Intelligent Transportation Systems Deployment Tracking Survey: 2020 Freeway Findings

Final Report

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16. Abstract

This report summarizes the Freeway Management Survey findings of the 2020 Intelligent Transportation Systems (ITS) Deployment Tracking Surveys (DTS). Since 1997, the ITS Joint Program Office (JPO) has used the DTS on an ongoing basis to collect information about ITS deployment in metropolitan areas across the United States by surveying state and local transportation agencies. These surveys measure ITS deployment nationwide and are used to inform the ITS JPO on strategic planning decisions such as response to ITS deployment gaps and ITS deployment planning and execution.

The 2020 Freeway Management Survey was administered online from December 3, 2020 to March 31, 2021. The survey population included freeway management agencies within 108 large and medium sized metropolitan areas nationwide, focusing on agencies that serve populations of 50,000 or greater. The survey achieved a response rate of 73 percent with 101 completed surveys by freeway management agencies.

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Acronyms

Acronym	Meaning
AV	Automated Vehicle
CAD	Computer-Aided Dispatch
CCTV	Closed-Circuit Television
CV	Connected Vehicle
DMS	Dynamic Message Signs
DSRC	Dedicated Short Range Communications
DTS	Deployment Tracking Survey
ESS	Environmental Sensor Stations
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HAR	Highway Advisory Radio
ICM	Integrated Corridor Management
IT	Information Technology
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
MDSS	Maintenance Decision Support System
TSMO	Transportation Systems Management and Operations
USDOT	United States Department of Transportation

Executive Summary

Introduction

This report summarizes the **Freeway Management Survey** (also referred to as the Freeway Survey in this Report) findings of the 2020 ITS Deployment Tracking Surveys (DTS) administered by the John A. Volpe National Transportation Center (Volpe) in support of the United States Department of Transportation (USDOT) Intelligent Transportation Systems (ITS) Joint Program Office (JPO). Since 1997, the ITS JPO has used the DTS on an ongoing basis to collect information about ITS deployment in metropolitan areas across the United States by surveying state and local transportation agencies. These surveys track ITS deployment (type and to what extent deployed) nationwide. The resulting data are used to inform the ITS JPO and other stakeholders on strategic planning and investment decisions related to ITS deployment (including gaps), market development, and technology transfer activities.

Methodology

The 2020 Freeway Survey was administered to freeway management agencies (also referred to as freeway agencies in this Report) within 108 large and medium sized metropolitan areas nationwide, focusing on agencies that serve populations of 50,000 or greater. The 2020 Freeway Survey is a modified version of the one conducted in 2016, shortened to reflect a core set of technologies (see Appendix A for the 2020 survey instrument). The survey was administered to freeway agencies from December 3, 2020 to March 31, 2021 using an online survey instrument. The Freeway Survey achieved 101 completes with a response rate of 73 percent, exceeding its data collection goal of 60 percent.

Key Findings for Freeway Management Agencies

This section describes key findings from the Freeway Survey.

ITS safety systems and work zone technology show increasing adoption.

The 2020 Freeway Survey shows continued growth in ITS safety system and work zone technology adoption among freeway agencies, as USDOT and state agencies continue to emphasize safety as a top goal.

- Use of ITS safety systems is practically universal among freeway agencies, as 85 percent have adopted at least one technology, an increase of nine percentage points since 2016. Adoption of *queue warning systems* and *over-height warning systems* has increased significantly since 2016 with close to 50 percent of agencies now deploying these systems.
- In 2020, 82 precent of freeway agencies report use of work zone technologies, up 20 percentage points since 2013, with roughly half the growth since 2016. Key technologies include *portable closed-circuit television (CCTV)* and *queue detection and alert systems*, both of which have seen significant growth in recent years.

- In addition, 76 percent of freeway agencies report deploying *environmental sensor stations (ESS)*, which support road weather management.

Adoption of some technologies is widespread, reflecting their maturity in the market.

The percent of freeway agencies using *real-time data collection* methods is high (85 percent) with adoption remaining relatively flat in recent years.

- Adoption of *roadside infrastructure* detection technologies is high, at 74 percent, remaining steady over the last two survey cycles. *Radar/microwave detection* is a mature roadside infrastructure technology with 71 percent of freeway agencies reporting use.
- Use of *vehicle probe readers* to collect real-time traffic data has increased significantly from 2013, up 15 percentage points to 51 percent.[1] *Bluetooth* (27 percent) and *toll tag readers* (16 percent) are the most commonly used technologies.

External data are widely used by freeway agencies.

The survey results suggest that *external data* are emerging as another source of real-time traffic collection data for freeway agencies (93 percent).

- Most freeway agencies are purchasing data from a *third-party commercial provider* (82 percent), looking to *publicly available mapping applications* (68 percent), or capturing *notifications from the public* (52 percent).

Mobile application (app) usage is up.

Freeway agencies are increasingly deployed *custom-built* and/or *third-party applications* (collectively, *mobile apps*). *Mobile apps* were the only traveler information dissemination method to experience a significant increase in usage, which may reflect travelers' increasing preference for use of their mobile phones to receive real-time information en route.

- *Mobile app* use grew by 28 percentage points since 2016 (to 73 percent in 2020).
- While *social media* and *websites* are still the two most commonly used methods of disseminating traveler information among freeway agencies (81 percent and 80 percent, respectively), these methods saw declines in usage since 2016.
- Two of the more traditional methods, *511* (60 percent) and *Highway Advisory Radio (HAR)* (37 percent), also experienced usage declines. Future surveys may want to explore the extent to which mobile apps are replacing versus complementing other traveler information technologies.

Both wired and wireless telecommunication technologies play a role in enabling ITS applications for freeway agencies.

Almost all freeway agencies indicate use of at least one wired telecommunication device (94 percent) and a similar proportion indicate use of at least one wireless telecommunication device (93 percent).

[1] The data from the probe reader questions are difficult to interpret because some agencies (it is unclear how many) included purchased (i.e., externally collected) probe data in their responses.

- *Fiber optic cable* is the most commonly used wired technology (93 percent), and *Cellular (LTE-4G)* (88 percent) is the most common wireless technology.

A majority of freeway agencies provide an open data feed.

Almost two-thirds of freeway agencies (62 percent) *provide an open data feed* (e.g., to app developers, information service providers, or the public). Another 10 percent of agencies are working on providing an open data feed.

CCTV is widely used for incident detection or verification.

Ninety percent of freeway agencies report using *CCTV* for incident detection or verification. Among surveyed freeway agencies, 40 percent report use of *external data sources* for incident detection or verification and fewer agencies us *computer algorithms* (23 percent).

Traffic management strategies such as managed lanes, ramp metering, and integrated corridor management (ICM) are used more selectively, although a majority of freeway agencies indicate interest in ICM.

Thirty-seven percent of freeway agencies report the use of *managed lanes* on their freeways, whereas somewhat fewer indicate they are using *ramp meter technology* (26 percent).

Twenty-one percent of freeway agencies report deploying *Integrated Corridor Management (ICM),* and an additional 46 percent indicate they *plan to deploy* an ICM system, suggesting there is interest in ICM among freeway agencies. About three-quarters of freeway agencies also report having a *Transportation Systems Management and Operations (TSMO)* plan.

A majority of freeway agencies have ITS cybersecurity policies.

Just over one-half (55 percent) of freeway agencies have a documented *ITS-specific cybersecurity policy*, and 17 percent are *planning to develop* one. Notably, nearly one-fifth (18 percent) of freeway agencies report experiencing a cybersecurity event that affected their *Information Technology (IT) systems* and/or *transportation operations* in the last three years.

A large majority of freeway agencies plan to invest in ITS in the next three years.

Nearly all freeway agencies (97 percent) plan to *expand or upgrade their current ITS* in the next three years. A large majority of freeway agencies also plan to *invest in new ITS* (78 percent).

Conclusions

The 2020 Freeway Survey provides insights that agencies can use to determine where assistance or outreach may be needed to support adoption of ITS technologies. It also raises some questions that may merit further research and investigation.

The survey shows that a number of ITS technologies experienced increasing levels of adoption since 2016. There was notable growth in the adoption of *work zone* and *safety system technologies*.

For other technologies, such as *roadside infrastructure*, overall adoption is high, as nearly three-quarters of surveyed freeway agencies report the use of such technologies. The 2020 Freeway Survey finds widespread adoption of *radar/microwave detection,* reflecting the maturity of this technology in the market. However, given the relatively flat trend over the last two surveys, adoption of *roadside infrastructure* (as well as *real-time data collection* more generally) may be plateauing. Future surveys might provide additional insight into this trend.

With respect to real-time traveler information methods, *mobile app* usage has increased dramatically since 2016, whereas other dissemination methods, such as *511, HAR, email or text alerts,* and *social media*, have experienced decreased use. The long-term trend shows how the use of traveler information dissemination methods has evolved, though it is unclear to what extent methods that provide information en route are replacing versus complementing other more traditional sources of traveler information. Future surveys may want to address this question.

Two other topics that might deserve a more detailed examination include both ICM and also the use of external data, particularly probe data. First, given that there appears to be relatively high level of interest among freeway agencies in *deploying ICM*, it would be useful to understand what strategies and technologies agencies are deploying (or planning to deploy) as part of their ICM, the extent to which agencies are coordinating with other modes, and the challenges faced in deploying ICM. Second, the survey also found that a large number of agencies are using *external data sources*, including third-party commercial data, such as probe data. It may be worth further investigating the ways in which agencies are using this data to complement or fill in the gaps of their own real-time data collection. This information could also be useful to other agencies who are considering the use of third-party commercial data.

Cybersecurity also is an area to watch. Just over one-half of freeway agencies have an *ITS-specific cybersecurity policy,* and notably, 18 percent have experienced a cybersecurity event affecting their *IT systems* and/or *transportation operations* in the last three years.

Chapter 1. Introduction

Purpose of the Report

This report summarizes the **Freeway Management Survey** (also referred to as the Freeway Survey in this Report) findings of the 2020 ITS Deployment Tracking Surveys (DTS), administered by the United States Department of Transportation (USDOT) John A. Volpe National Transportation Center (Volpe) in support of the USDOT Intelligent Transportation System's Joint Program Office (ITS JPO). These surveys track ITS deployment (type and to what extent deployed) nationwide. The resulting data are used to inform the ITS JPO and other stakeholders on strategic planning and investment decisions related to ITS deployment (including gaps), market development, and technology transfer activities. The mission of the ITS JPO is to lead collaborative and innovative research, development, and implementation of ITS to improve the safety and mobility of people and goods. The DTS data serve a critical role in supporting this mission.

