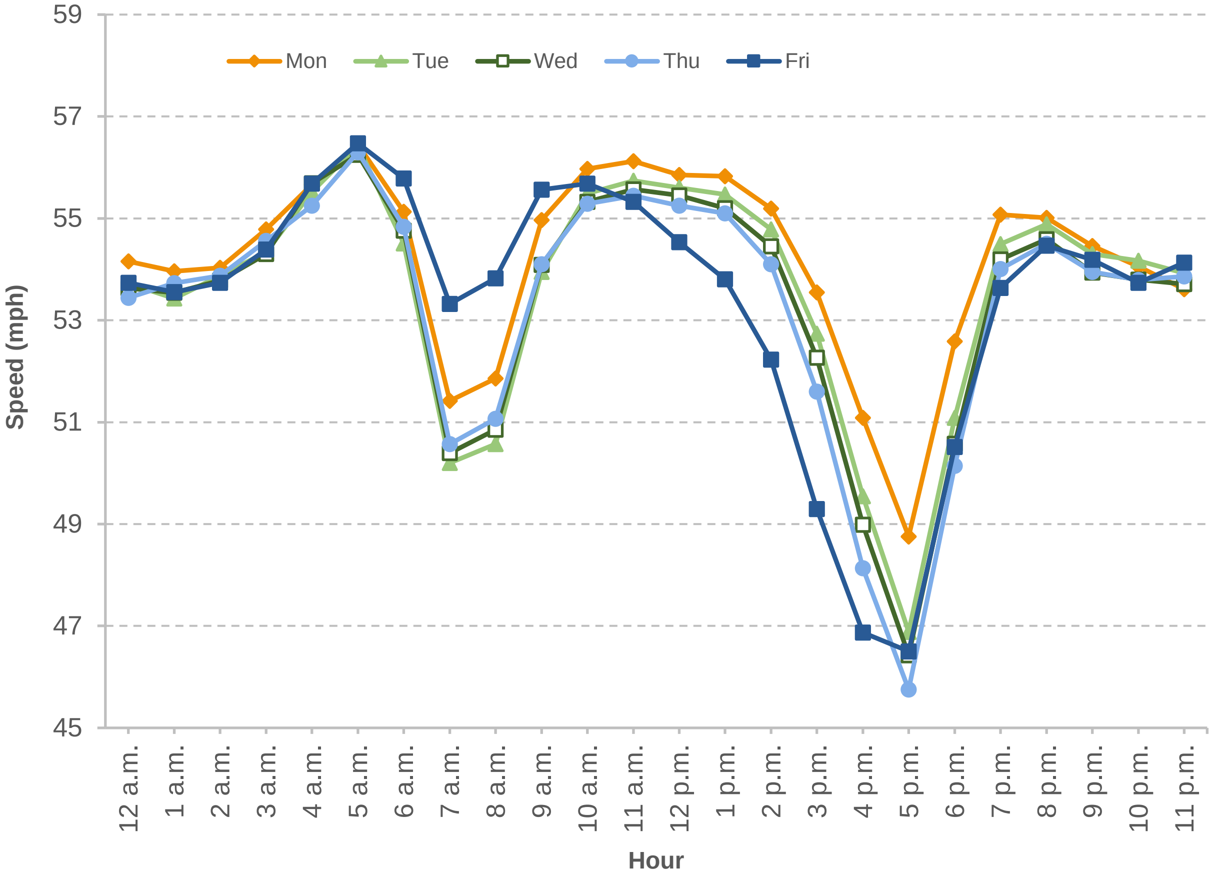
During p.m. peak hours, travelers on urban Interstate highways experienced the highest speed in January, March, and September and the lowest speeds in May and June. September was unique because it had higher speeds than most months in the p.m. peak hour, but the lowest speeds of the year in the a.m. peak hour.

On rural Interstates, a.m. and p.m. peak hour speeds were relatively uniform and limited in a small range between 59 and 62 mph. The highest a.m. peak hour speed was recorded in the months of August and September, and lowest in June and December. Traveling speed on rural Interstates during the p.m. peak hour was the highest in March and October, and the lowest in August and December.

Speed by Day of the Week on Urban Interstates

National average speeds on rural Interstate highways do not fluctuate much by hour of the day or by day of the week, but this is not the case for urban Interstate highways. In addition to the variations by hour identified in *Exhibit 4-15*, urban Interstate highways experienced variations by day of the week, as illustrated in *Exhibit 4-17*.

Exhibit 4-17 ■ Hourly Speed by Day of the Week on Urban Interstate, 2016



Note: Observed speed is averaged over mainline Interstate highways.

Source: FHWA staff calculation from the National Performance Management Research Data Set and Highway Performance Monitoring System.

Although all weekdays had similar speed trends of daytime troughs of congestion, individual hourly speed profiles by weekday were different. Monday tended to be the least congested weekday except in the morning peak period, during which Friday had the least congestion (a shallower trough). The Friday afternoon peak period started about one hour earlier than other weekdays.

The three middle weekdays (Tuesday, Wednesday, Thursday) follow typical weekday traffic conditions and experienced the most congested morning and afternoon peaks among all five weekdays.

For all weekdays, the afternoon peak period is consistently more congested than the morning peak period. The most congested afternoon peak period occurs on Thursday, when average speed dipped below 46 mph. The peak period on Friday afternoon tended to be longer than that of other weekdays.

Congestion Trends

This section focuses on examining congestion development from 2006 to 2016, based on the *2019 Urban Mobility Report*. As noted earlier, the Urban Mobility Report uses some of the same metrics as those presented above for 2012 to 2016, but the values were calculated using a different data source and methodology for a larger number of urban areas. Thus, the values presented in this section are not comparable with the values for the indicators reported above, although they represent similar concepts.

The average TTI first decreased during the economic downturn of 2009–2011, but subsequently rebounded and exceeded the pre-recession levels in urbanized areas. The TTI increased from 2011 to 2016 (*Exhibit 4-18*), consistent with the trend illustrated in *Exhibit 4-1*.

The Urban Mobility Report also reported on travel delay and its associated costs. Travel delay, the amount of extra time spent traveling due to congestion, was calculated at the individual roadway section level and for both weekdays and weekends. Annual delay per auto commuter is a measure of the extra travel time endured throughout the year by auto commuters who make trips during the peak period. An average auto commuter logged 53 additional hours sitting in traffic during the peak traveling period in 2016, which is a substantial escalation from 42 hours in 2006. Even at a modest national VMT growth, this increase in average delay could translate into a massive increase in nationwide total delay time. Total travel delay surged by 27 percent over the decade and reached 8.6 billion hours in 2016.

Congestion wastes an enormous amount of fuel. Over the 10-year period of 2006–2016, wasted fuel rose by 0.2 billion gallons. In 2016, 3.3 billion gallons of extra fuel was purchased due to delays on roadways. Combining wasted fuel with time delay, the total cost of congestion was estimated to be $171 billion in 2016, $26 billion higher than in 2006. (The average cost of time was assumed to be $18.29 per hour of personal travel and $59.94 per hour of truck time in 2017 constant dollars, which differs from the value used in the analyses reflected in Part II of this report.)

National Congestion Trends Since 2016

The Urban Mobility Report estimates that delay per auto commuter rose to 54 hours in 2017, while total delay rose to 8.8 billion hours. The total cost of congestion was estimated to be $179 billion in 2017.

Exhibit 4-18 ■ National Congestion Measures, 2006–2016

Year	Travel Time Index	Delay per Auto Commuter (Hours)	Total Delay (Billions of Hours)	Total Fuel Wasted (Billions of Gallons)	Total Cost (Billions of 2017 Dollars)
2006	1.22	42	6.7	3.1	$115
2007	1.22	43	6.8	3.2	$121
2008	1.22	42	6.8	3.2	$127
2009	1.21	43	6.9	3.1	$124
2010	1.21	44	7.2	3.1	$132
2011	1.21	45	7.5	3.2	$143
2012	1.22	47	7.7	3.2	$150
2013	1.22	48	8.0	3.2	$157
2014	1.22	50	8.2	3.2	$163
2015	1.23	51	8.4	3.3	$165
2016	1.23	53	8.6	3.3	$171

Source: Texas Transportation Institute (2019).

TPM Delay and Congestion Measures

TPM establishes two performance measures to assess traffic congestion for the purpose of carrying out the Congestion Mitigation and Air Quality Improvement (CMAQ) Program in urbanized areas. One measure is the annual hours of peak hour excessive delay (PHED) per capita. The other measure is the percentage of non-single occupancy vehicles (non-SOV), which may include travel via carpool, van, public transportation, commuter rail, walking, or bicycling, as well as telecommuting. The non-SOV rule applies initially to urbanized areas of more than 1 million people that are also in nonattainment or maintenance areas for ozone, carbon monoxide, or particulate matter. In the second performance period (which begins on January 1, 2022), the population threshold changes to areas of more than 200,000. All States and MPOs with NHS mileage that overlaps within an applicable urbanized area must coordinate on a single, unified target and report on the measures for that area.

Access

Transportation is a vital link that allows full participation in the community and contribution to a better society. Improved access to transportation helps ensure that all Americans, including those with disabilities, have equal opportunity to participate in and enjoy the benefits of society.

Definition and Measurement

Access is defined as the ability of travelers to reach their desired destinations. It is a broad concept that is applicable to all user groups and modes, accounting for distance, travel time, and travel costs of reaching destinations. The measures of access provide a user-centric approach to compare the performance of the transportation system to the population's needs. They can also be used to understand the distribution of user benefits associated with transportation investment and land use development.

Sometimes the term "accessibility" is used in reference to specific requirements under The Americans with Disabilities Act (ADA) of 1990; to avoid confusion this report uses the term "access" when referring to access for the general population. Transportation accessibility in this report refers to the provision of transportation facilities, including pedestrian facilities, that are accessible to and usable by individuals with mobility, visual, hearing, and other disabilities.

Access to destinations refers to the ability of people in a community to reach employment and essential services, such as health care, education, transit, and recreation, among others, through a diverse transportation network. Access to destinations can be measured for different transportation modes, to different types of destinations, and at different times of the day. For example, access to health care can be defined as the number of medical facilities that can be reached by the public within a given time. *Access Across America: Auto 2016*[15] argues that "(j)obs are the most significant non-home destination, and job accessibility is an important consideration in the attractiveness and usefulness of a place or area." According to the American Community Survey,[16] 85 percent of commuting trips used cars, trucks, vans, and other private motor vehicles in 2016 in the United States.

A laborshed is defined as the area or region from which an employment center draws its commuting workers within a travel time threshold. The *Access Across America: Auto* report uses employee home and work locations in the U.S. Census Bureau's Longitudinal Employer-Household Dynamics program (LEHD). Auto travel times are evaluated from the centroid of the origin census block to the centroid of the destination census block based on detailed auto travel network and link speed data.

---

[15] Accessibility Observatory, University of Minnesota, 2018.

[16] (https://www.census.gov/programs-surveys/acs/data.html).

Access to jobs is calculated using average speed and job densities across entire metropolitan areas for an 8 a.m. Wednesday morning departure, weighted by the number of workers in in all blocks in a statistical area. *Exhibit 4-19* presents information on access to jobs that are reachable within a given travel time by automobiles for the 50 most populous metropolitan areas. This measurement of laborshed identifies the areas with the highest auto access to jobs in 2016 as major economic centers such as New York, Los Angeles, Chicago, and Washington.

Exhibit 4-19 ■ Access to Jobs by Vehicles by Travel Time, 2016

Metropolitan Area	Jobs Reachable within 60 Minutes	Compared to Jobs Reachable within 60 Minutes, Share of Jobs Reachable within		
		10 Minutes	30 Minutes	50 Minutes
New York	6,529,209	3%	35%	80%
Los Angeles	5,544,460	3%	37%	82%
Chicago	3,537,245	3%	33%	80%
Washington	3,039,577	3%	33%	80%
Dallas	2,985,510	3%	44%	89%
San Francisco	2,959,082	4%	33%	79%
Philadelphia	2,904,106	2%	30%	76%
Riverside	2,694,177	2%	22%	64%
Boston	2,651,404	3%	32%	78%
San Jose	2,621,869	6%	38%	75%
Baltimore	2,590,067	3%	29%	69%
Houston	2,570,577	4%	44%	89%
Atlanta	2,093,630	3%	34%	81%
Detroit	2,006,487	4%	46%	86%
Miami	1,935,235	5%	47%	87%
Minneapolis	1,727,354	5%	57%	91%
Phoenix	1,726,471	6%	59%	94%
Denver	1,604,629	6%	61%	90%
Seattle	1,595,463	5%	45%	85%
Providence	1,580,807	3%	24%	67%
San Diego	1,534,217	6%	50%	84%
Hartford	1,485,579	4%	36%	79%
Tampa	1,426,024	5%	41%	83%
Orlando	1,401,750	4%	49%	83%
Cleveland	1,375,378	3%	41%	85%
Cincinnati	1,203,048	4%	47%	86%
St. Louis	1,196,601	5%	54%	91%
Milwaukee	1,170,906	9%	54%	83%
Portland	1,135,524	6%	58%	91%
Charlotte	1,125,078	5%	49%	87%
Indianapolis	1,116,321	5%	54%	87%
Sacramento	1,092,420	7%	54%	86%
Columbus	1,078,073	7%	58%	87%
Raleigh	1,074,819	6%	53%	86%
Pittsburgh	1,072,265	3%	37%	81%
Kansas City	1,064,141	6%	61%	90%
Austin	1,031,311	8%	56%	86%
Salt Lake City	1,007,582	12%	64%	95%
San Antonio	944,741	8%	65%	90%
Nashville	843,120	5%	44%	87%
Las Vegas	821,502	14%	96%	100%
Louisville	727,100	8%	61%	88%
Richmond	707,197	7%	58%	84%
Virginia Beach	669,966	8%	56%	88%
Jacksonville	656,444	7%	59%	91%
New Orleans	619,656	10%	52%	82%
Oklahoma City	613,589	9%	67%	93%
Memphis	605,349	10%	71%	93%
Buffalo	601,055	11%	71%	92%
Birmingham	585,400	6%	49%	82%

Source: Accessibility Observatory, University of Minnesota (http://access.umn.edu/research/america/index.html).