Background

Since 1997, the ITS JPO has used the DTS to collect information about ITS deployment in metropolitan areas across the United States. The surveys track the deployment of ITS technology by state and local transportation agencies. The DTS has been administered to freeway, arterial, and transit management agencies 12 times prior to the 2020 survey effort, and roughly once every three years since 2007. The ITS DTS survey program was initially developed to support ITS deployment program assessment by the ITS JPO, and to track and manage progress toward the ten year ITS deployment goal set by the Secretary of Transportation in 1995. The survey was conducted every 1-2 years during the goal measurement period. Following the goal period, the survey was conducted less regularly on a roughly 3-year cycle to monitor the deployment of ITS across the country. Prior to 2020, the most recent ITS DTS was conducted in 2016. In the fall of 2019, the ITS JPO administered a DTS-related special topic survey to obtain baseline data on the deployment of connected vehicle (CV) and automated vehicle (AV) technologies. This CV/AV survey was administered to the DTS population (108 large and medium sized metropolitan areas). The ITS Small Urban and Rural Transit Provider Survey was also conducted in 2019, in response to a General Accountability Office recommendation that the ITS JPO track the deployment of ITS among small urban and rural transit providers.

Data collection for the 2020 DTS was conducted between December 3, 2020 and March 31, 2021, roughly 9 to 11 months after COVID-19 pandemic restrictions were introduced. The pandemic did not appear to significantly impact survey response rates; however, it is unclear what impact, if any, the pandemic has had or will have on ITS adoption or plans for adoption. Future surveys may add clarity and additional insight on this issue.

Chapter 2. Methodology

This chapter describes the methodology for the Deployment Tracking Survey (DTS), including sample development, the survey instrument, and data collection. The final section addresses data reporting.

Sample Development

The 2020 Freeway Survey was administered to freeway management agencies (also referred to as freeway agencies in this Report) within 108 large and medium sized metropolitan areas nationwide, focusing on agencies that serve populations of 50,000 or greater. The 2020 survey utilized the agency contact lists from the most recent DTS conducted in 2016. Prior to data collection, each agency was contacted by email or phone to notify them of the upcoming survey and to verify that the listed contact was the appropriated respondent for the 2020 DTS. Replacement contacts were obtained when necessary.

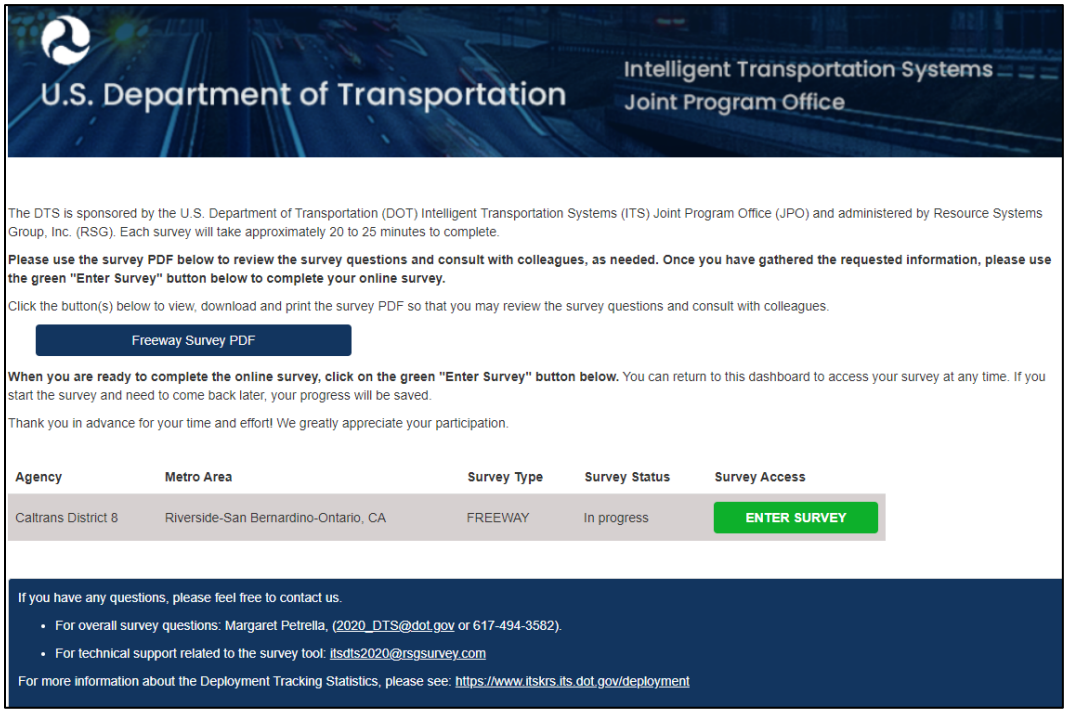
Survey Instrument

The 2020 Freeway Survey is a modified version of the one conducted in 2016, shortened to reflect a core set of ITS technologies (see Appendix A for the 2020 survey instrument). Changes to the survey included adding a question on external data usage, updating question wording to improve clarity, adding response options to reflect newer ITS technologies or services, and removing out-of-date options. Questions on cybersecurity were added to the survey, along with questions on whether agency staff or contractors are used for ITS installation, maintenance, and inspection. The survey team shared the survey with ITS JPO staff for their review and comment, as well as with subject matter experts at the Volpe Center and Noblis. Stakeholder input was particularly helpful in designing the new cybersecurity questions.

Key topics covered by the Freeway Survey include real-time data collection, sources of external data, traffic management, safety and work zone technologies, integrated corridor management, performance measurement, telecommunications, agency coordination and data sharing, ITS cybersecurity, maintenance of ITS devices, inspection and maintenance staffing, and future plans for ITS deployment.

Data Collection

The Freeway Survey was administered using an online survey instrument. Each respondent was provided access to a personalized dashboard that provided details on the survey effort, allowed them to download fillable PDFs of the survey instrument(s), and included unique links to access their survey(s). Several respondents were assigned two or more surveys, representing multiple metropolitan areas and/or more than one type of survey (freeway, arterial, or transit) for a single metropolitan area. If respondents left the survey prior to completion, responses to any completed questions were saved and were accessible by respondents if they returned to the survey (see Figure 1 for an example of a Freeway Survey dashboard).

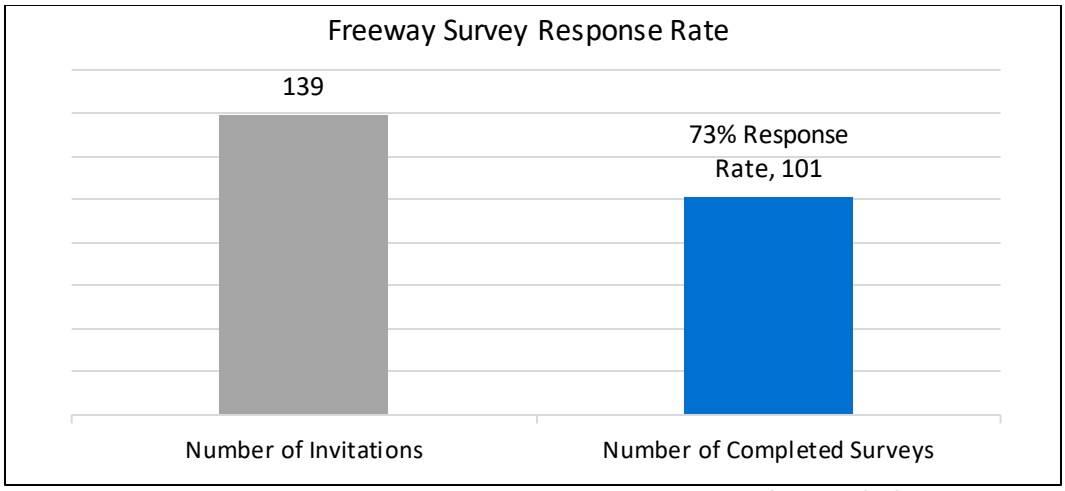


Source: USDOT

Figure 1. DTS Respondent Dashboard

To ensure that the online survey instrument and email distribution were working correctly, the survey invitation was sent to a small subset of freeway contacts (i.e., soft launch) on December 3, 2020, prior to the full launch of the Freeway Survey. The full launch of the survey occurred on December 8, 2020. In total, 139 invitations were sent out (Figure 2).

Three rounds of reminder emails were sent out in December 2020 and January 2021. Additional efforts to contact those who had not completed their assigned survey(s) were conducted by phone in February and March of 2021. Agencies were called and encouraged to complete the survey. Messages were left for respondents who could not be reached by phone and email reminders were also sent. The survey was closed March 31, 2021, resulting in 101 completes and a response rate of 73 percent (Figure 2).



Source: USDOT

Figure 2. Freeway Survey Response Rate

The survey data went through an extensive review and cleaning process and open-ended responses were reviewed and coded into existing or new categories (where applicable).

Reporting

Where available, trend data are shown for the freeway findings. In some cases, however, the question wording changed substantially over time, so it is not possible to show the trend. For most survey questions, trend is reported either over the last three (2013, 2016, 2020) or four surveys (2010, 2013, 2016 and 2020), and for a smaller subset of questions longer term trend is available (i.e., 2002-2020). Sample sizes for all survey years are provided in Appendix B and are not provided in trend charts due to space constraints. Table 1 describes how different magnitudes of change in the trend data are interpreted, providing a uniform way of describing the trend data.

Table 1. Interpretation of Trend Data

Change (positive or negative)	Growth (or Decline) Category
Zero percentage points	No growth/decline
One to four percentage points	Minimal growth/decline (not meaningful)
Five to eight percentage points	Moderate growth/decline
Nine percentage points or more	Significant growth/decline

For all charts not displaying trend data, data are from the 2020 survey. Question numbers from the 2020 surveys are referenced at the bottom of each figure.

Chapter 3. Freeway Management Findings

This chapter presents the 2020 Freeway Survey findings for key deployment tracking questions (see Appendix C for additional survey findings that are not reported in this chapter). Findings are based on total sample unless otherwise noted.

Real-Time Data Collection

Use of *real-time data collection* is common among surveyed freeway agencies in 2020, with 85 percent indicating that at least a portion of their freeway centerline miles are covered by real-time traffic data collection technologies. Real-time data collection technologies include roadside infrastructure such as *inductive loops, radar detectors, video imaging detection*, or *magnetometers*, as well as vehicle probe readers such as *toll tag, license plate, Bluetooth, GPS*, etc.

Figure 3 presents the long-term trend for use of *real-time data collection*, showing the percent of surveyed freeway agencies indicating centerline miles covered by real-time data collection technologies from 2002 to 2020. The trend shows the percent of freeway agencies deploying real-time technologies reached its highest point in 2020 (at 85 percent), generally increasing steadily over time, with the exception of 2005 to 2006.

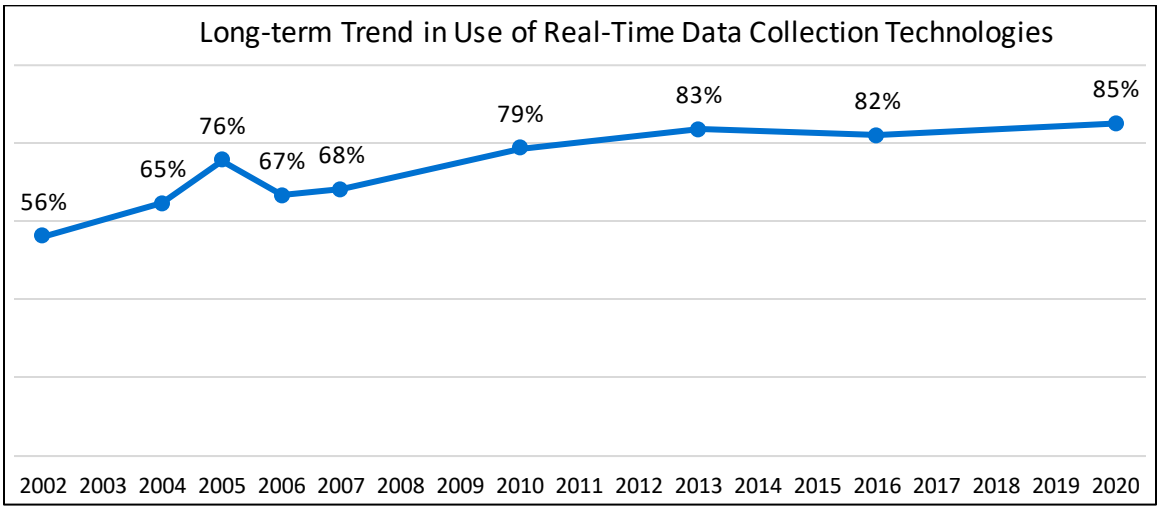
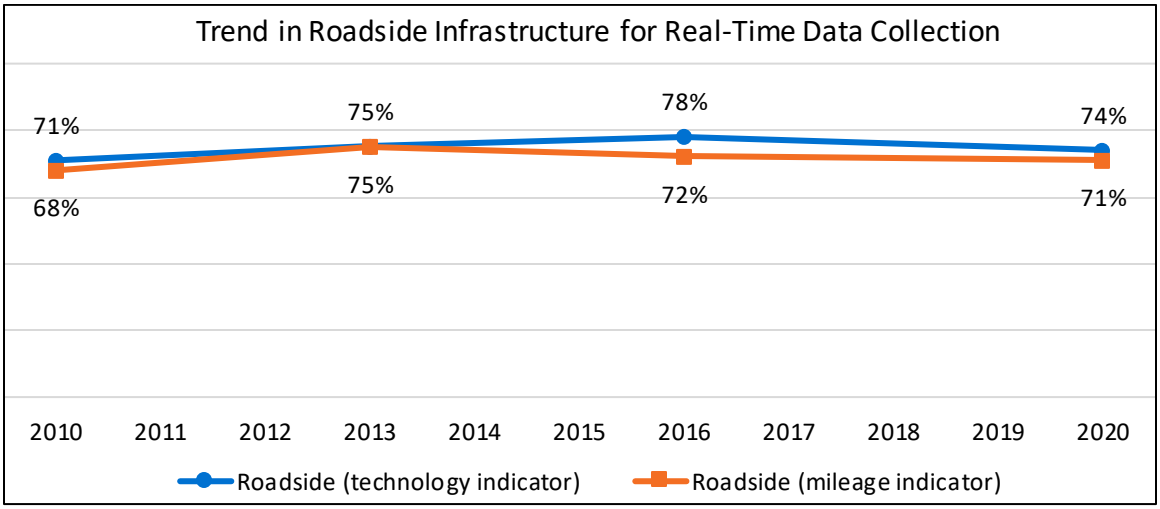


Figure 3. Long-term Trend in Use of Real-Time Data Collection Technologies

Roadside Infrastructure

Figure 4 shows two different summary measures of roadside infrastructure usage among surveyed freeway agencies. The mileage indicator is derived from agencies' reporting of their centerline miles covered by roadside infrastructure; if an agency reported any miles, they are counted in the mileage indicator. The other derived measure, the technology indicator, is developed from agencies' reported use of one or more roadside infrastructure technologies; agencies that report using any roadside infrastructure technologies are included in the technology indicator (regardless of the number of technologies deployed).

Figure 4 shows 71 percent of surveyed freeway agencies report centerline miles with *roadside infrastructure* in 2020 whereas 74 percent indicate use of at least one *roadside infrastructure* technology. Both measures show usage of roadside infrastructure leveling off in recent years, although there are small differences in some years, which could be due to differences in the question formats.



2020 Q3a, Q3b *Source: USDOT*

Figure 4. Trend in Use of Roadside Infrastructure for Real-Time Data Collection

Figure 5 shows that most agencies deploying real-time data collection have *radar/microwave detection* (71 percent), reflecting the maturity of that technology in the market. Forty-two percent are deploying *inductive loops*, followed by 13 percent deploying *video imaging detection*, 9 percent deploying *magnetometers*, and 4 percent indicating *other* roadside infrastructure technologies. Of the remaining freeway agencies, 24 percent indicate no use of roadside infrastructure for real-time data collection and 2 percent are missing responses.

Trend data for roadside infrastructure technology is not shown due to a change in question format. The 2016 question asked respondents to enter the number of each technology deployed, while the 2020 question asked respondents to select specific technologies deployed, without asking for the number of each.

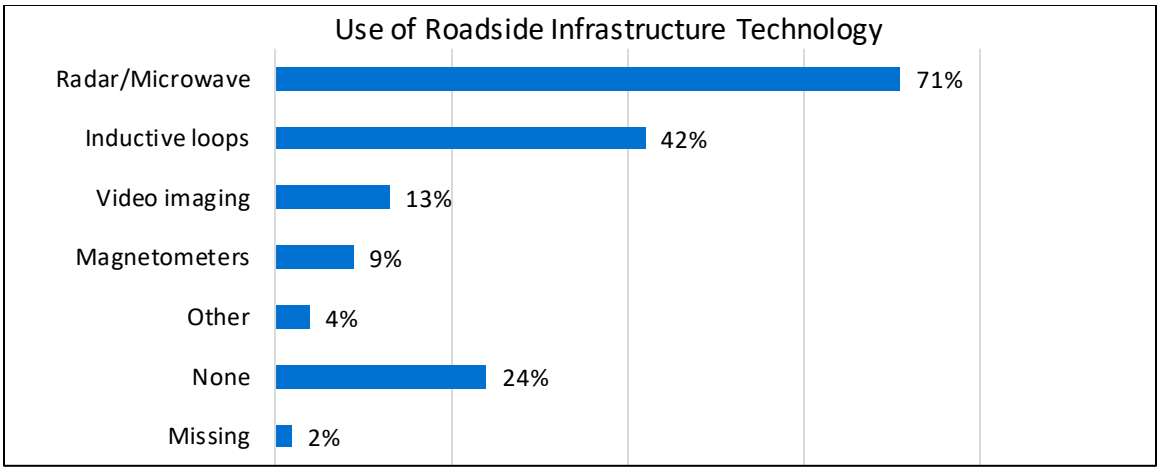


Figure 5. Use of Roadside Infrastructure Technology

Vehicle Probe Readers

Figure 6 shows trend in two different measures of vehicle probe usage among surveyed freeway agencies. The mileage indicator is derived from agencies' reporting of their centerline miles covered by vehicle probe readers. The technology indicator is derived from agencies' reporting use of one or more vehicle probe technologies. Although both measures indicate that roughly half of freeway agencies use *vehicle probe readers*, 51 percent (mileage indicator) and 53 percent (technology indicator), the numbers have not always aligned. In general, the mileage indicator tends to be less than technology indicator; however, both indicators show trend in vehicle probe readers use has increased about 25 percentage points since 2010. It is not clear why these two indicators show differences in usage. The differences could stem from changes in question wording or the increasing use of third-party probe data (and possible respondent confusion as to whether to include purchased external probe data when reporting the number of centerline miles covered by probes). Future DTS will design measures that clearly distinguish agency deployment of their own probe technology versus agency use of external probe data.

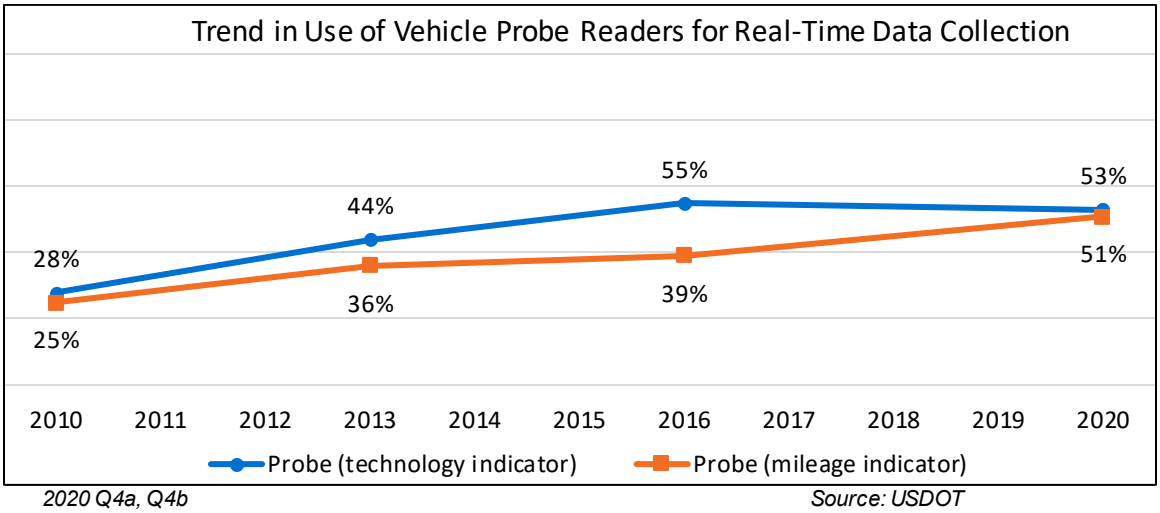


Figure 6. Trend in Use of Vehicle Probe Readers for Real-Time Data Collection

As shown in Figure 6, 53 percent of surveyed freeway agencies report deploying at least one type of *vehicle probe reader* for real-time data collection. Figure 7 shows the most commonly reported vehicle probe reader is *Bluetooth* at 27 percent. This is followed by *toll tag readers* (16 percent), and *in-vehicle GPS* (10 percent). Few freeway agencies are deploying *cellular or mobile phone readers* (5 percent) or *license plate readers* (4 percent). Six percent of freeway agencies responded with *other* which includes 3 percent of all surveyed freeway agencies indicating use of purchased data.[2] Forty percent of surveyed freeway agencies indicate they did not use any type of vehicle probe reader, while 8 percent did not provide an answer to this question.