Exhibit 4-19 shows the distribution of time it takes workers in U.S. metropolitan areas to drive to their job locations from their homes. Of the jobs reachable within 60 minutes of driving, less than 5 percent can be reached within 10 minutes in most metropolitan areas. Approximately one-third can be reached in 30 minutes or less in large metropolitan areas and more than half can be reached in 30 minutes or less in medium-size metropolitan areas. Generally speaking, less populous metropolitan areas tend to have more jobs concentrated within shorter commutes. For example, in New York City approximately 3 percent of jobs in the one-hour laborshed can be reached within 10 minutes, and 35 percent of jobs can be reached within 30 minutes. In the much smaller city of Memphis, 10 percent of jobs in the one-hour laborshed can be reached within 10 minutes and 71 percent of jobs can be reached within 30 minutes.

Lower speeds due to congestion reduce the number of jobs reachable within the same travel time. The *Access Across America: Auto* report measures the impact of congestion on access to jobs by comparing job accessibility during the morning commute peak (8 a.m.) with accessibility during free-flow traffic, measured by the percentage reduction in job access within a given travel time threshold that is caused by highway congestion compared with free-flow speeds.

The impact of congestion is more pronounced in city cores, and the negative impact of congestion on access to jobs eases as the travel time threshold increases (*Exhibit 4-20*). For example, a congestion impact of 42 percent at the 10-minute travel time threshold in New York City indicates that the number of workers who can access their jobs within 10 minutes is 42 percent lower during the morning commute peak compared with off-peak periods. At a 30-minute travel time threshold in New York City, job access is cut by 37 percent; at 50 minutes it is cut by 20 percent, whereas at 60 minutes it is cut by only 15 percent.

Exhibit 4-20 ■ Congestion Impact on Job Access by Travel Time, 2016

	Travel Time Threshold			
Metropolitan Area	**10 Minutes**	**30 Minutes**	**50 Minutes**	**60 Minutes**
New York	42%	37%	20%	15%
Los Angeles	43%	42%	23%	14%
Chicago	38%	33%	18%	11%
Washington	37%	34%	17%	12%
Dallas	32%	25%	8%	3%
San Francisco	36%	40%	24%	13%
Philadelphia	35%	29%	17%	14%
Riverside	25%	34%	46%	39%
Boston	43%	34%	20%	13%
San Jose	41%	24%	30%	18%
Baltimore	27%	24%	30%	25%
Houston	38%	29%	9%	4%
Atlanta	34%	32%	16%	10%
Detroit	22%	16%	7%	6%
Miami	36%	23%	10%	7%
Minneapolis	28%	15%	4%	2%
Phoenix	28%	19%	4%	2%
Denver	32%	16%	4%	4%
Seattle	37%	28%	15%	9%
Providence	24%	18%	34%	33%
San Diego	33%	19%	8%	9%
Hartford	28%	14%	9%	9%
Tampa	25%	20%	8%	6%
Orlando	29%	11%	5%	5%
Cleveland	26%	15%	5%	4%
Cincinnati	23%	14%	5%	5%
St. Louis	22%	11%	3%	2%
Milwaukee	23%	8%	4%	6%
Portland	35%	18%	6%	4%
Charlotte	26%	15%	5%	5%
Indianapolis	24%	11%	4%	4%
Sacramento	31%	12%	6%	8%
Columbus	27%	7%	4%	4%
Raleigh	20%	11%	5%	4%
Pittsburgh	38%	21%	10%	7%
Kansas City	18%	8%	2%	2%
Austin	34%	16%	5%	5%
Salt Lake City	21%	4%	2%	1%
San Antonio	27%	7%	4%	6%
Nashville	30%	18%	5%	4%
Las Vegas	21%	1%	0%	0%
Louisville	23%	6%	3%	4%
Richmond	19%	5%	2%	3%
Virginia Beach	21%	9%	4%	3%
Jacksonville	27%	10%	4%	3%
New Orleans	31%	7%	6%	7%
Oklahoma City	20%	6%	2%	1%
Memphis	17%	5%	2%	2%
Buffalo	19%	5%	1%	2%
Birmingham	25%	9%	6%	5%

Note: The congestion impact compares job accessibility between morning commute peak (8 a.m.) and the maximum accessibility achieved across the 24-hour period.

Source: Accessibility Observatory, University of Minnesota

Large metropolitan areas observe more noticeable negative impacts of congestion on access to jobs than do their medium-size counterparts. At the 30-minute travel time threshold, the congestion impacts are 42 percent in Los Angeles and 33 percent in Chicago, whereas the impacts are more limited at 5 percent in Memphis and Buffalo.

Separated Bike Lane Planning and Design Guide

This FHWA guide (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/page00.cfm) outlines planning considerations for separated bike lanes and provides a menu of design options covering typical one- and two-way scenarios. It includes options for providing separation, midblock design, and intersection design. A new State law required the California Department of Transportation (Caltrans) to address separated bike lanes in its Highway Design Manual. Caltrans used and referenced this FHWA guide in the development of its State-level guidance. The Minnesota Department of Transportation also used this guide to inform the development of Statewide design standards for separated bike lanes. Delaware metropolitan planning organizations used and recommended the guide in updating their bike plan and cycle track designs.

The definition of access is not limited to vehicles: it also includes other transportation modes such as pedestrians and bicycles. The boxes present examples of State departments of transportation and metropolitan planning organizations that are developing and enhancing their strategic plans to improve access to destinations for non-vehicle travelers.

Incorporating On-Road Bicycle Networks into Resurfacing Projects

This guidebook (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/resurfacing/resurfacing_workbook.pdf) helps communities integrate on-road bicycle facilities as part of their routine roadway resurfacing process. It is an efficient and cost-effective way for communities to create connected networks of bicycle facilities. Many States, including Connecticut, Florida, Iowa, Maine, Massachusetts, and Wisconsin, provided trainings and workshops on the guidebook and have incorporated some of its suggested approaches into their policies and programs. Some States and Michigan's Pioneer Valley metropolitan planning organization have hosted multi-State trainings or have worked with FHWA to extend trainings to local entities. Arkansas's State Plan includes objectives that are directly connected to recommendations in this resource.

Accessible Pedestrian Facilities

The pedestrian system (including sidewalks, shared-use paths and trails, street crossings, bus stops, and even temporary facilities to mitigate the impacts of construction) is a critical link in providing access to all components of the Nation's transportation environment. Accessible pedestrian routes, which provide continuous and clear pedestrian pathways, enhance mobility and encourage independence by increasing transportation choice. Much work has been done to prevent or eliminate barriers that hinder travel for individuals with mobility, visual, hearing, or other disabilities. Accessible pedestrian facilities improve the quality of life for those with disabilities by reducing barriers to services, opportunities, and social activities.

Nearly one in five adults under the age of 65 has difficulty getting around outside due to an impairment or health problem, with difficulty in walking cited as the most common problem.[17] However, many people with mobility, sensory, and cognitive impairments continue to encounter barriers in their efforts to gain access to work, school, commerce, health, and leisure activities. Often the built environment is a primary reason for this difficulty because it has historically been designed for people who do not have a disability. Design details for surfaces, streetscape furniture, sidewalks, signals, street crossings, and transit stops may render pedestrian facilities inaccessible.

---

[17] The Future of Disability in American, Institute of Medicine of the National Academies, 2007, p. 522. https://www.nap.edu/read/11898/chapter/1.

Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities

This FHWA report (available at https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/accessible_shared_streets/fhwahep17096.pdf) reviews approaches for accommodating pedestrians with vision disabilities on shared streets where pedestrians, bicyclists, and motor vehicles are intended to mix in the same space. It describes specific challenges that pedestrians with vision disabilities face when navigating shared streets and provides strategies to address accessibility for pedestrians with vision disabilities in the planning and design process. The City of Minneapolis recently conducted a shared street study incorporating strategies to facilitate navigation and movement for people with visual disabilities in residential and commercial settings.

As a result, pedestrians with disabilities may be forced to walk in the street or otherwise be placed in direct conflict with motor vehicles or bicycles.

Strategic Agenda for Pedestrian and Bicycle Transportation

This document (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/strategic_agenda/) provides a framework to guide FHWA's pedestrian and bicycle initiatives and investments during the five-year period from Federal Fiscal Years 2017 to 2021. It establishes a strategic, collaborative approach for making walking and bicycling viable transportation options for people of all ages and abilities in communities throughout the United States. The Florida Department of Transportation used this document for guidance on data collection and implementation in its Pedestrian and Bicycle Strategic Safety Plan. It is also recommended to be included in updating design manuals by the Pennsylvania Department of Transportation.

The ADA requires pedestrian facilities in the public right-of-way to be accessible to and usable by individuals with disabilities. Common barriers to accessibility include issues such as curbs at street intersections with sidewalks, excessive sidewalk cross slopes, vision-dependent signal communications, and a variety of constraints posed by space limitations, roadway design practices, slope, and terrain. Accessible street designs can minimize multimodal conflicts by eliminating barriers for pedestrians, communicating street crossing information, and promoting predictable behavior for all roadway users. This ensures that the same degree of convenience, connection, and safety afforded to the public generally is also available to pedestrians with disabilities.

Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts

This guidebook (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_networks/fhwahep16055.pdf) helps practitioners address topics such as intersection design, road diets, pedestrian crossings, transit and school access, freight, and accessibility. It highlights ways to apply design flexibility while focusing on reducing multimodal conflicts and achieving connected networks. A number of States, including Washington, Oregon, and Wyoming, have used this guidebook in their State or MPO Bicycle and Pedestrian Plans.

These projects aim to spur business growth and job creation, and to make communities more livable through improved transportation infrastructure. These goals are achieved by reducing barriers to safety, providing greater connectivity to activity centers, accelerating project delivery, incorporating data in planning decisions, and offering technology innovations.

Recent FHWA Resources

- ***2019 Recreational Trails Program (RTP) Annual Report***. (https://www.fhwa.dot.gov/environment/recreational_trails/overview/report/2019/report2019.pdf)
- ***Accessible Shared Streets: Notable Practices and Considerations for Accommodating Pedestrians with Vision Disabilities.*** (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/accessible_shared_streets/fhwahep17096.pdf)
- ***Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts*****.** (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_networks/fhwahep16055.pdf)
- ***Case Studies in Realizing Co-Benefits of Multimodal Roadway Design and Gray and Green Infrastructure***.

  (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_green_infrastructure/).
- ***Guidebook for Measuring Multimodal Network Connectivity.*** (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_connectivity/)
- ***Guidebook for Developing Pedestrian and Bicycle Performance Measures***. (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/performance_measures_guidebook/pm_guidebook.pdf)
- ***Incorporating On-Road Bicycle Networks into Resurfacing Projects***. (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/resurfacing/resurfacing_workbook.pdf)
- ***Metropolitan Pedestrian and Bicycle Planning Handbook***. (https://www.fhwa.dot.gov/planning/processes/pedestrian_bicycle/publications/mpo_handbook/index.cfm)
- ***Noteworthy Local Polices That Support Safe and Complete Pedestrian and Bicycle Networks***. (https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa17006-Final.pdf)
- ***Pursuing Equity in Pedestrian and Bicycle Planning***. (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/resources/equity_paper/equity_planning.pdf)
- ***Safety for All Users Report***. (https://www.transportation.gov/sites/dot.gov/files/docs/mission/safety/303201/safety-all-users-report.pdf)
- ***Separated Bike Lane Planning and Design Guide***. (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/page00.cfm)
- ***Small Town and Rural Multimodal Networks***. (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/small_towns/fhwahep17024_lg.pdf)
- ***Strategies for Accelerating Multimodal Project Delivery***. (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/multimodal_delivery/)
- ***Strategic Agenda for Pedestrian and Bicycle Transportation***. (https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/strategic_agenda/)

Mobility and Access – Transit

The basic goal of all transit operators is to connect people to the places they want to go in a safe and efficient manner. Transit operators seek to minimize travel times, make effective use of vehicle capacity, and provide reliable performance. The Federal Transit Administration (FTA) collects data on average speed, how full the vehicles are on average (utilization), and how often they break down (mean distance between failures) to characterize how well transit service meets these goals. These data are discussed in this chapter; transit safety data are summarized in Chapter 5.