Over the past three survey cycles, *Bluetooth* have consistently been the most commonly used type of vehicle probe technology. However, trend data are not shown for this question, because it is unclear how respondents interpreted the question; there is evidence that freeway agencies may have interpreted this question differently and differed on whether or not the agency itself deployed vehicle probe reader technologies for real-time data collection or if the agency purchased these data from a third party.

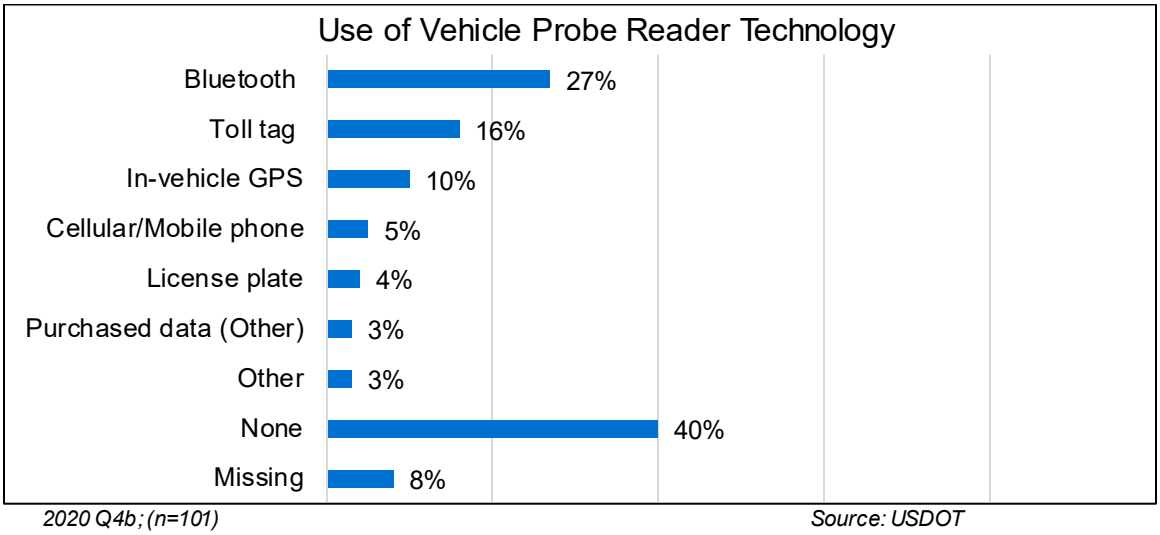


Figure 7. Use of Vehicle Probe Reader Technology

[2] The *other* response category allows respondents to write in responses, specifying what they mean by "other." If at least 2 to 3 percent of respondents write in the same response, these are typically recoded into a new response category.

External Data Sources

A more comprehensive question was added to the 2020 DTS to capture the use of data collected outside of freeway agencies, shown in Figure 8. The results show that almost all surveyed freeway agencies, 93 percent, are using at least one source of external data for traffic information. Most surveyed agencies report purchasing data from a *third-party commercial provider* (82 percent) such as INRIX, HERE or Waze. More than half of freeway agencies are sourcing traffic information from *publicly available mapping and traffic information applications* or *notifications from the public* (68 percent and 52 percent, respectively). Use of information from *police or highway computer-aided dispatch (CAD)* was not an original response category, but 7 percent of freeway agencies wrote this option under the *other* choice. Another 3 percent of freeway agencies selected the *other* choice, and 7 percent indicated they are not using any external data sources.[3] Future surveys may want to explore the ways in which agencies are using this data to complement or fill the gaps of their own real-time data collection.

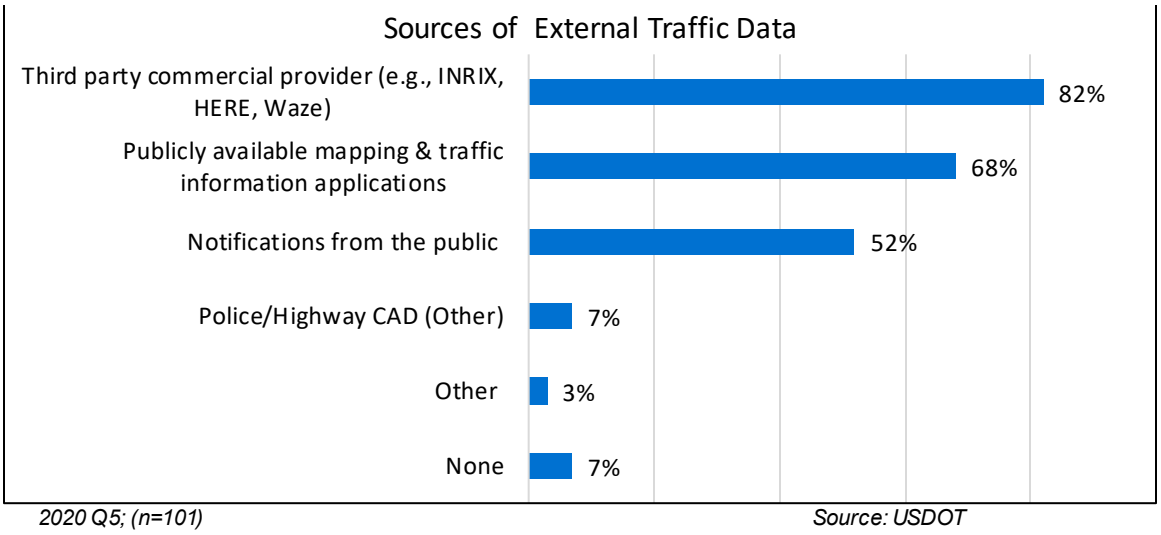


Figure 8. Sources of External Traffic Data

[3] This question had a *don't know* response option which was not selected by any respondents.

Traveler Information

Practically all surveyed agencies (98 percent) disseminate real-time traveler information about freeways (Figure 9). The most common technology is *dynamic message signs (DMS)* with 96 percent of freeway agencies indicating use. A similar number are using *social media* (81 percent) and *websites* (80 percent). Seventy percent of agencies use *email or text alerts,* and 60 percent are using *511 systems*. Overall, about three-quarters (73 percent) of freeway agencies indicate use *mobile apps* (*custom-built* and/or *third-party apps*). Individually, about half of agencies use each type of mobile app (*custom-built app* – 54 percent and *third-party app* – 47 percent). Thirty-seven percent are using *highway advisory radio (HAR)*. Six percent of freeway agencies report *other* dissemination, and 2 percent did not answer this question.

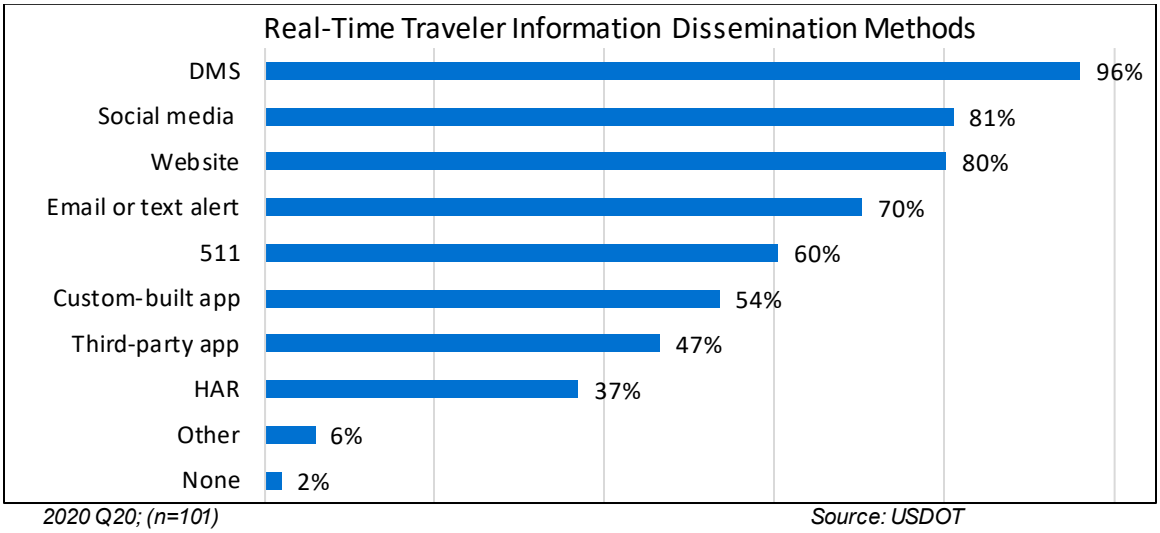
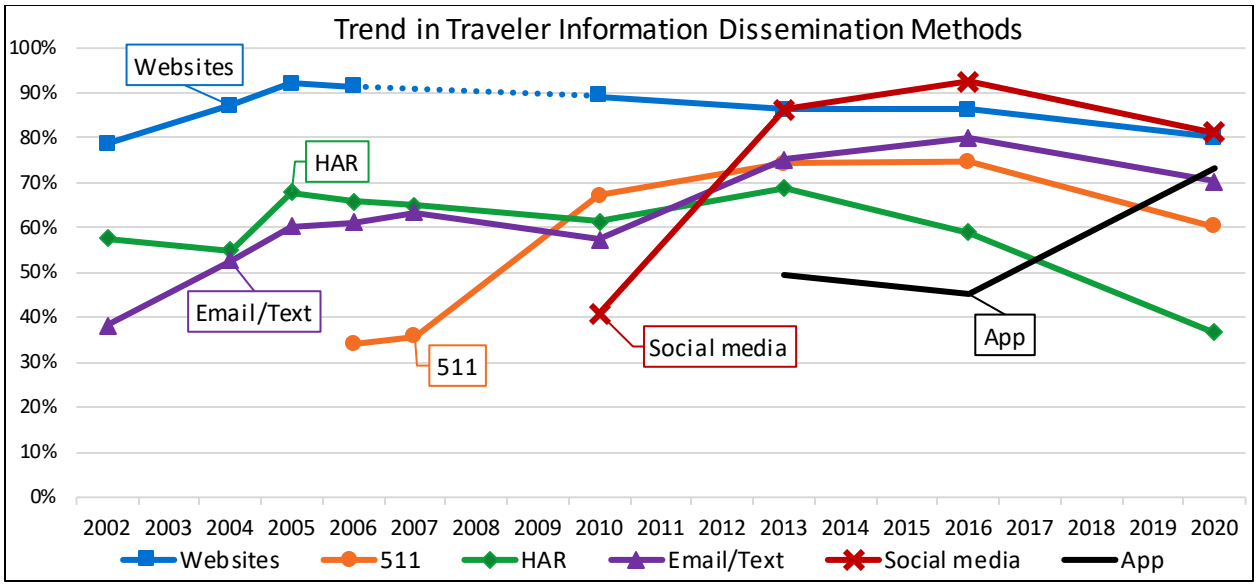


Figure 9. Real-Time Traveler Information Dissemination Methods

The trend in the use of traveler information dissemination methods (Figure 10) shows that use of *mobile apps* has increased dramatically, and it is the only type of traveler information system showing growth in 2020. All other traveler information systems show a decline from 2016 usage levels.[4] Future surveys should monitor the trend to determine if 2020 was an anomaly or represents a shift in traveler information systems usage.

Social media (81 percent) and *websites* (80 percent) are the most used method of traveler information dissemination, despite declining 11 percentage points and six percentage points since 2016, respectively. In contrast, *mobile apps* increased 28 percentage points from 45 percent to 73 percent during the same period. *Email or text alerts* became the fourth most common dissemination method, declining 10 percentage points from 2016 to 70 percent in 2020. Older technologies, *511 systems* (60 percent) and *HAR* (37 percent) are the least used methods in 2020, down 14 percentage points and 22 percentage points, respectively.

[4] It is not clear whether the usage reductions are due to the evolution of information technologies or to changes in question wording. The 2020 question specifically asks about real-time traveler information, whereas previous surveys referred to traveler information (and did not reference "real-time").

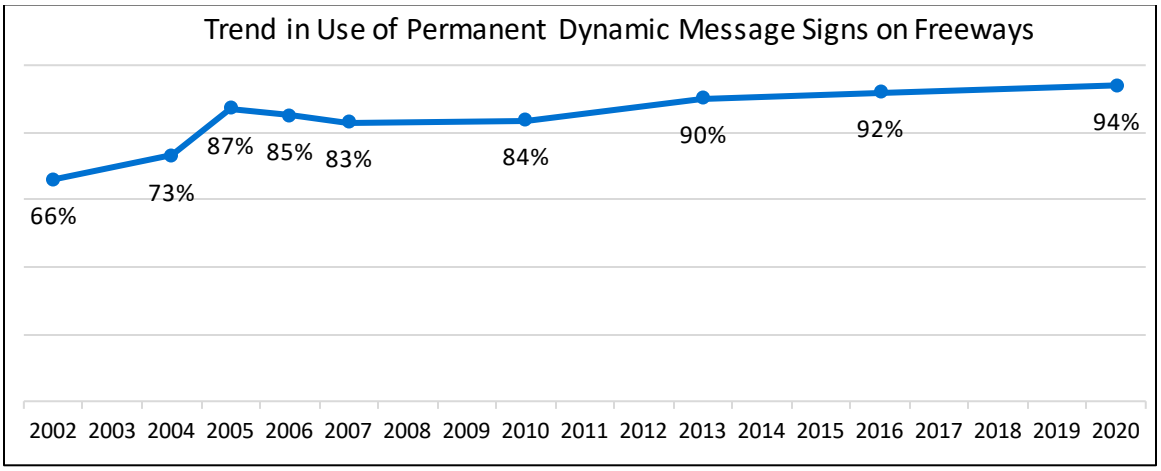


2020 Q20 *Source: USDOT*

NOTE: In 2007 "websites" was not a response option, so data for that survey year were imputed, as represented by the dashed line between 2006 and 2010.

Figure 10. Trend in Traveler Information Dissemination Methods

In a separate question, 94 percent of surveyed freeway agencies indicate deploying *permanent DMS* on freeways (Figure 11), reflecting the maturity of the market for this technology.[5] With the exception of 2005, *DMS* use has increased gradually since 2002 (by 18 percentage points from 66 percent in 2002 to 94 percent in 2020). Among agencies reporting DMS use, the number deployed ranges from 3 to 476, with a mean of 84.9 and a median of 41 permanent DMS.



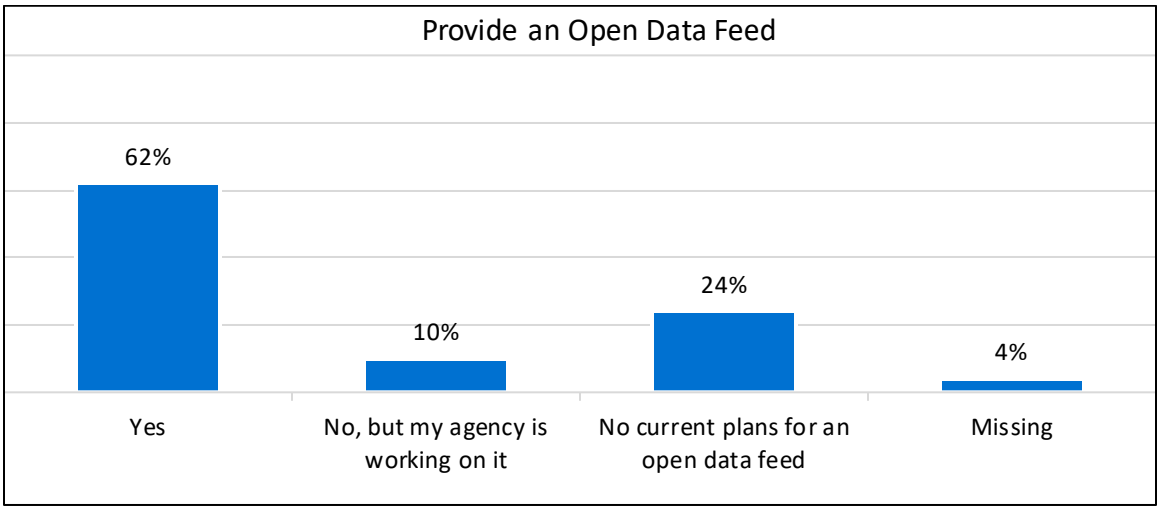
2020 Q19 *Source: USDOT*

Figure 11. Trend in Use of Permanent Dynamic Message Signs on Freeways

[5] Agencies were asked to provide the number of permanent DMS deployed (Question 19), and an indicator variable was created. The DMS measure from the traveler information question (Question 20) is slightly higher (96 percent), likely due to the differences in question wording. Question 20 does not specify "permanent" DMS.

Open Data Feed

Figure 12 shows almost two-thirds of surveyed freeway agencies (62 percent) *provide an open data feed* (e.g., to app developers, information service providers, or the public). Another 10 percent of agencies are *working on providing* an open data feed. One-quarter of agencies (24 percent) have *no plans* to provide a data feed, and the remaining 4 percent of agencies did not provide a response.



2020 Q21; (n=101) *Source: USDOT*

Figure 12. Provide an Open Data Feed

Telecommunications

Both wired and wireless telecommunication technologies play a role for freeway agencies in providing communications between any of their ITS devices, and/or between ITS roadside devices and a central processing location (Figure 13), typically for data collection and dissemination. Almost all surveyed freeway agencies indicate use of at least one wired telecommunication option (94 percent), and a similar proportion indicate use of at least one wireless telecommunication option (93 percent). On average, freeway agencies indicate use of a combination of 4.5 telecommunication technologies. Of the wired technologies, *fiber optic cable* (93 percent) is the most common. About one-third of freeway agencies use *twisted copper pair or twisted wire pair* (36 percent), *coaxial cable* (35 percent), and *data cable over modem* (35 percent). *Digital Subscriber Line* technology has lower deployment, with 20 percent of agencies reporting use.

Among the wireless telecommunication technologies, most freeway agencies are using *Cellular (LTE-4G)* (88 percent). About half of freeway agencies report *microwave* (47 percent), followed by *Dedicated Short Range Communications (DSRC)* at 28 percent, *Cellular (GPRS-2G or 3G)* at 27 percent, *5G New Radio and small cell infrastructure*[6] at 19 percent, and *Wi-Fi* at 12 percent. Few freeway agencies indicate the

[6]At this time, *5G New Radio* is not yet commercially available, but it is likely respondents have implemented and are using *small cell infrastructure* with 4G radios.

remaining telecommunication technologies: *LTE-Cellular V2X*[7] (6 percent), *ultra-wideband* (2 percent) and *mobile or fixed service satellite* (1 percent). Eight percent of freeway agencies report *other* wired or wireless telecommunication technology, and 2 percent did not answer this question.

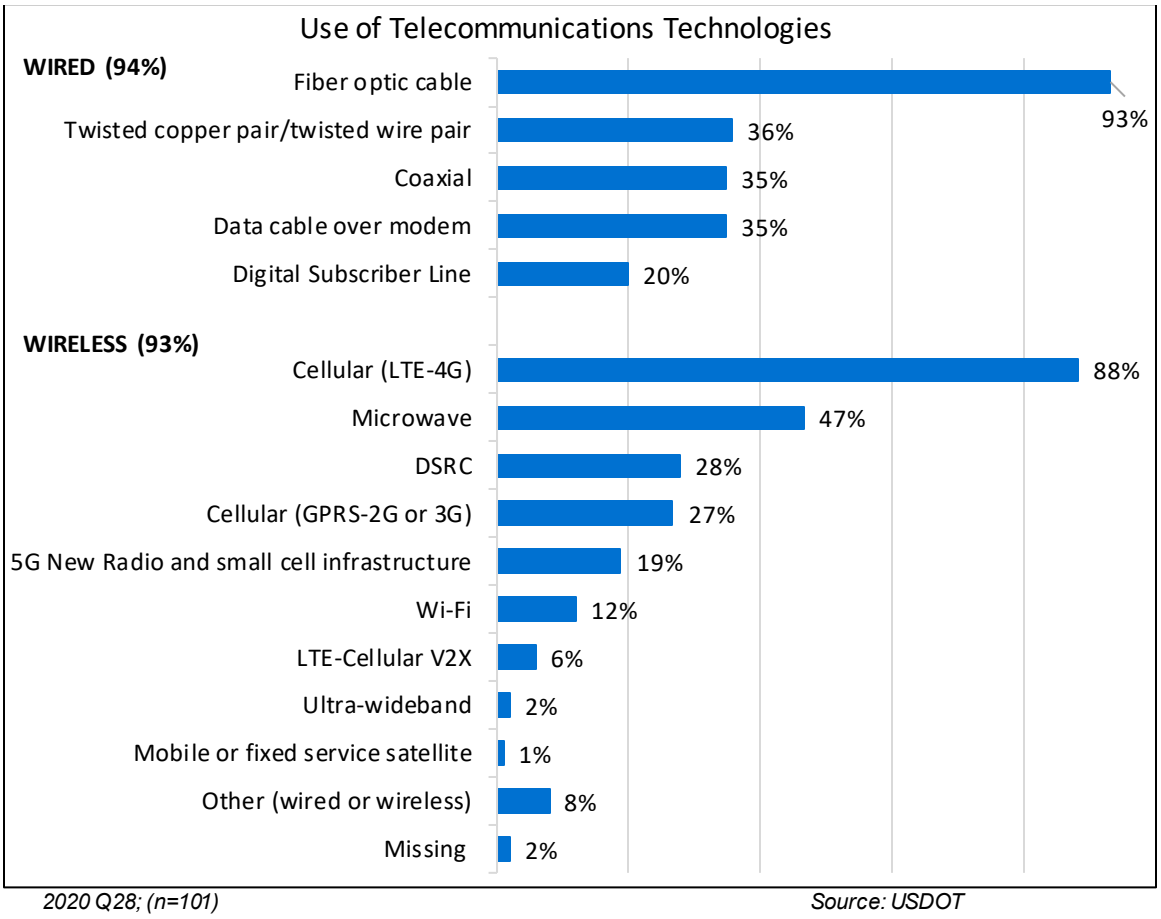
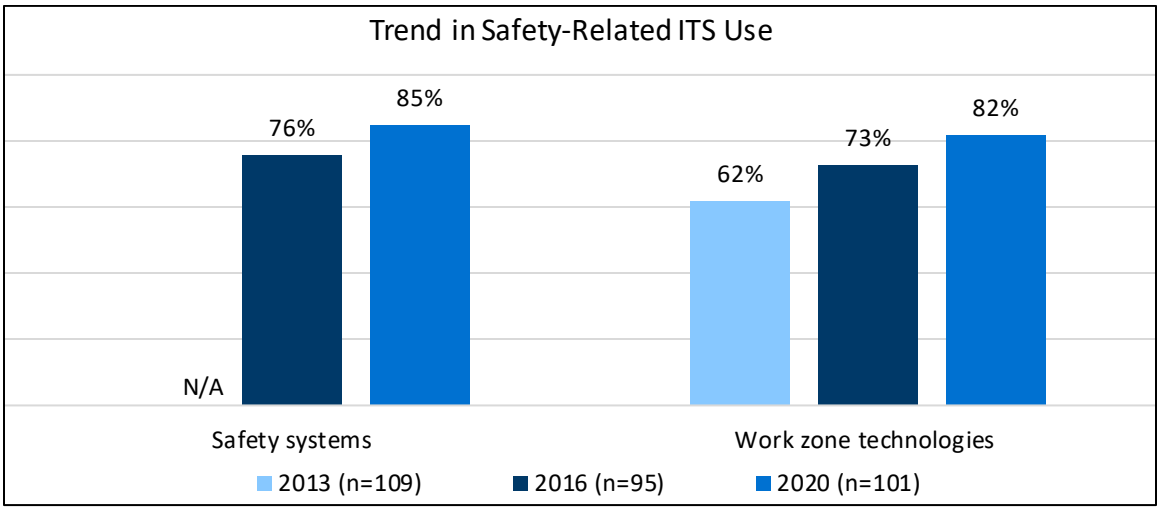