The first section of this chapter presents data on average operating speeds, average number of passengers per vehicle, average percentage of seats occupied per vehicle, average distance traveled per vehicle, and mean distance between vehicle failures. Average speed, seats occupied, and distance between failures provide metrics for evaluating efficiency and customer service issues; passengers per vehicle and miles per vehicle are primarily effectiveness and efficiency measures, respectively. Financial efficiency metrics for transit, including operating expenditures per revenue mile or passenger mile, are discussed in Chapter 2.

The second section presents an analysis of the progress that transit agencies have made in improving accessibility to transit for persons with disabilities as well as an analysis of transit system coverage, frequency of service, and waiting times.

The National Transit Database (NTD) includes urban data reported by mode and type of service. As of December 2010, NTD contained data for 16 modes. Beginning in January 2011, FTA added new modes to the NTD urban data, including:

- Streetcar rail—previously reported as light rail
- Hybrid rail—previously reported as light rail or commuter rail
- Commuter bus—previously reported as motorbus
- Bus rapid transit—previously reported as motorbus
- Demand-response taxi—previously reported as demand response

Data from NTD are presented for each new mode for analyses specific to 2016. For NTD time series analysis, however, streetcar rail and hybrid rail are included as light rail, commuter bus and bus rapid transit as fixed-route bus, and demand-response taxi as demand response.

KEY TAKEAWAYS

- The average speed of transit modes varies considerably. Modes such as trolleybus and streetcar operate mostly in mixed traffic rights-of-way and serve downtown areas. The average speed of these modes is less than 10 mph.
- Rail modes operate at average speeds of over 15 mph; modes with a long-distance commuter orientation, such as commuter rail average over 30 mph.
- The utilization of the fleet as measured by revenue miles per size of fleet increased appreciably for light rail (including streetcars) and commuter rail, whereas it declined for bus and demand response.
- Heavy rail vehicle occupancy increased by 17 percent from 2006 to 2016 but declined marginally on most other modes. Following four years of steady ridership increases, ridership declined by roughly 1.4 percent from 2014 to 2016.
- The mean distance between vehicle failures has shown steady improvement across all modes since 2009.
- Ridership in 2016 was 10.4 billion trips, an increase of 10.5 percent compared with 9.4 billion in 2006.
- As of 2016, 48 percent of transit passengers wait five minutes or less for transit vehicles to arrive and 74 percent wait 10 minutes or less. Only 3 percent wait more than 30 minutes.
- The level of ADA accessibility to transit service vehicles rose from 94 percent in 2006 to 95 percent in 2016. Light rail had the highest increase in accessibility, from 83 percent in 2006 to 93 percent in 2016.

Ridership

The two primary measures of transit ridership are unlinked passenger trips (UPTs) and PMT. An unlinked passenger trip, sometimes called a boarding, is defined as a journey on one transit vehicle. PMT is calculated based on UPTs and estimates of average trip length. Either measure provides a similar picture of ridership trends because average trip lengths, by mode, have not changed substantially over time. Comparisons across modes, however, could differ substantially depending on which measure is used, due to significant differences in the average trip length for the various modes.

Exhibit 4-21 provides total PMT for selected years between 2006 and 2016, showing steady growth across all major modes. The ferryboat, light rail, other rail, and vanpool modes grew at the highest rates, whereas heavy rail had the largest increase in total passenger miles (accounting for close to half the growth in total passenger miles).

Exhibit 4-21 ■ Transit Passenger Miles Traveled, 2006–2016

Mode	Passenger Miles (in Millions)						Average Annual Rate of Change 2016 to 2006
	2006	2008	2010	2012	2014	2016	
Rail	**26,972**	**29,989**	**29,380**	**31,176**	**32,672**	**32,944**	**2.0%**
Heavy Rail	14,721	16,850	16,407	17,516	18,339	18,357	2.2%
Commuter Rail	10,359	11,032	10,774	11,121	11,600	11,768	1.3%
Light Rail[1]	1,866	2,081	2,173	2,489	2,675	2,756	4.0%
Other Rail[2]	25	26	26	50	59	64	9.7%
Nonrail	**22,351**	**23,723**	**23,247**	**23,993**	**24,340**	**23,378**	**0.5%**
Fixed-route Bus[3]	20,390	21,198	20,570	21,142	21,429	20,411	0.0%
Demand Response[4]	753	844	874	887	917	943	2.3%
Ferryboat	178	390	389	402	414	490	10.7%
Trolleybus	164	161	159	162	158	154	-0.6%
Vanpool	689	992	1,087	1,254	1,310	1,288	6.5%
Other Nonrail[5]	176	138	169	145	112	92	-6.3%
Total	**49,322**	**53,712**	**52,627**	**55,169**	**57,012**	**56,322**	**1.3%**
Percent Rail	54.7%	55.8%	55.8%	56.5%	57.3%	58.5%	

[1] Includes light rail, hybrid rail, and streetcar rail.

[2] Includes Alaska railway, monorail/automated guideway, cable car, and inclined plane.

[3] Includes bus, commuter bus, and bus rapid transit.

[4] Includes demand-response and demand-response taxi.

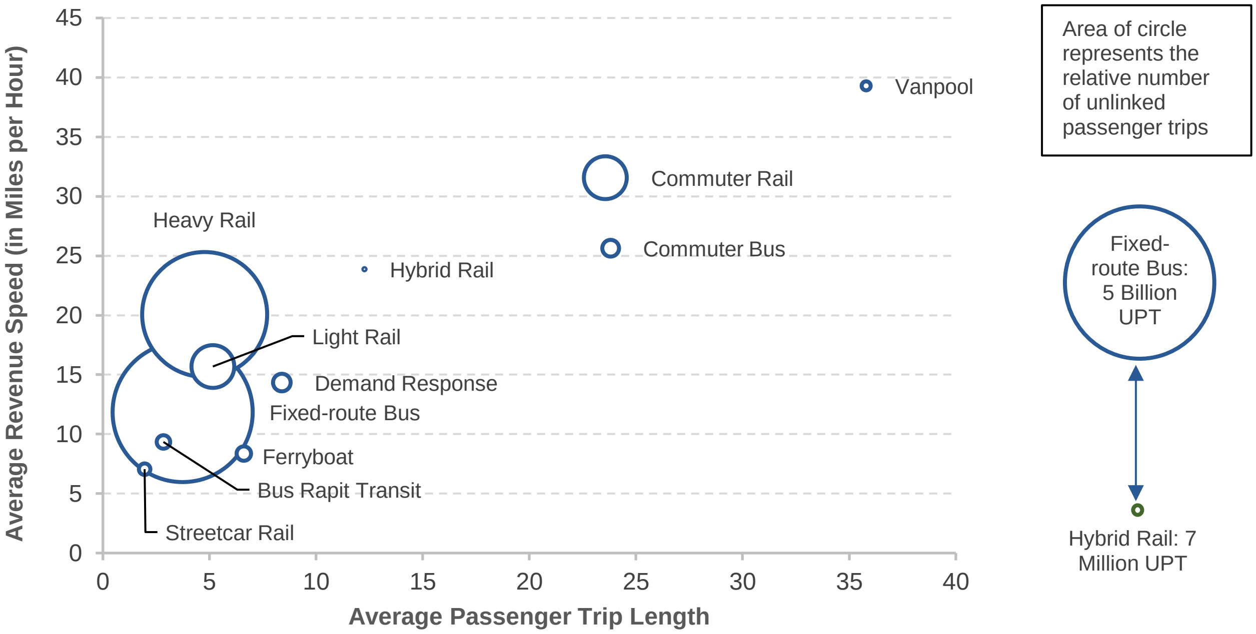
[5] Includes aerial tramway and público.

Source: National Transit Database.

Growth in demand response (up 2.3 percent per year) could reflect demand from the growing number of elderly citizens. Light rail (up 4.0 percent per year) enjoyed increased capacity during this period due to expansions and addition of new systems. The rapidly increasing popularity of vanpools (up 6.5 percent per year), particularly the surge between 2006 and 2008 (up 44 percent over that period), can be attributed partially to rising gas prices: Regular gasoline sold for more than $4 per gallon in July of 2008. FTA also encouraged vanpool reporting during this period, successfully enrolling many new vanpool systems to report to NTD. *Exhibit 4-22* depicts average passenger trip length (defined as PMT per UPT) vs. revenue speed (defined as VRMs per vehicle revenue hours), and UPTs for transit modes. Note that average passenger trip length is the average distance traveled of one unlinked trip. Most riders use more than one mode to commute from origin to destination (linked trip), which could include other transit modes, car, or other modes, such as bicycle and walking. Therefore, the average trip length of an individual mode as depicted in

Exhibit 4-22 is the lower bound of the total average distance traveled. The total trip distance is a function of a linked trip factor that varies from mode to mode and is not available in the NTD.

Exhibit 4-22 ■ Transit Urban Average Unlinked Passenger Trip Length vs. Average Revenue Speed for Selected Modes



Source: National Transit Database.

Demand-response and vanpool systems are modes with linked factors close to 1; that is, the average trip length of one unlinked trip should be close to the total length of the linked trip. This is because vanpools and demand response are "by-demand" modes, and the routes can be set up to optimize the proximity from the origin and destination.

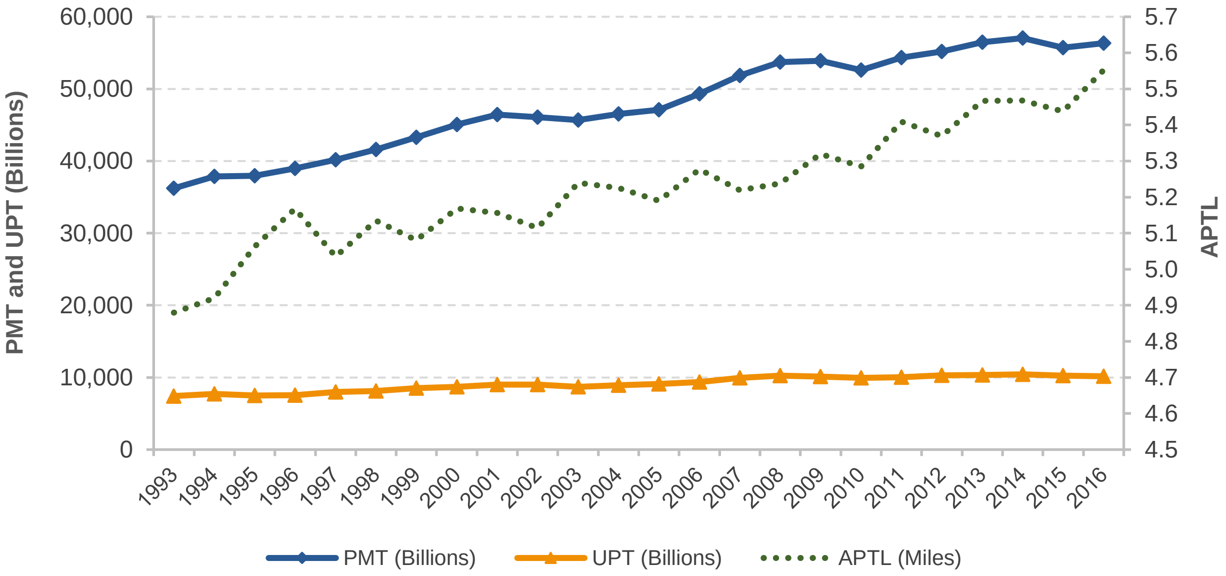
Commuter bus and commuter rail, on the other hand, are fixed-route modes, and a high percentage of commuters require other modes to reach their final destinations. Additionally, commuter bus and commuter rail are not as fast as vanpools due to more frequent stops near areas of attraction and generation of trips, among other factors. Prior to being introduced in 2011, hybrid rail was reported as commuter rail and light rail. However, hybrid rail has quite different operating characteristics than commuter rail and light rail; it has higher average station density (stations per track mileage) than commuter rail and a lower average station density than light rail. This results in revenue speeds that are lower than commuter rail and higher than light rail. Hybrid rail has a smaller average peak-to-base ratio (number of trains during peak service per number of trains during midday service) than commuter rail, which indicates higher demand at off-peak hours.

Several modes (heavy rail, light rail, fixed-route bus, bus rapid transit, streetcar, and ferryboat) cluster within a narrow range for average passenger trip length (less than 5 miles) and a wider range for average revenue speed (10 to 20 mph). Heavy rail and light rail have higher average speeds than nonrail modes for operating in exclusive rights-of-way. The modes in this cluster serve areas with high population density and significant average number of boarding and alighting per station or stop, which results in shorter average trip lengths than modes with a commuter orientation. These modes should have similar link factors but smaller than those of commuter rail and commuter bus.

Transit Travel Trends

As shown in *Exhibit 4-23*, UPT trends since 1993 have generally mirrored those of PMT, increasing and decreasing in the same years. From 1993 to 2016, PMT increased on average by 1.9 percent annually, outpacing UPT, which grew by 1.3 percent per year. This was reflected in an increase in average passenger trip lengths. In 1993, the average transit trip was 4.9 miles. By 2016, the average transit trip increased to 5.6 miles, a 14-percent increase. The increase is due in part to the expansion of service areas into growing suburbs. UPT and PMT have decreased more recently, starting in 2013 and going through to 2016 and beyond.

Exhibit 4-23 ■ PMT, UPT, and APTL, 1993–2016



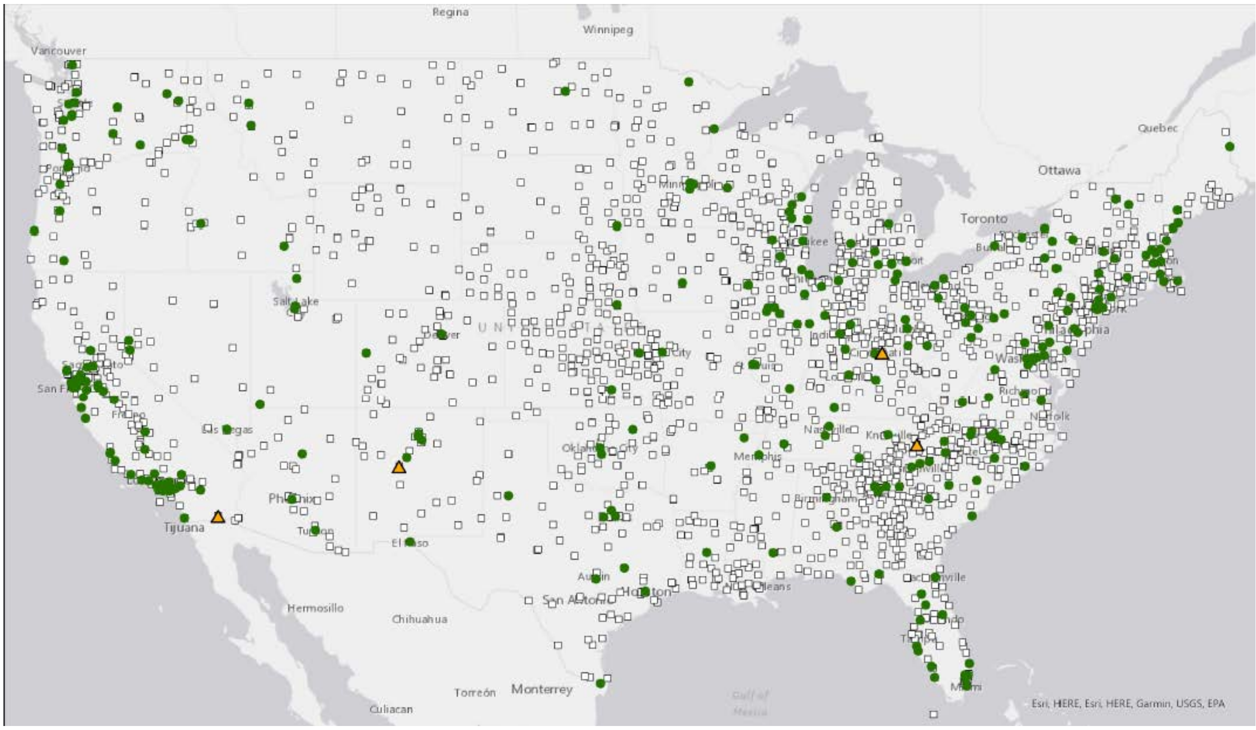
Notes: PMT is passenger miles traveled; UPT is unlinked passenger trips; APTL is average passenger trip length.

Source: National Transit Database.

National Transit Map

In 2016, FTA partnered with the Bureau of Transportation Statistics to begin collection of data for a National Transit Map. Participation in the National Transit Map is voluntary, but the goal is to collect route and schedule information for every fixed-route transit provider in the country. Data are collected using the General Transit Feed Specification (GTFS) data model, and the information will be updated multiple times per year from the GTFS data that transit systems are already making publicly available. Eventually, the National Transit Map will allow FTA to replicate the analyses first completed in the "Missed Opportunities" report, and also to eventually develop national performance measures for access to fixed-route transit. As of April 2018, the National Transit Map included route maps from 331 participating transit providers (see *Exhibit 4-24*). The National Transit Map is available at https://www.bts.gov/content/national-transit-map.

Exhibit 4-24 ■ Transit Agencies in the Continental United States and Agencies Participating in the National Transit Map, 2018



Note: Participating agencies are represented by green dots, declining agencies by orange triangles, and agencies not yet contacted by white squares.

Source: Bureau of Transportation Statistics, National Transit Map, updated on April 24, 2018.

Exhibit 4-25 shows the market share of transit for the top 10 urbanized areas, ranked by their market shares. Most of these areas have large populations and high population density, and account for the majority of transit service in the United States. Concord, California; and Bridgeport–Stamford, Connecticut are exceptions: Both have smaller populations than the other areas. Given their proximity to large metropolises (San Francisco and New York, respectively), the data show high ridership for trips between the small satellite areas and major cities.

Exhibit 4-25 ■ Market Share of Public Transit of Work Trips for the Top 10 Urbanized Areas, 2016

Rank	Urbanized Area	Public Transit Share	Margin of Error ±
1	New York–Newark, NY–NJ–CT Urbanized Area (2010)	33.0%	0.3%
2	San Francisco–Oakland, CA Urbanized Area (2010)	19.6%	0.5%
3	Washington, DC–VA–MD Urbanized Area (2010)	15.7%	0.4%
4	Boston, MA–NH–RI Urbanized Area (2010)	14.2%	0.4%
5	Chicago, IL–IN Urbanized Area (2010)	13.0%	0.3%
6	Concord, CA Urbanized Area (2010)	12.1%	1.0%
7	Bridgeport–Stamford, CT–NY Urbanized Area (2010)	10.8%	0.8%
8	Champaign, IL Urbanized Area (2010)	10.5%	2.0%
9	Seattle, WA Urbanized Area (2010)	10.3%	0.4%
10	Philadelphia, PA–NJ–DE–MD Urbanized Area (2010)	10.0%	0.3%

Note: Urbanized area refers to a Census-designated urban area with 50,000 residents or more.

Source: American Community Survey 2016.

The National Household Travel Survey and Key Public Transportation Characteristics 2009–2017

The 2017 National Household Travel Survey is based on data collected over a one-year period, starting in the second quarter of 2016 and ending in the first quarter of 2017.

Introduction

All analyses in this section are concentrated in three mode groups:

Group 1: Includes cars, SUVs, vans, and trucks, but not taxis and other transportation network company (TNC) services (alternatively referred to as ridesharing) such as Uber, Lyft, and other providers, which are designated as "private vehicles."

Group 2: The second group, which includes public transportation modes and is designated as "PTRANS" (public transit), includes up to three subgroups:[18]

NHTS Designation	C&P Designation
Local Bus and Commuter Bus	Bus
Amtrak/Commuter Rail	Commuter Rail
Heavy Rail, Light Rail, and Streetcars	Local Rail

Group 3: Due to extraordinary growth in TNC services between the 2009 and 2017 NHTS surveys, the analyses in this section added a separate group to consider them.

The NHTS data were surveyed and thus probabilistic, with the margin of error (MOE) provided by FHWA's querying tool or calculated when not retrievable from the tool. The analyses that follow do not generally show the MOE although it is calculated and factored into each analysis.

The NHTS provides summaries at the 95-percent confidence level. Whenever this level yields nonsignificant estimates, a 90-percent level is tried, and if significant at that level is presented as statistically significant. Differences between variables that fall within the MOEs are indicated in the text. Otherwise, the reader should assume the differences are statistically significant.

Most of the analyses in this section rely on data changes between the 2009 and 2017 surveys. The 2017 survey differed significantly from the 2009 survey in many respects, such as sampling method. In the specific case of public transportation, the composition and granularity of public transportation modes changed as shown in *Exhibit 4-26.*[19]

All other modes not included in these three groups are not presented or discussed in the analyses below. Thus, the sum of individual modes depicted in the exhibits does not equal the "All Modes" total, which sums all modes including those not considered here.

---

[18] Information on these modes is available in the NTD *2018 Policy Manual*, located at https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/ntd/117156/2018-ntd-policy-manual_1.pdf, and NHTS *Data User Guide* at https://nhts.ornl.gov/assets/2017UsersGuide.pdf.

[19] Further information on these and other mode changes is available in the 2017 NHTS *Data User Guide* at https://nhts.ornl.gov/assets/2017UsersGuide.pdf.

Exhibit 4-26 ■ Public Transportation Mode Correspondence between 2009 and 2017 NHTS Surveys

Item	2009 NHTS	2017 NHTS
1	Local and Commuter Bus services were two distinct modes.	Merged these two modes into a single “Local or Commuter Bus” mode.
2	The following rail modes were separate modes: ▪ Heavy Rail (Subway and Elevated) ▪ Streetcar and Trolley	Merged into a single “Subway/Elevated, Light Rail, and Streetcar” mode.
3	Commuter Rail and Amtrak/Intercity were separate modes	Combined into “Amtrak/Commuter Rail” mode.

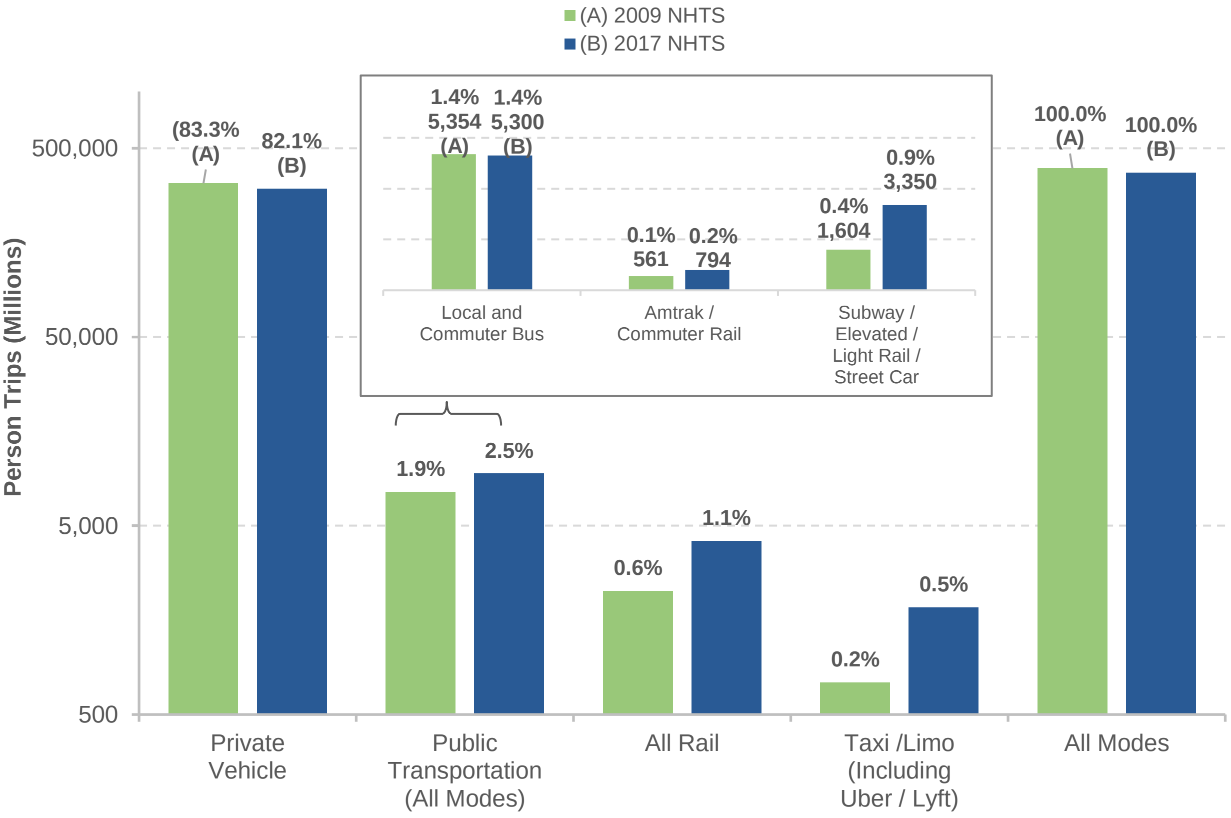
Source: 2017 NHTS Data User Guide (https://nhts.ornl.gov/assets/2017UsersGuide.pdf).