Figure 13. Use of Telecommunication Technologies

[7] Details about whether these *LTE-Cellular V2X* installations are being used with applications under their experimental license versus installed for testing needs further exploration.

Safety-Related ITS Technologies

In recent years, significantly more freeway agencies have adopted safety-related ITS. Figure 14 shows that since 2016, the number of surveyed agencies deploying *safety systems* increased from 76 percent to 85 percent.[8] There has been a 20 percentage point increase in adoption of *work zone technologies* since 2013, moving from 62 percent to 82 percent, with significant growth between each survey period.



2020 Q12, Q17 *Source: USDOT*

Figure 14. Trend in Safety-Related ITS Use

The commitment of USDOT and state agencies to improving safety may be one of several factors contributing to growth in the use of these safety-related ITS technologies, although the data cannot confirm this link.

Safety Systems Technologies

Figure 15 shows the trend in the surveyed freeway agencies' deployment of safety system technologies from 2016 to 2020.

Freeway agencies use a range of safety system technologies, on average 2.7 per agency. The two most commonly used safety systems among surveyed freeway agencies saw significant increases from 2016: *queue warning systems* increased by nine percentage points from 38 percent to 47 percent, and *over-height warning systems* increased by eight percentage points from 37 percent to 45 percent. Technologies such as *dynamic curve warning* (30 percent) and *dynamic speed limit* (24 percent) have remained relatively stable since 2016. *Reference location signs* saw a moderate decline during this period (down six percentage points from 35 percent to 29 percent). *Lane use control* (20 percent) and *wrong*

[8] The safety systems indicator was created by selecting the agencies that reported using one or more safety system technologies. The work zone indicator represents responses to a screener (i.e., yes/no) question on whether or not the agency deploys work zone technologies. The 2013 safety systems use is not shown, because the data are not comparable (the list of technologies changed significantly since 2013).

way detection (39 percent) were new response options in 2020 so trend cannot be assessed for these technologies (Figure 15).

Safety systems such as *automated and/or manual freeway ramp gates* (16 percent), *downhill truck speed warning* (9 percent), and *wireless truck inspection* (7 percent) are used by a smaller fraction of surveyed agencies in 2020, and there was minimal variation in adoption from 2016. *Other* safety technologies were mentioned by 10 percent of agencies. The most common response for the *other* responses included technology specifically for tunnels (e.g., tunnel fire system, tunnel traffic management, and lane use control for tunnels). Fifteen percent of surveyed agencies report no use of safety system technologies (down 9 percent points from 24 percent in 2016). It should be noted that some technologies, such as downhill truck speed warning, are only applicable in areas with specific physical characteristics, and so the ceiling for adoption is likely to be lower.

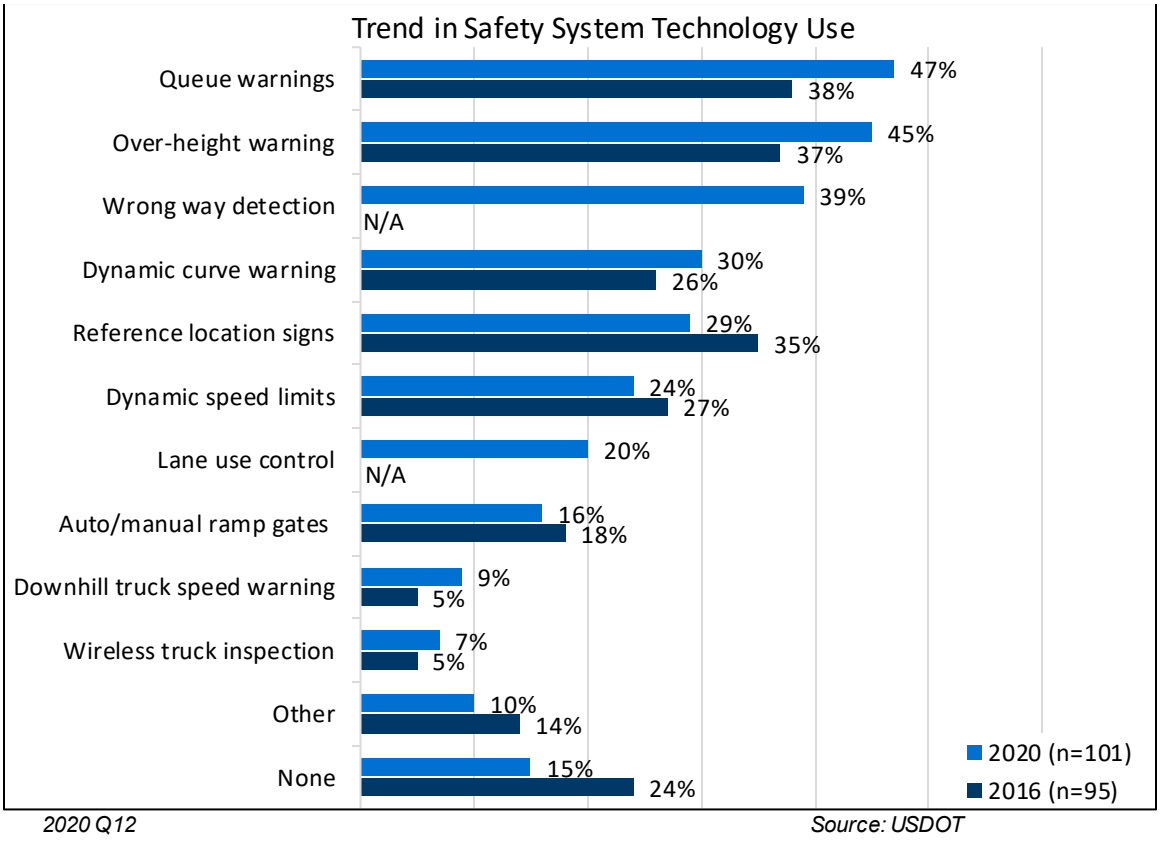


Figure 15. Trend in Safety System Technology Use

Work Zone Technologies

On average, surveyed freeway agencies have deployed 2.8 work zone technologies. Figure 16 shows that the most common work zone technology among surveyed freeway agencies in 2020 is *portable closed-circuit television (CCTV)* with almost two-thirds of freeway agencies deploying (65 percent). Other common technologies including *queue detection and alerts* (47 percent), *travel time systems* (42 percent), *portable traffic monitoring* (36 percent), and *route guidance* (25 percent) are used by one-at least one quarter of agencies.

Less common work zone technologies include *variable speed limit* (16 percent), *dynamic lane merge system* (10 percent), *temporary ramp metering* (8 percent), and *intrusion alarm* (7 percent). Additionally, *portable DMS* and *speed display feedback* (at 13 percent and 7 percent, respectively) were not original response options, but a sufficient number of respondents wrote in these technologies under the *other* response category that they were added as new response categories.

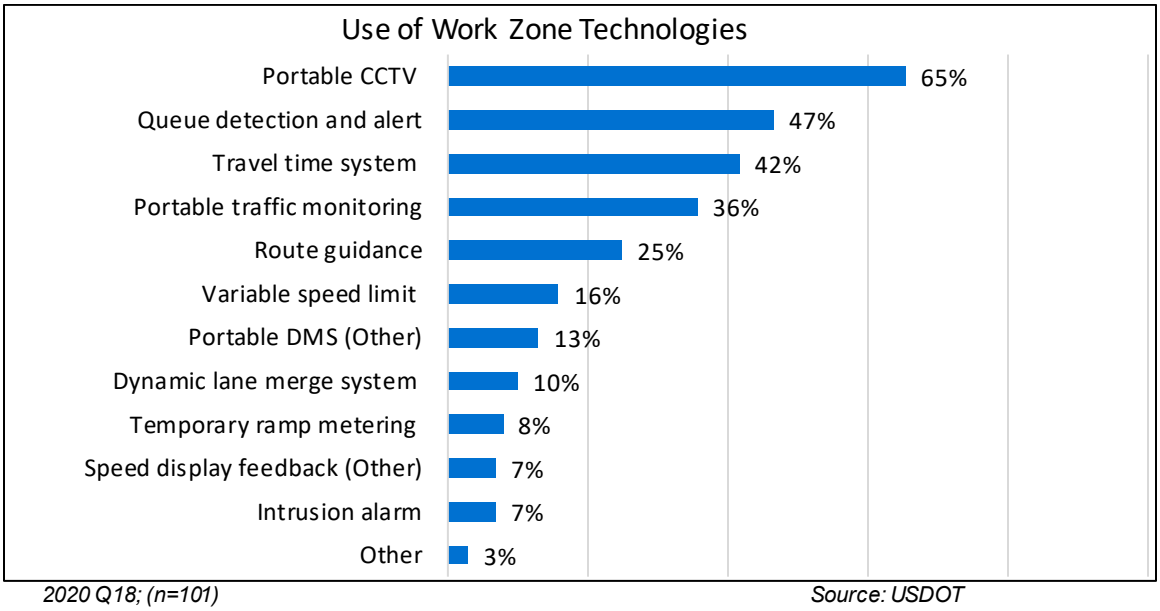


Figure 16. Use of Work Zone Technologies

As previously shown in Figure 14, the overall adoption of work zone technologies increased from 62 percent in 2013 to 73 percent in 2016 and 82 percent in 2020.