Market Share of Person Trips, All Modes and All Purposes, 2009 and 2017 NHTS

Exhibit 4-27 depicts the estimated share of all trips, for all purposes and all modes, from the 2009 and 2017 surveys.

There were more Americans in 2017 than in 2009, but they traveled less. The number of person trips decreased from 391.3 billion in 2009 to 371.1 billion trips in 2017, a five-percent decrease. Overall, the average number of trips per person decreased from 1.4 in 2009 to 1.2 trips/person in 2017, a 17-percent decrease.

Exhibit 4-27 ■ Market Share Change of Public Transportation, Private Vehicles, and Taxi Trips, 2009 and 2017



Note: NHTS is National Household Travel Survey.

Public or Commuter Bus, Amtrak/Commuter Rail, and Subway/Elevated/Light Rail/Streetcar are all subsets of Public Transportation.

Source: NHTS, FHWA, 2017.

Public transportation had the largest increase in the number of trips and market share among all modes. The number of trips rose from 7.5 billion in 2009 to 9.4 billion in 2017, a 25-percent increase. As *Exhibit 4-28* shows, this considerable increase was due to the rise in local rail trips (heavy rail, light rail, streetcars, etc.), which more than doubled from 1.6 billion in 2009 to 3.4 billion in 2017, an increase of 1.7 billion trips. Commuter rail trips also increased, but due to their low market share cannot be reliably quantified.

Bus trips, which account for over 50 percent of all public transportation trips, remained essentially unchanged. The number of trips using TNCs increased dramatically, from 738 million trips in 2009 to 1.8 billion trips in 2017, 1.1 billion more trips or a 143-percent increase.

The count of all persons in the two surveys included all individuals in the United States more than 5 years old. The number of persons increased by 14 percent over the period, whereas the number of trips decreased by 5 percent.[20]

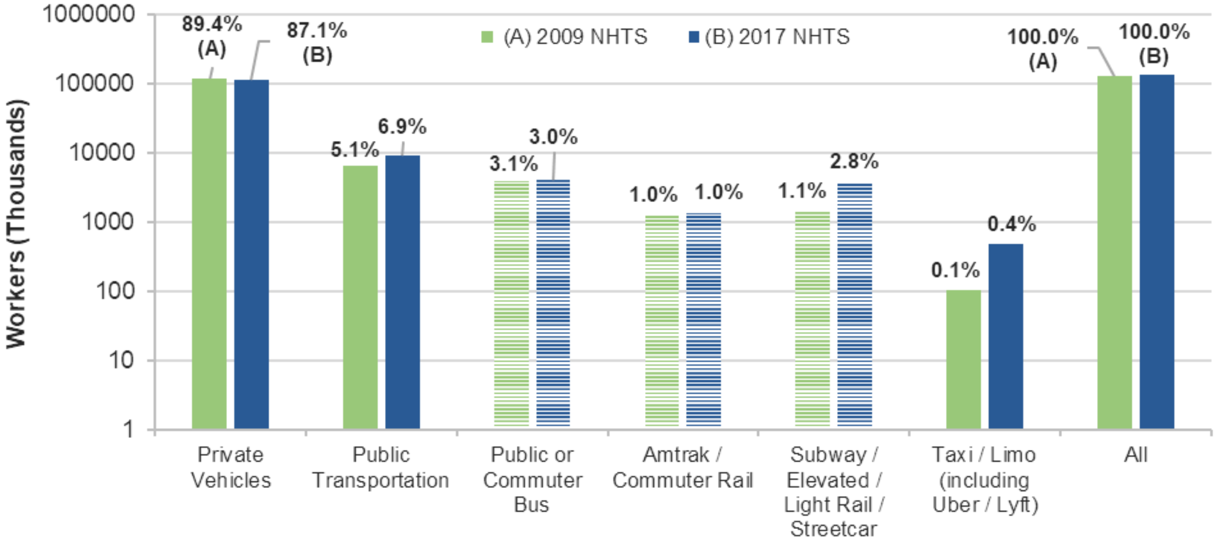
Market Share of Persons Commuting to Work by Public Transportation

On a per-person basis, the market share of commuting to work by public transportation was higher in 2017 than in 2009, but the increase in persons is commensurate to the increase when all trips and purposes are considered as shown in *Exhibit 4-27*. "Workers" are a subset of the overall transportation market, and represent commuting work trips.

Public transportation has a higher share of the market when rail trip purposes are included, at 6.9 percent in the 2017 NHTS, divided equally between rail and bus as shown in *Exhibit 4-28*.

Compared with the 2009 NHTS, public transportation had the greatest increase in market share, from 5.1 percent in 2009 to 6.9 percent in 2017. This increase was due to the more than 100-percent increase in the share of local rail modes. The bus market remained unchanged. The total share is less than 100 percent because only private vehicles and public transportation were included in the analysis. All other modes account for the difference.

Exhibit 4-28 ■ Market Share of Mode of Transportation to Work, 2009 and 2017



Note: NHTS is National Household Travel Survey.

Public or Commuter Bus, Amtrak/Commuter Rail, and Subway/Elevated/Light Rail/Streetcar are all subsets of Public Transportation.

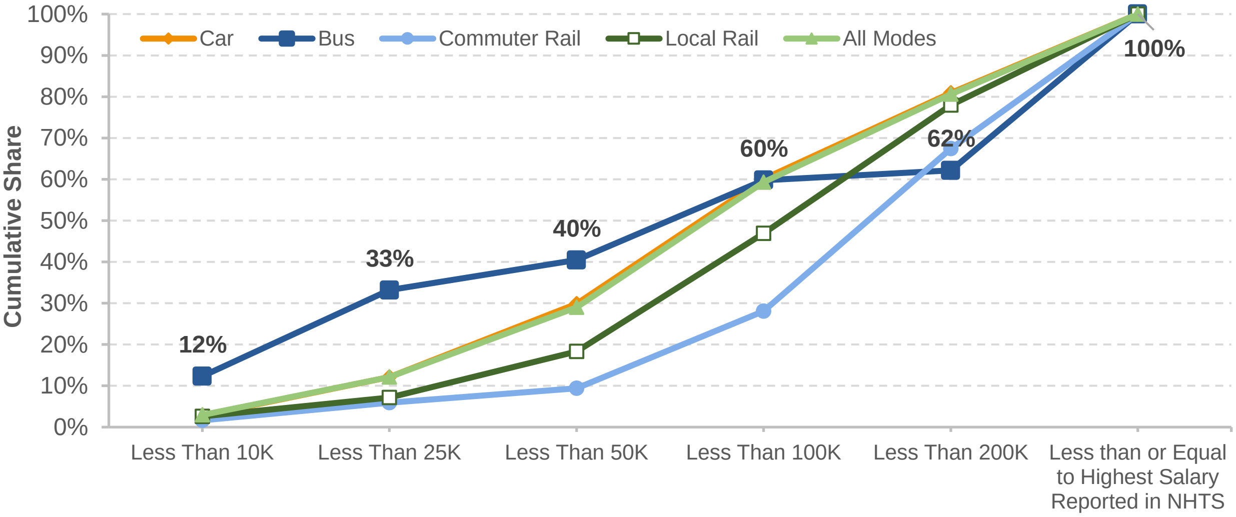
Source: NHTS, FHWA, 2017.

---

[20] Source: Summary of Travel Trends–2017 National Household Survey (https://nhts.ornl.gov/assets/2017_nhts_summary_travel_trends.pdf).

Exhibit 4-29 shows the distribution of cumulative household income of work trips by mode. Private vehicles (“cars” in the exhibit) are included for comparison. Bus, which accounts for 45 percent of the public transportation market, has the lowest household income distribution of all modes. Approximately 56 percent of bus commuters earn less than the national median household income ($53,156 in 2016), and 26 percent earn less than the poverty level of households with three people (the average household size of bus commuters).

Exhibit 4-29 ■ Distribution of Cumulative Household Income of Work Trips by Mode, 2017

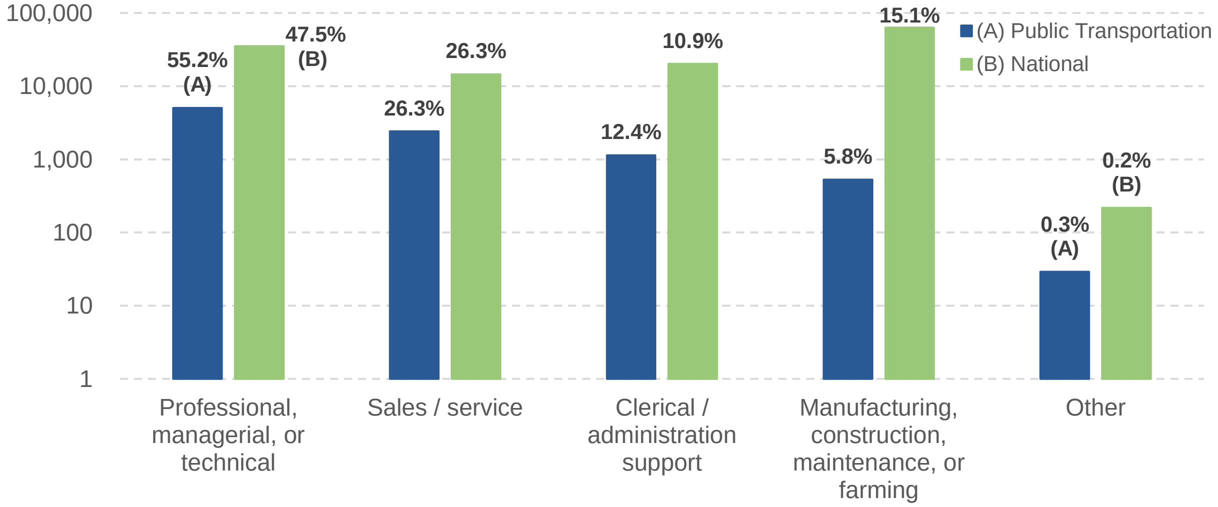


Source: National Household Transit Survey, FHWA, 2017.

Job Market

More than 50 percent of public transportation commuters work in the professional, managerial, or technical category; the second most common category is sales or service. The national distribution is similar to that for public transportation except in the manufacturing and construction category, where the national share is three times greater than that of public transportation commuters (see *Exhibit 4-30*).

Exhibit 4-30 ■ Public Transportation Commuting by Job Category, 2017



Source: National Household Transit Survey, FHWA, 2017.

System Capacity

Exhibit 4-31 provides reported vehicle revenue miles (VRMs) for both rail and nonrail modes. These numbers show the actual number of miles each mode travels in revenue service (the time when a vehicle is available to the general public and there is an expectation of carrying passengers). VRMs provided by fixed-route bus services and rail services show consistent growth, with light rail and vanpool miles growing somewhat faster than the other modes. Overall, the number of VRMs has increased by 28.8 percent since 2006, with an average annual rate of change of 2.6 percent. Transit system capacity, particularly in cross-modal comparisons, is typically measured by capacity-equivalent VRMs. This parameter measures the distances transit vehicles travel in revenue service and adjusts them by the passenger-carrying capacity of each transit vehicle type, with the average carrying capacity of fixed-route bus vehicles representing the baseline. To calculate capacity-equivalent VRMs, the number of revenue miles for a vehicle is multiplied by the bus-equivalent capacity of that vehicle. Thus, a heavy rail car that seats 2.4 times more people than a full-size bus provides 2.4 capacity-equivalent miles for each revenue mile it travels.

Exhibit 4-31 ■ Rail and Nonrail Vehicle Revenue Miles, 2006–2016

	Vehicle Revenue Miles (in Millions)						
Mode	**2006**	**2008**	**2010**	**2012**	**2014**	**2016**	**Average Annual Rate of Change 2006 to 2016**
Rail	**997**	**1,053**	**1,056**	**1,056**	**1,109**	**1,143**	**1.4%**
Heavy Rail	634	655	647	638	657	676	0.6%
Commuter Rail	287	309	315	318	339	344	1.8%
Light Rail[1]	73	86	92	99	112	121	5.2%
Other Rail[2]	3	3	2	1	1	1	-6.9%
Nonrail	**2,673**	**3,171**	**3,235**	**3,273**	**3,469**	**3,584**	**3.0%**
Fixed-route Bus[3]	1,910	2,026	1,996	1,978	2,047	2,126	1.1%
Demand Response[4]	607	948	1,010	1,046	1,155	1,186	6.9%
Ferryboat	2	3	3	3	3	4	7.8%
Trolleybus	12	11	12	11	11	11	-0.4%
Vanpool	110	158	181	207	228	234	7.8%
Other Nonrail[5]	32	25	32	27	25	23	-3.5%
Total	**3,670**	**4,225**	**4,291**	**4,328**	**4,578**	**4,727**	**2.6%**

[1] Includes light rail, hybrid rail, and streetcar rail.

[2] Includes Alaska railway, monorail/automated guideway, cable car, and inclined plane.

[3] Includes bus, commuter bus, and bus rapid transit.

[4] Includes demand response and demand response taxi.

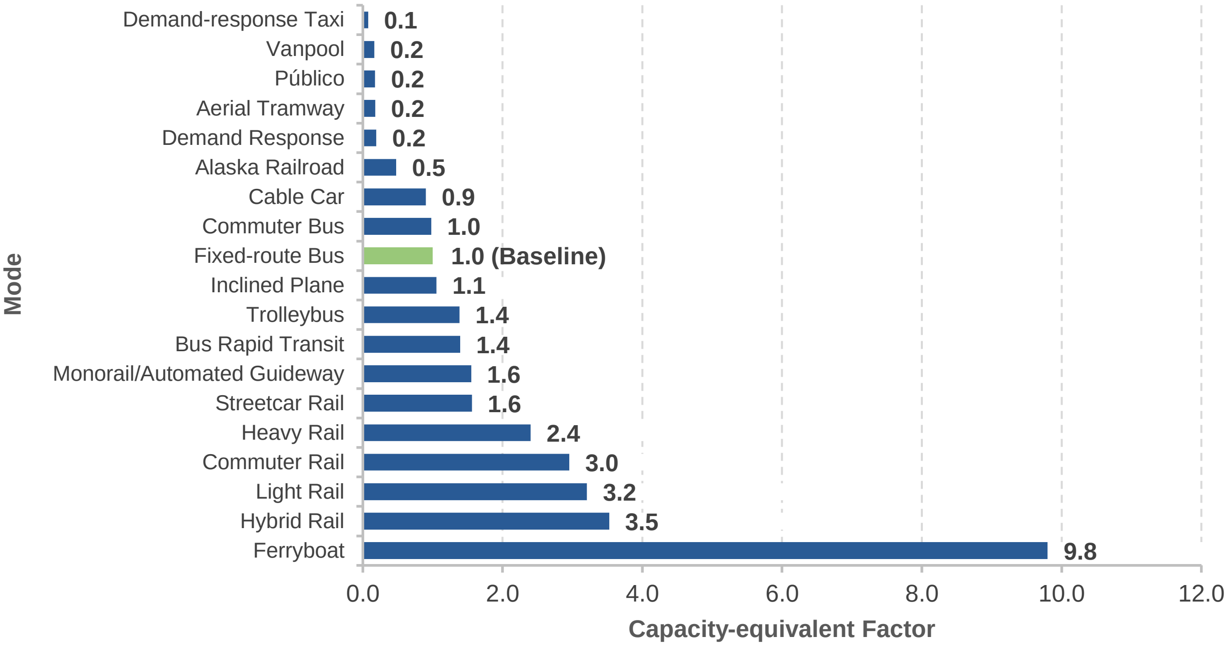
[5] Includes aerial tramway and público.

Source: National Transit Database.

Exhibit 4-32 shows the 2016 capacity-equivalent factors for each mode. Unadjusted VRMs for each mode are multiplied by a capacity-equivalent factor to calculate capacity-equivalent VRMs. These factors are equal to the average full-seating and full-standing capacities of vehicles in active service for each transit mode divided by the average full-seating and full-standing capacities of all motor bus vehicles in active service. The average capacity of the national motor bus fleet changes slightly from year to year as the proportion of large, articulated, and small buses varies. The average capacity of the bus fleet in 2016 was 37 seated and 22 standing, or 59 riders.

A typical vanpool vehicle has 20 percent of the capacity of a typical bus, and a typical ferry vehicle has 10 times more than a typical bus.

Exhibit 4-32 ▪ Capacity-equivalent Factors by Mode, 2016



Note: Data do not include agencies that qualified for and opted to use the small systems waiver of the National Transit Database.

Source: National Transit Database.

Exhibit 4-33 shows total capacity-equivalent VRMs. Demand response showed the most rapid expansion in capacity-equivalent VRMs from 2006 to 2016, followed by vanpool, light rail, and ferryboat. Annual VRMs for monorail/automated guideway more than doubled, resulting in an increase in capacity-equivalent VRMs for the "other" rail category. Total capacity-equivalent revenue miles increased from 4,668 million in 2006 to 5,476 million in 2016, an increase of 17 percent.

Exhibit 4-33 ▪ Capacity-equivalent Vehicle Revenue Miles, 2006–2016

Mode	2006	2008	2010	2012	2014	2016	Average Annual Rate of Change 2016 to 2006
Rail	**2,576**	**2,703**	**2,714**	**2,760**	**2,932**	**3,030**	**1.6%**
Heavy Rail	1,592	1,621	1,599	1,580	1,582	1,625	0.2%
Commuter Rail	777	844	860	888	996	1,018	2.7%
Light Rail[1]	201	235	252	284	345	378	6.5%
Other Rail[2]	6	4	3	9	9	9	4.1%
Nonrail	**2,091**	**2,267**	**2,262**	**2,255**	**2,352**	**2,446**	**1.6%**
Fixed-route Bus[3]	1,910	2,026	1,996	1,980	2,041	2,128	1.1%
Demand Response[4]	113	159	176	183	218	222	7.0%
Ferryboat	22	32	35	35	35	38	5.6%
Trolleybus	18	16	17	16	17	16	-1.2%
Vanpool	20	27	30	34	38	39	6.6%
Other Nonrail[5]	8	6	8	7	4	4	-7.1%
Total	**4,668**	**4,970**	**4,976**	**5,015**	**5,284**	**5,476**	**1.6%**

[1] Includes light rail, hybrid rail, and streetcar rail.

[2] Includes Alaska railway, monorail/automated guideway, cable car, and inclined plane.

[3] Includes bus, commuter bus, and bus rapid transit.

[4] Includes demand response and demand-response taxi.

[5] Includes aerial tramway and público.

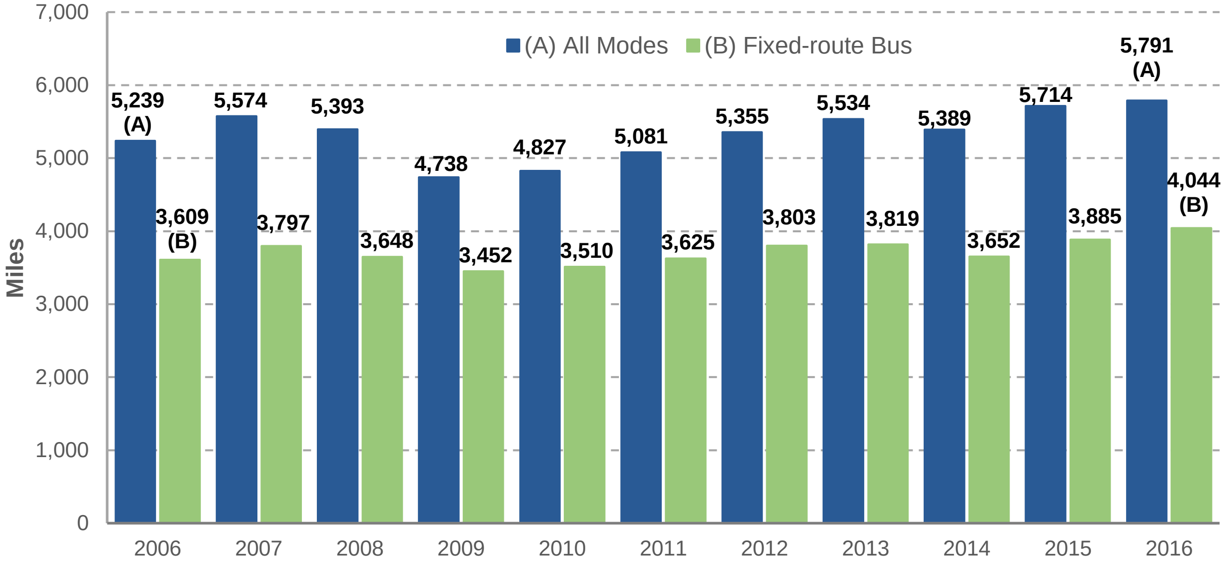
Note: The 2012 data do not include agencies that qualified for and opted to use the small systems waiver of the National Transit Database.

Source: National Transit Database.

Maintenance Reliability

Mean distance between failures, shown in *Exhibit 4-34*, is calculated as the ratio of VRMs per mechanical (major) and other (minor) failures for directly operated vehicles in urban areas. FTA does not collect data on delays caused by guideway conditions, which would include congestion for roads and slow zones (due to system or rail problems) for track, but began doing so in 2018. Miles between failures for all modes combined increased by 11 percent between 2006 and 2016, a 1.0 percent annual average increase. Miles between failures for all modes combined increased in 2007, decreased until 2009, then increased steadily until 2016. The trend for fixed-route bus is nearly identical to that of all modes combined. Miles between failures for fixed-route bus increased by 12 percent between 2006 and 2016.

Exhibit 4-34 ■ Mean Distance Between Urban Vehicle Failures, 2006–2016



Notes: Only directly operated vehicle data were used to calculate mean distance between failures. Data from 2014 to 2016 do not include agencies that qualified for and opted to use the small systems waiver of the National Transit Database.

Source: National Transit Database.

Transit System Characteristics for Americans with Disabilities

Transit access and accessibility are central elements of a multimodal transportation system that meets the needs of people of all ages and abilities. Compliance with the Americans with Disabilities Act (ADA) of 1990 is a condition of eligibility to receive certain Federal funding. Title II of ADA applies to all programs, services, and activities provided or made available by public entities, including State and local governments or any of their instrumentalities or agencies. The scope of Title II coverage extends to the entire operations of a public entity and includes public transportation services, vehicles, and facilities; airport services and facilities; intercity rail travel, railcars, and facilities; passenger vessel services and facilities; and roadway facilities, including sidewalks and pedestrian crosswalks.

ADA requirements ensure that transit services, vehicles, and facilities are accessible to and usable by persons with disabilities (e.g., wheelchair users), and provide for complementary paratransit service for those individuals whose disabilities prevent the use of an accessible fixed-route system.

Exhibit 4-35 presents the change in the level of ADA accessibility of transit service vehicles from 2006 to 2016. The level of accessibility rose from 94 percent in 2006 to 95 percent in 2016. The most significant increases were in other rail vehicles, including monorail, automated guideway, inclined plane, and cable cars, whose accessibility rose from 46 percent in 2006 to 80 percent in 2016. Commuter rail passenger and self-propelled cars saw an increase in ADA accessibility from approximately 55 percent in 2014 to over 80 percent in 2016. In 2006, commuter rail and other rail vehicles had the smallest share of ADA-accessible passenger cars compared with other rail modes, such as heavy rail and light rail.