Figure 17 shows that the biggest change in work zone technology use from 2013 to 2020 was seen in *queue detection* (up 26 percentage points to 47 percent), and experienced significant growth across both survey cycles (2013 to 2016 and 2016 to 2020). There also has been a notable increase in the use of moveable technologies; *portable CCTV* use is up a significant 20 percentage points since 2013 (to 65 percent) and *portable traffic monitoring device* use has increased moderately, up eight percentage points since 2016 (to 36 percent).

Travel time systems (42 percent) have remained relatively stable since 2013. Reported use of *route guidance* has varied over the past two survey cycles and is currently at 25 percent. Less common technologies in 2020 include *variable speed limit* (16 percent), *dynamic lane merge* (10 percent), *temporary ramp metering* (8 percent) and *intrusion alarm* (7 percent). *Other* work zone technologies were mentioned by 23 percent of agencies.[9]

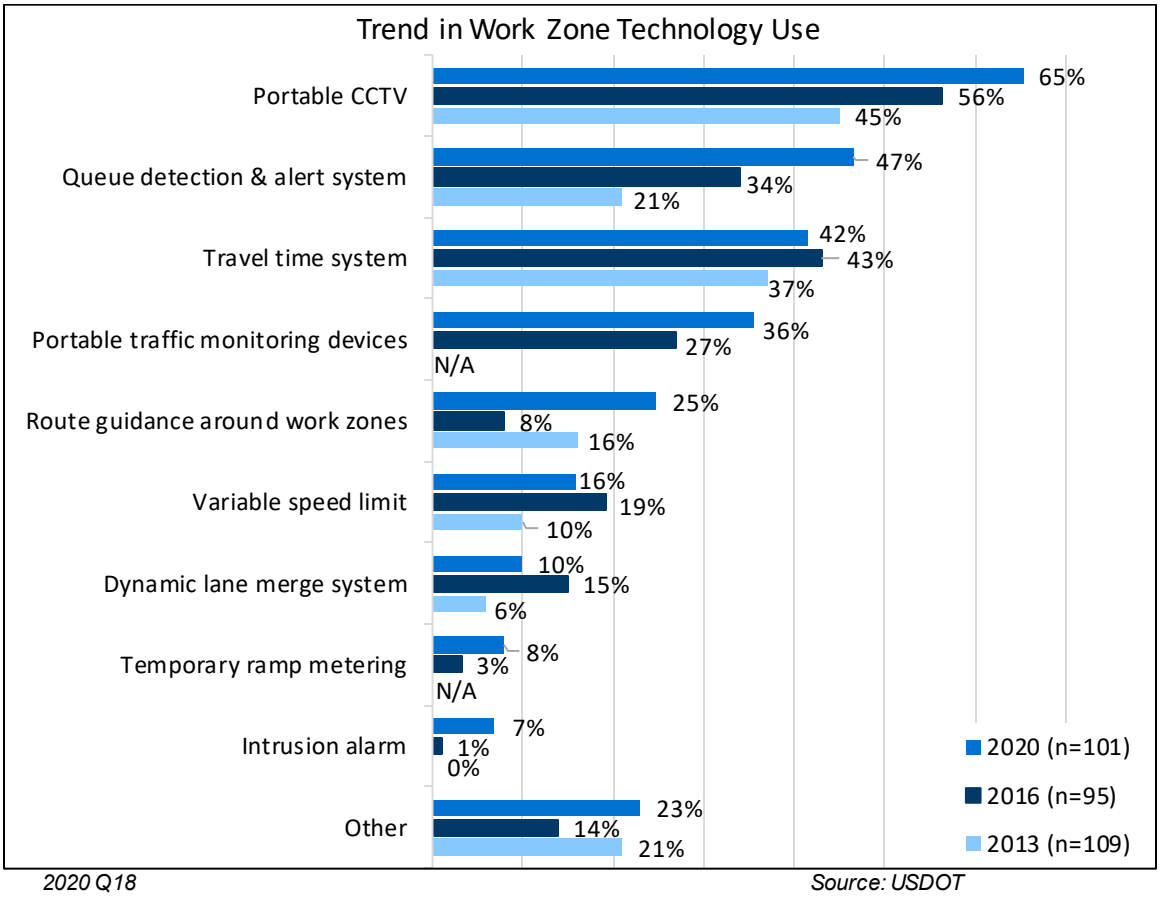
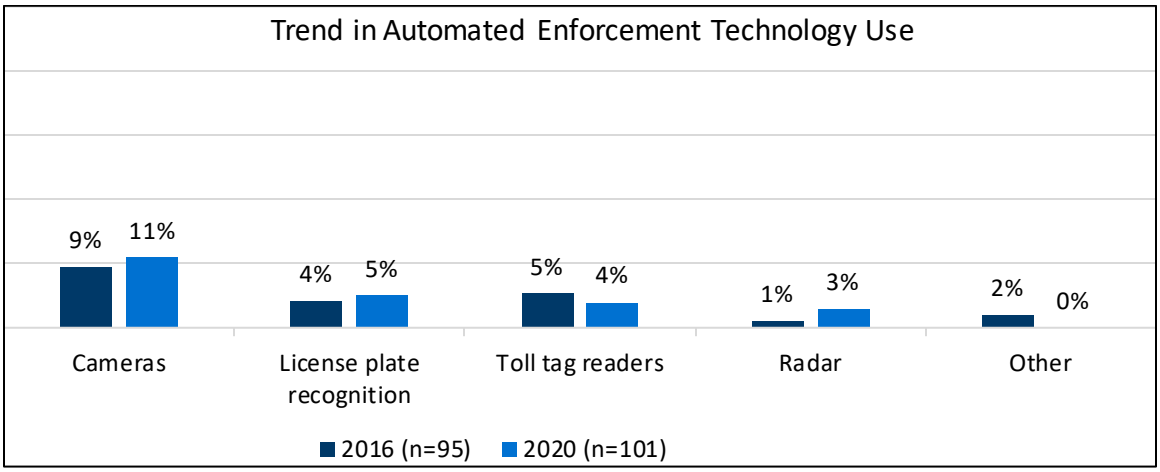


Figure 17. Trend in Work Zone Technology Use

[9] Portable traffic monitoring devices and temporary ramp metering first appeared on the 2016 survey.

Automated Enforcement

In 2020, 12 percent of surveyed freeway agencies report deploying automated enforcement. Figure 18 shows that almost all freeway agencies using automated enforcement are deploying *cameras* (11 percent). Fewer agencies use *license plate recognition* (5 percent), *toll tag readers* (4 percent), or *radar* (3 percent). Since 2016, overall deployment of automated enforcement has remained consistent and low.

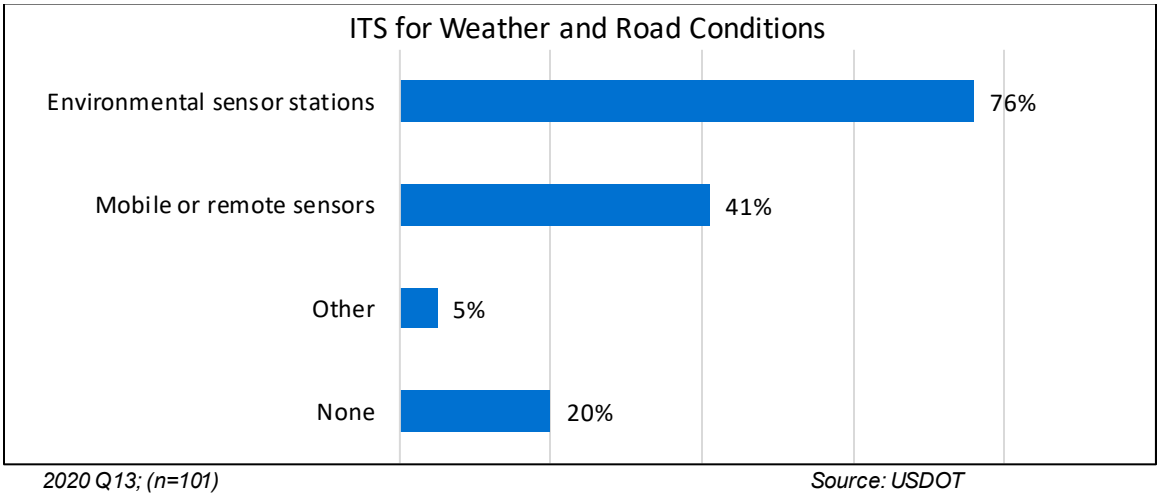


2020 Q11 *Source: USDOT*

Figure 18. Trend in Automated Enforcement Technology Use

ITS for Weather and Road Conditions

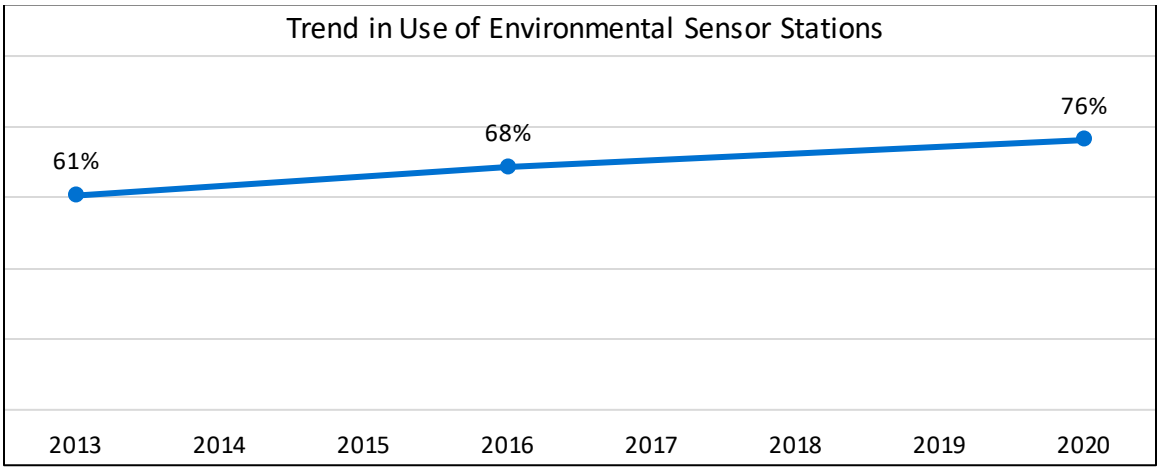
In 2020, 80 percent of surveyed freeway agencies indicate they use ITS technology to collect information on weather and road conditions for freeways. Figure 19 shows that the most common ITS technology used to collect this information is *environmental sensor stations (ESS)* (76 percent). Less than half (41 percent) are using *mobile or remote sensors*, 5 percent of agencies report o*ther* technologies, and 20 percent report *none*.