Exhibit 4-35 ■ ADA Accessibility by Vehicle Type, 2006–2016

Vehicle Type	Active Fleet 2006	ADA Fleet 2006	ADA Fleet Share 2006	Active Fleet 2016	ADA Fleet 2016	ADA Fleet Share 2016	Change in Fleet	% Change in Share
Buses, Cutaways, and Over-the-road Buses	67,934	66,922	98.5%	61,411	60,794	99.0%	-9.6%	0.5%
Vans (Demand-response Service)	13,167	11,591	88.0%	11,359	9,006	79.3%	-13.7%	-8.7%
Heavy Rail Passenger Cars	11,083	10,511	94.8%	11,841	11,405	96.3%	6.8%	1.5%
Articulated Buses	2,294	2,290	99.8%	5,522	5,500	99.6%	140.7%	-0.2%
Commuter Rail Passenger Coaches	3,423	1,892	55.3%	3,648	3,031	83.1%	6.6%	27.8%
Commuter Rail Self-propelled Passenger Cars	2,576	1,768	68.6%	2,785	2,343	84.1%	8.1%	15.5%
Light Rail Vehicles and Streetcars	1,802	1,459	81.0%	2,378	2,046	86.0%	32.0%	5.1%
All Other Rail Vehicles[1]	143	65	45.5%	208	166	79.8%	45.5%	34.4%
All Other Nonrail Vehicles[2]	1,080	1,021	94.5%	1,348	984	73.0%	24.8%	-21.5%
Total	**103,502**	**97,519**	**94.2%**	**100,500**	**95,275**	**94.8%**	**-2.9%**	**0.6%**

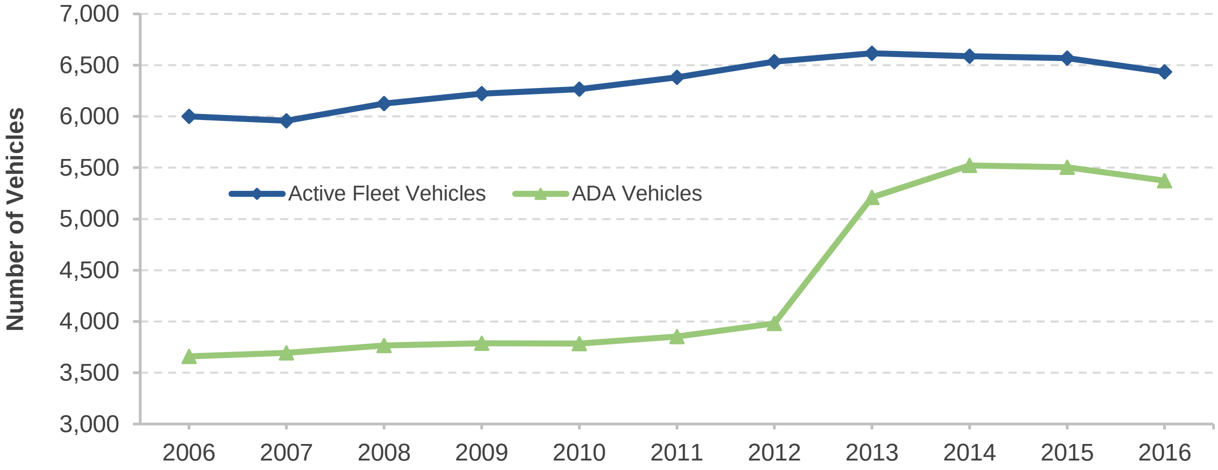
[1] Monorail vehicles, automated guideway vehicles, inclined plane vehicles, and cable cars.

[2] Ferryboats, trolleybuses, school buses, and other vehicles.

Source: National Transit Database.

Exhibit 4-36 depicts the trends in the total active fleet and the ADA-accessible fleet for 2006–2016. The data show that the ADA-accessible fleet increased steadily from 2006 to 2012 at an average rate of approximately 54 passenger cars per year, whereas the total fleet increased at an average of 89 cars per year. This corresponded to a period that saw a geographic expansion of service, with the introduction of four new systems. Some of the largest agencies replaced or rehabilitated their old fleets during this period, bringing the accessibility rate from 61 percent to 84 percent in just two years. Due to the long service life of rail vehicles, 100 percent fleet accessibility is a long-term goal that will not be achievable until the last inaccessible cars from the oldest fleets are retired or remanufactured. In the case of remanufacturing, provisions allow inaccessible cars to remain in service if making them accessible would harm the structural integrity of the vehicles.

Exhibit 4-36 ■ Total Active Fleet and ADA Fleet for Commuter Rail, 2006–2016



Source: National Transit Database.

The ADA requires that new transit facilities and alterations to existing facilities be accessible to and usable by persons with disabilities, including wheelchair users. *Exhibit 4-37* presents the changes between 2006 and 2016 in the number of urban transit ADA stations and the percentage of total ADA-compliant stations by mode. In 2016, 80.7 percent of total transit stations were either 100 percent accessible or self-certified as accessible, an increase from 72 percent in 2006. The ADA also required existing rail transit systems to identify "key" rail stations that would be made accessible by July 26, 1993. Rail stations identified as "key" have the following characteristics:

- The number of passengers boarding exceeds the average number of passengers boarding on the rail system by at least 15 percent.
- The station is a major point where passengers shift to other transit modes.
- The station is at the end of a rail line, unless it is close to another accessible station.
- The station serves a "major" center of activities, including employment or government centers, institutions of higher education, and major health facilities.

Although the statute established a deadline of July 23, 1993, for completion of alterations to these key stations, it also permitted the Secretary of Transportation to grant extensions until July 26, 2020, for stations that required extraordinarily expensive structural modifications to achieve compliance. Of the 680 stations designated as key, 607 were accessible and fully compliant, 30 were accessible but not fully compliant, and 35 were self-certified as accessible as of February 22, 2017, but had not yet been certified as fully compliant by FTA. "Accessible but not fully compliant" means that these stations are functionally accessible (i.e., persons with disabilities, including wheelchair users, can make use of the station), but minor outstanding issues must be addressed for the station to be fully compliant. Example issues include missing or misallocated signage and parking-lot striping errors. Eight key rail stations that are not yet compliant are in the planning, design, or construction stages. These stations are in New York (two), Miami (one), and Cleveland (five). Of these, four stations are under FTA-approved time extensions to 2020. FTA continues to focus its attention on the four stations that are not accessible and are not under a time extension, and on the four stations with time extensions that will be expiring in the coming years.

Exhibit 4-37 ■ ADA Accessibility of Stations, 2006 and 2016

Mode Category	2006 Stations	2006 ADA Stations	2006 ADA Stations Share	2016 Stations	2016 ADA Stations	2016 ADA Stations Share
Fixed-route Bus	1,308	1,221	93.3%	1,780	1,739	97.7%
Other Nonrail[1]	53	48	90.6%	139	121	87.1%
Commuter Rail	1,169	712	60.9%	1,261	873	69.2%
Heavy Rail	1,042	479	46.0%	1,051	574	54.6%
Light Rail	764	635	83.1%	871	807	92.7%
Other Rail[2]	68	66	97.1%	264	218	82.6%
Total	**4,404**	**3,161**	**71.8%**	**5,366**	**4,332**	**80.7%**

[1] Includes ferryboat, aerial tramway, and trolleybus.

[2] Includes hybrid rail, automated guideway, monorail, streetcar rail, and inclined plane.

Source: National Transit Database.

In addition to the services that urban and rural transit operators provide through FTA's core Formula programs, approximately 4,800 providers operate in rural and urban areas through FTA's Formula Grants for Special Services for the Elderly and Disabled. This funding supports primarily demand-response services. Of these, FTA estimates that approximately 700 providers offer public transportation service. The remainder are primarily nonprofit social service organizations, for which transportation is a secondary activity relative to their primary mission. Nevertheless, services provided by these private organizations help relieve the demand for trips on demand-response public transportation services. Nonprofit providers include religious organizations, senior citizen centers, rehabilitation centers, nursing homes, community action centers, sheltered workshops, and coordinated human services transportation providers. FTA estimates that approximately 40 percent of these providers are true public transit providers that began reporting asset inventory data for the NTD in 2018.

Transit System Coverage and Frequency

The extent of the Nation's transit system is measured in directional route miles, or simply "route miles." Route miles measure the distance covered by a transit route. Transit routes that use the same road or track, but in the opposite direction, are counted separately. Data associated with route miles are not collected for demand-response and vanpool modes because these transit modes do not travel along specific predetermined routes. Route mile data are also not collected for jitney services because these transit modes often have highly variable route structures.

Exhibit 4-38 shows directional route miles by mode over the past 10 years. Growth in both rail (14.5 percent) and nonrail (4.2 percent) route miles is evident over this period. The average 3.7-percent rate of annual growth for light rail outpaces the rate of growth for all other major modes due to the significant increase in new systems in the past 10 years.

Exhibit 4-38 ■ Transit Directional Route Miles, 2006–2016

Mode	2006	2008	2010	2012	2014	2016	Average Annual Rate of Change 2016 to 2006
Rail	**10,978**	**11,317**	**11,720**	**12,067**	**12,298**	**12,573**	**1.4%**
Heavy Rail	1,617	1,617	1,617	1,622	1,622	1,646	0.2%
Commuter Rail	6,970	7,256	7,532	7,674	7,795	7,912	1.3%
Light Rail[1]	1,392	1,446	1,581	1,766	1,877	2,004	3.7%
Other Rail[2]	998	998	991	1,005	1,005	1,011	0.1%
Nonrail	**227,823**	**230,170**	**237,712**	**240,176**	**239,836**	**237,408**	**0.4%**
Fixed-route Bus[3]	227,187	229,113	236,615	238,903	238,388	235,876	0.4%
Ferryboat	210	601	641	817	990	1,074	17.7%
Trolleybus	425	456	456	456	458	458	0.7%
Total	**238,800**	**241,487**	**249,432**	**252,243**	**252,134**	**249,981**	**0.5%**
Percent Nonrail	95.4%	95.3%	95.3%	95.2%	95.1%	95.0%	

[1] Includes light rail, hybrid rail, and streetcar rail.

[2] Includes Alaska railway, monorail/automated guideway, cable car, and inclined plane.

[3] Includes bus, commuter bus, and bus rapid transit.

Note: Nonrail excludes demand response and demand-response taxi, aerial tramway, and público. The 2012 data do not include agencies that qualified for and opted to use the small systems waiver of the National Transit Database.

Source: National Transit Database.

The frequency of transit service varies considerably based on location and time of day. Transit service is more frequent in urban areas and during rush hours, corresponding to the places and times with the highest demand for transit. Studies have found that transit passengers consider the time spent waiting for a transit vehicle to be less well spent than the time spent traveling in a transit vehicle. The higher the degree of uncertainty in wait times, the less attractive transit becomes as a means of transportation—and the fewer users it will attract. To minimize this problem, many transit systems have recently begun implementing technologies to track vehicle location (automatic vehicle location systems) that, combined with data on operating speeds, enable agencies to estimate the amount of time required for arrival of vehicles at stations and stops. This information is displayed in platforms and bus stops in real time. By knowing the wait time, passengers are less frustrated and could be more willing to use transit.

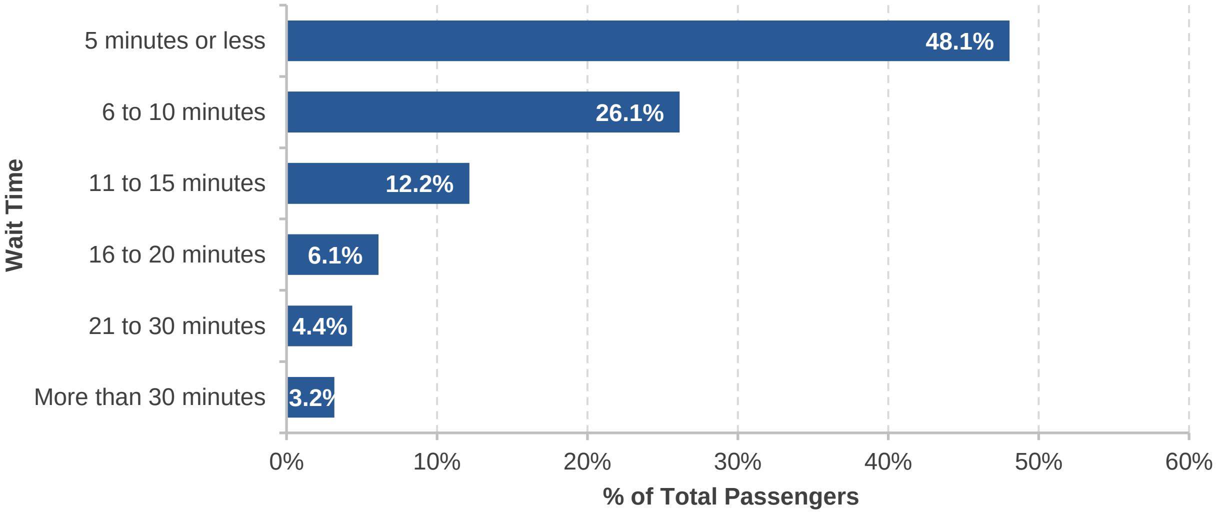
Exhibit 4-39 shows findings on wait times from the 2016 FHWA National Household Travel Survey. The survey found that 48.1 percent of passengers who ride transit wait 5 minutes or less and 74.2 percent wait 10 minutes or less. The survey also found that 7.6 percent of passengers wait 21 minutes or more. Several factors influence passenger wait times, including the frequency and reliability of service and passengers' awareness of timetables. These factors are interrelated. For example, passengers could intentionally arrive earlier for service that is infrequent, or arrive closer to the scheduled time for equally reliable services that are more frequent. Overall, wait times of five minutes or less are clearly associated with good service that is either frequent or reliably provided according to a schedule, or both. Wait times of 5 to 10 minutes are most likely consistent with adequate levels of service that are both reasonably frequent and generally reliable. Wait times of 21 minutes or more indicate that service is likely less frequent or less reliable.

Transit System Resilience

Transit systems are managed to be resilient because they are required to operate on a daily basis through all but the worst weather. Most are instrumental in community emergency-response plans. Dispatchers and vehicle operators receive special training for these circumstances. All bus systems maintain a small fleet of spare buses that enables them to schedule maintenance activities while maintaining regular service levels. These spare buses also can be used to replace damaged vehicles on short notice. Rail systems have contingency plans for loss of key assets and most can muster local resources to operate bus bridges in emergencies.

Operationally, transit providers are some of the most resilient community institutions. Although FTA does not collect systematic data on transit infrastructure resiliency upgrades, significant grant money has been made available for transit systems to upgrade their structures and guideways to be more resistant to extreme precipitation events, sea level rise, storm surge, heat waves, and other environmental stressors. Efforts to improve resilience have been particularly evident in the aftermath of Superstorm Sandy and its impact on the Mid-Atlantic area. Addressing such issues is a common use of FTA grant funds.

Exhibit 4-39 ■ Distribution of Passengers by Wait Time, 2017



Source: National Household Travel Survey, FHWA.

Vehicle Occupancy

Exhibit 4-40 shows vehicle occupancy by mode for selected years from 2006 to 2016. Vehicle occupancy is calculated by dividing passenger miles traveled (PMT) by VRMs, resulting in the average passenger load in a transit vehicle. From 2006 to 2016, average passenger load increased by 17 percent for heavy rail (mostly reflecting significant ridership increases in the New York urbanized area) but declined marginally for commuter rail, light rail, and bus.

Exhibit 4-40 ■ Unadjusted Vehicle Occupancy: Passenger Miles per Vehicle Revenue Mile, 2006–2016

Mode	2006	2008	2010	2012	2014	2016
Rail						
Heavy Rail	23	26	25	27	28	27
Commuter Rail	36	36	34	35	34	34
Light Rail[1]	26	24	24	25	24	23
Other Rail[2]	9	9	11	8	9	10
Nonrail						
Fixed-route Bus[3]	11	11	11	11	11	10
Demand Response[4]	1	1	1	1	1	1
Ferryboat	98	118	119	125	128	132
Trolleybus	14	14	14	14	14	14
Vanpool	6	6	6	6	6	6
Other Nonrail[5]	6	6	5	5	5	5

[1] Includes light rail, hybrid rail, and streetcar rail.

[2] Includes Alaska railway, monorail/automated guideway, cable car, and inclined plane.

[3] Includes bus, commuter bus, and bus rapid transit.

[4] Includes demand response and demand-response taxi.

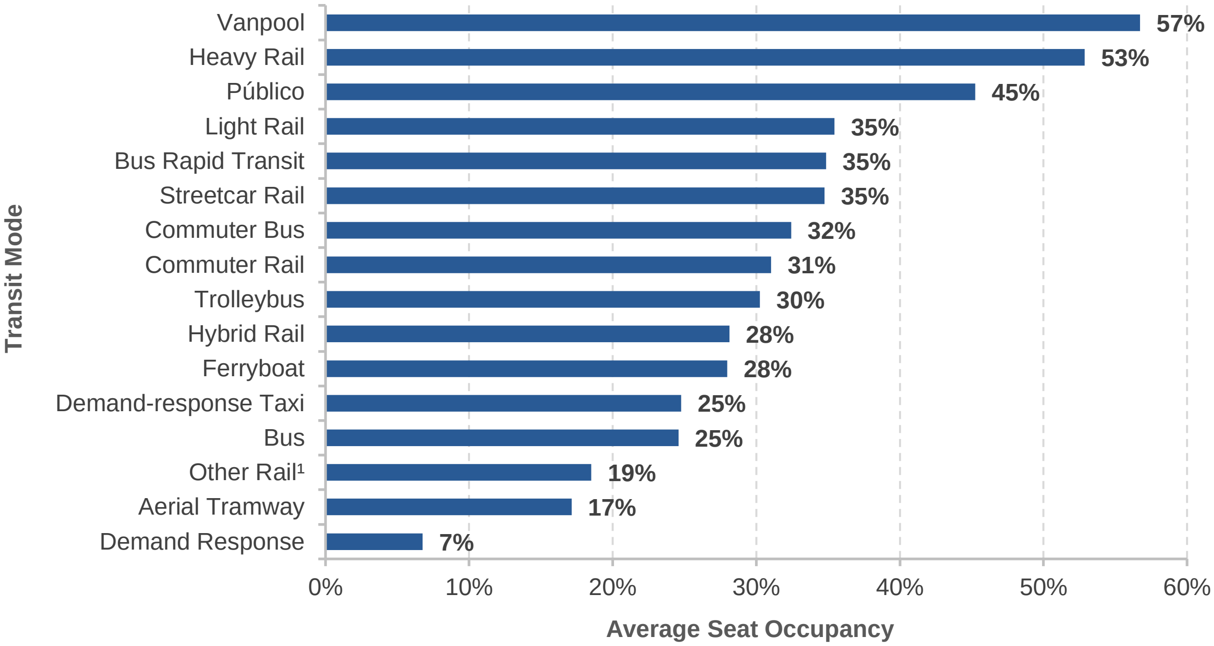
[5] Includes aerial tramway and público.

Source: National Transit Database.

An important metric of vehicle occupancy is weighted average seating capacity utilization. This average is calculated by dividing passenger load by the average number of seats in the vehicle (or passenger car for rail modes). The weighting factor is the number of active vehicles in the fleet. The weighted average seating capacity for some modes are vanpool, 10; heavy rail, 51; light rail, 65; ferryboat, 471; commuter rail, 110; fixed-route bus, 39; demand response, 17.

As shown in *Exhibit 4-41*, the average seating capacity utilization ranges from 7 percent for demand response to 57 percent for vanpools. At first glance, the data seem to indicate excess seating capacity for all modes. Several factors, however, explain these apparent low utilization rates. For example, the low utilization rate for fixed-route bus, which operates in large and small urbanized areas, can be explained partially by low average passenger loads in urbanized areas with low ridership. Other factors could include high passenger demand in one direction and small or very small demand in the opposite direction during peak periods, and sharp drops in loads beyond segments of high demand with limited room for short turns (loops on a bus route that allow buses to reverse direction before reaching the end of the route). Vehicles also tend to be relatively empty at the beginning and ends of their routes. For many commuter routes, a vehicle that is crush-loaded (i.e., filled to maximum capacity) on part of the trip ultimately might only achieve an average occupancy of around 35 percent (as shown by analysis of the Washington Metropolitan Area Transit Authority peak-period data).

Exhibit 4-41 ■ Average Seat Occupancy Calculations for Passenger-carrying Transit Modes, 2016



[1] Includes Alaska railroad, cable car, inclined plane and monorail/automated guideway.

Notes: Aerial tramway has substantial standing capacity that is not considered here, but which can allow the measure of the percentage of seats occupied to exceed 100 percent for a full vehicle. These data do not include agencies that qualified for and opted to use the small systems waiver of the National Transit Database.

Source: National Transit Database.

Vehicle Use

Revenue miles per active vehicle (service use), defined as the average distance traveled per vehicle in service, can be measured by the ratio of VRMs per active vehicles in the fleet. *Exhibit 4-42* provides vehicle service use by mode for selected years from 2006 to 2016. Heavy rail, generally offering long hours of frequent service, had the highest vehicle use during this period. Vehicle service use for heavy rail appears to be stable across the past few years. Vehicle service use for commuter rail, light rail, and vanpool shows an increasing trend. Vehicle service use for trolleybus shows a decreasing trend. Vehicle service use for nonrail modes other than trolleybus appears to be relatively stable over the past few years with no apparent trends in either direction.

Exhibit 4-42 ■ Vehicle Service Utilization: Average Annual Vehicle Revenue Miles per Active Vehicle by Mode, 2006–2016

Mode	Vehicle Revenue Miles (Thousands of Miles)						Average Annual Rate of Change 2016 to 2006
	2006	2008	2010	2012	2014	2016	
Rail							
Heavy Rail	57	58	57	56	57	57	0.0%
Commuter Rail	43	45	45	44	46	48	1.1%
Light Rail[1]	40	44	43	42	46	47	1.8%
Nonrail							
Fixed-route Bus[2]	30	31	31	31	28	28	-0.7%
Demand Response[3]	22	29	28	28	20	20	-0.7%
Ferryboat	21	22	25	23	21	21	0.2%
Trolleybus	19	19	20	20	20	15	-2.5%
Vanpool	14	14	15	15	15	15	1.1%

[1] Includes light rail, hybrid rail, and streetcar rail.

[2] Includes bus, bus rapid transit, and commuter bus.

[3] Includes demand response and demand-response taxi.

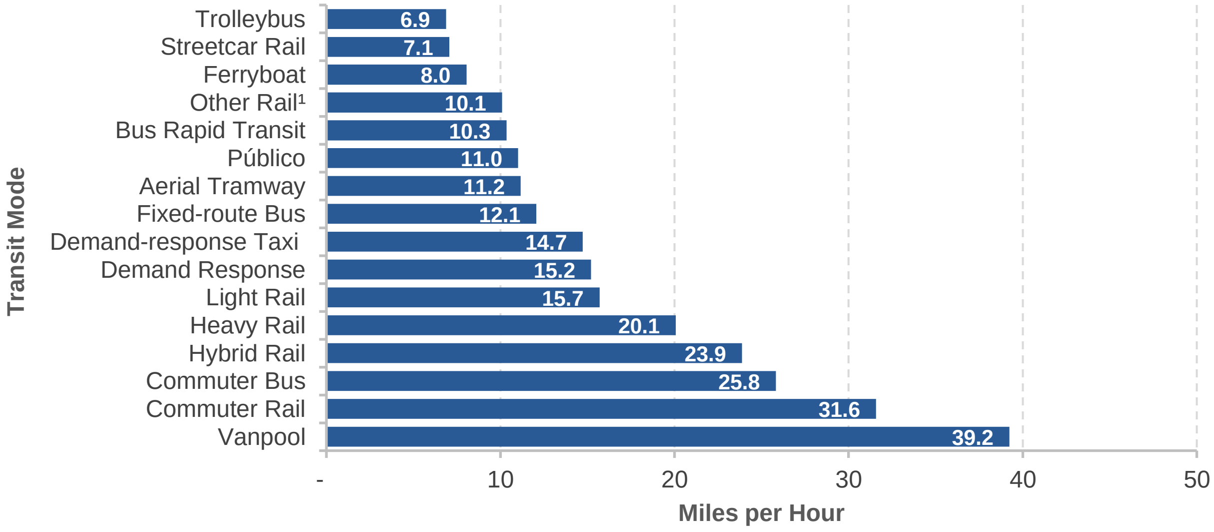
Notes: Does not include agencies that qualified for and opted to use the small systems waiver of the National Transit Database. Rail category does not include Alaska railroad, cable car, inclined plane, or monorail/automated guideway. Nonrail category does not include aerial tramway or público.

Source: National Transit Database.

Average Operating (Passenger-carrying) Speeds

Average vehicle operating speed is an approximate measure of the speed experienced by transit riders; it is not a measure of the operating speed of transit vehicles between stops. More specifically, average operating speed is a measure of the speed passengers experience from the time they enter a transit vehicle to the time they exit it, including dwell times at stops. It does not include the time passengers spend waiting or transferring. Average vehicle operating speed is calculated for each mode by dividing annual vehicle revenue miles by annual vehicle revenue hours for each agency in each mode, as reported to NTD. When an agency contracts with a service provider or provides the service directly, the speeds for each service within a mode are calculated and weighted separately. *Exhibit 4-43* presents the results of these average speed calculations.

Exhibit 4-43 ■ Average Speeds for Passenger-carrying Transit Modes, 2016



[1] Includes Alaska railroad, monorail/automated guideway, cable car, and inclined plane.

Note: The table does not include services provided by agencies that qualified for and opted to use the small systems waiver of the National Transit Database.

Source: National Transit Database.

The number of and distance between stops and the time required for boarding and alighting of passengers strongly influence the average speed of a transit mode. Fixed-route bus service, which typically makes frequent stops, has a relatively low average speed. In contrast, commuter rail has sustained high speeds between infrequent stops and thus has a relatively high average speed. Vanpools also travel at high speeds, usually with only a few stops at each end of the route. Modes using exclusive guideway (including HOV lanes) can offer more rapid travel time than similar modes that do not. Heavy rail, which travels exclusively on dedicated guideway, has a higher average speed than streetcar, which often shares its guideway with mixed traffic. These average speeds have not changed significantly over the past decade.

One of the reasons for creating new modal categories in the NTD for commuter bus and hybrid rail in 2011 was the significantly higher speeds these systems attain. For example, commuter bus systems typically operate with very few intermediate stops and often use limited-access highways, allowing them to achieve average speeds more than double those of traditional fixed-route bus systems.

Hybrid rail systems typically operate in a suburban environment with longer distances between stops, allowing them to achieve average speeds that are significantly higher than those for light rail.

The bus rapid transit systems in the NTD are currently reporting an average speed that is slightly lower than that of regular fixed-route bus and light rail. This is in part because bus rapid transit systems typically operate in the highest-density urban environments where speeds are lower. Nevertheless, the average speed for bus rapid transit is still nearly 50 percent higher than that of streetcar rail, which also tends to operate in the highest-density areas.

This page intentionally left blank.