2020 Q13; (n=101) *Source: USDOT*

Figure 19. ITS for Weather and Road Conditions

Since 2013, there has been significant growth in the use of *ESS*, from 61 percent to 76 percent in 2020 (Figure 20).[10]

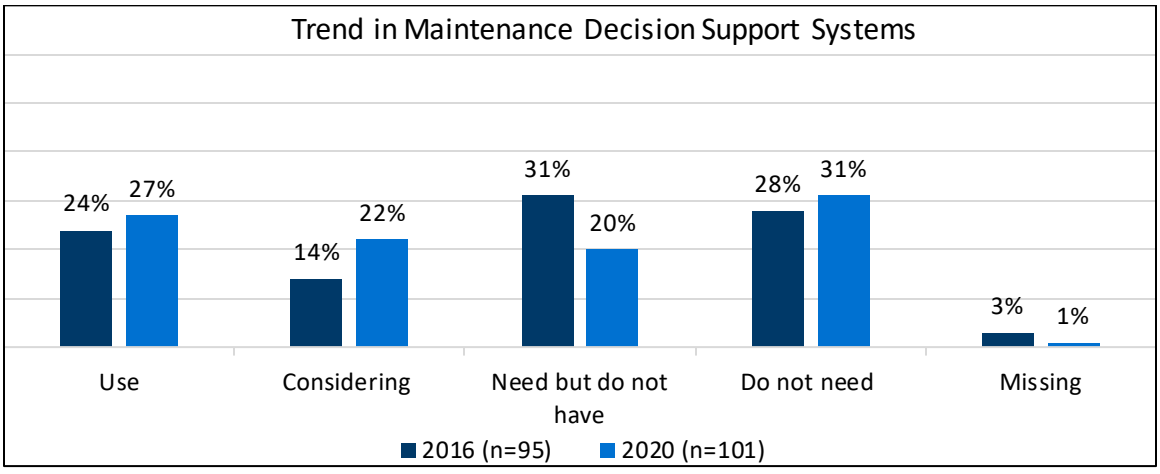


2020 Q13 *Source: USDOT*

Figure 20. Trend in Use of Environmental Sensor Stations

Maintenance Decision Support System (MDSS)

Figure 21 shows the number of surveyed freeway agencies using *Maintenance Decision Support Systems (MDSS)* remained relatively stable from 2016 to 2020, moving from 24 percent to 27 percent. Adoption of these systems could increase more in the future, as the percent of agencies *considering MDSS* has increased during this period, up eight percentage points to 22 percent in 2020. The increase is accompanied by a decline in agencies indicating they *need MDSS but do not have* a system (down 11 percentage points to 20 percent in 2020), and the number of agencies indicating they *do not need* the technology remains close to 30 percent.



2020 Q14 *Source: USDOT*

Figure 21. Trend in Maintenance Decision Support Systems

[10] Although the question was reworded in 2020, the research team believes the questions are comparable.

Incident Detection and Verification

Almost all surveyed freeway agencies (93 percent) report centerline miles covered by at least one type of incident detection or verification technology. Figure 22 shows that 90 percent of agencies report using *CCTV,* making it the most common incident detection or verification technology. Forty percent of agencies report use of *external data*, and about one-quarter (23 percent) report use of *computer algorithms*. Eight percent of freeway agencies use *call boxes* and 3 percent report use of *other* technologies.

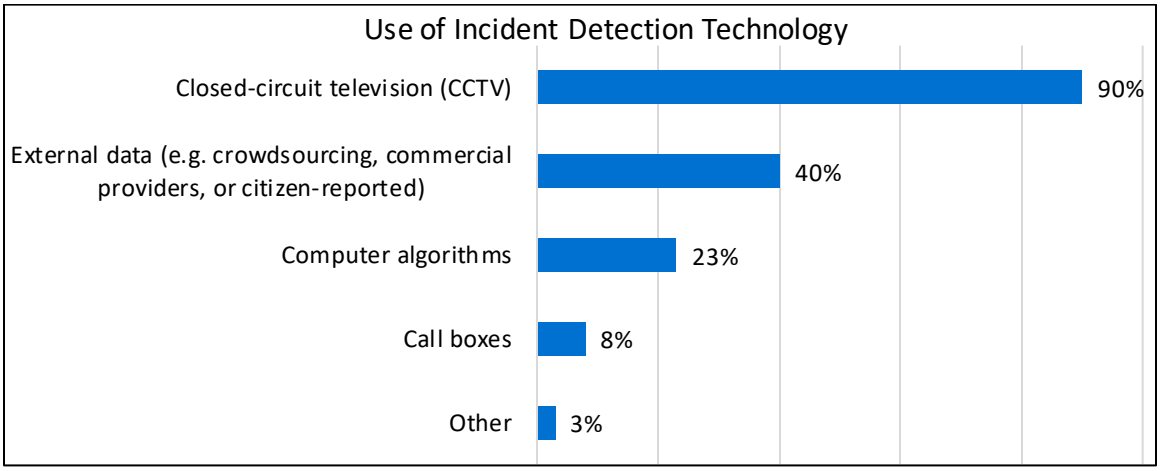


Figure 22. Use of Incident Detection Technology

Figure 23 shows the trend of use in *CCTV* and *computer algorithms* for incident detection or verification from 2002 to 2020. Overall, the trends in use of *CCTV* and *computer algorithms* have been flat in recent years.

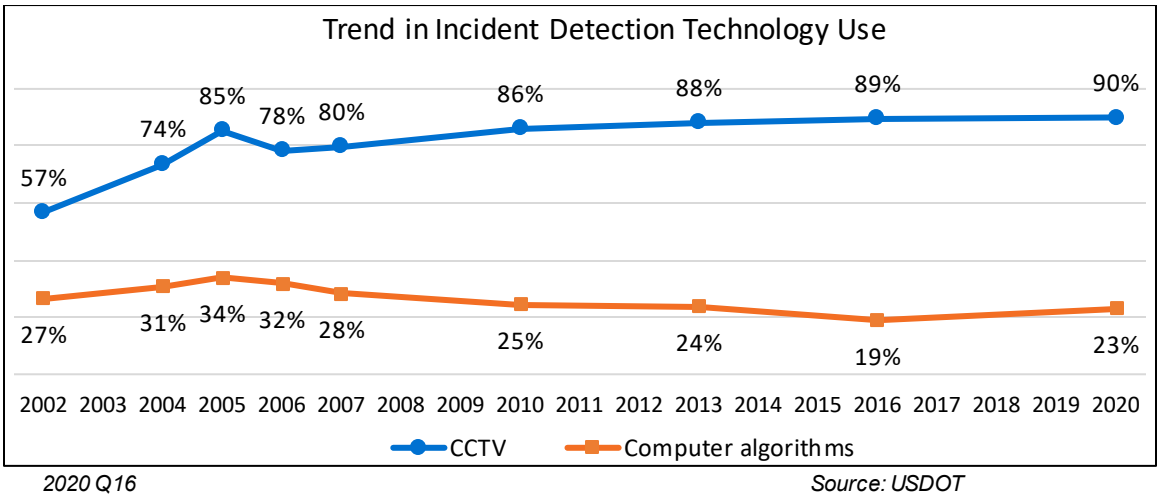
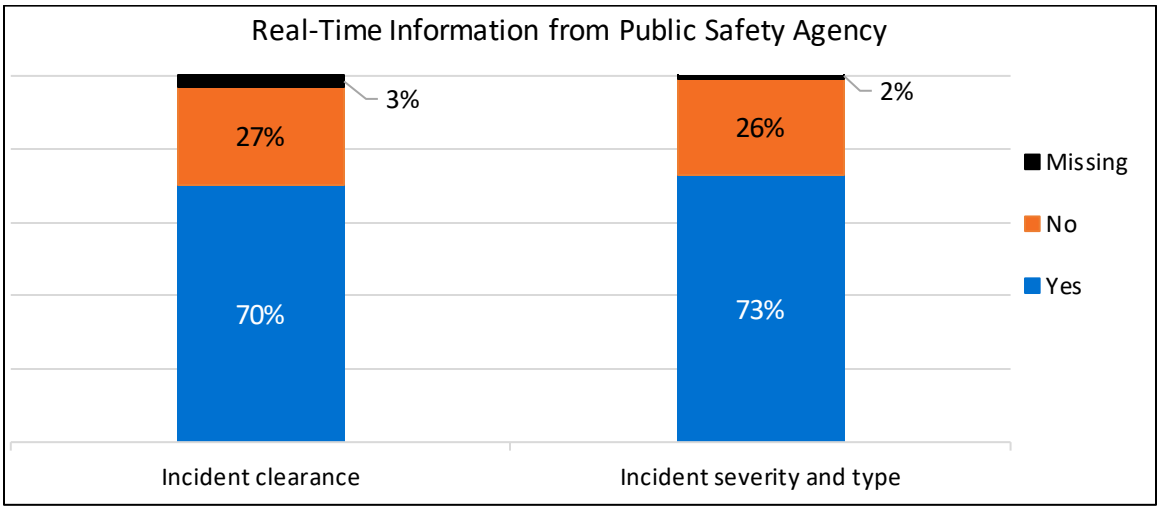


Figure 23. Trend in Incident Detection Technology Use – CCTV and Computer Algorithms

Agency Coordination

Figure 24 shows almost three-quarters of surveyed freeway agencies report receiving real-time *incident clearance* information (70 percent) and/or *incident and severity type* information (73 percent) from public safety agencies. Roughly one-quarter of surveyed agencies report not receiving real-time safety information – with 27 percent not receiving *incident clearance* information and 26 percent not receiving *incident severity and type* information. An additional 2 to 3 percent of agencies did not respond.



2020 Q25; (n=101) *Source: USDOT*

Figure 24. Real-Time Information from Public Safety Agency

Along with receiving real-time information, freeway agencies also provide real-time information on incidents (e.g., type and severity) and traffic to several different types of agencies. Figure 25 shows that overall, incident information is more commonly provided than traffic information. Three-quarters of surveyed freeway agencies are providing real-time *incident information* to *law enforcement agencies* (76 percent), followed by 61 percent providing information to *fire rescue agencies*, and 56 percent providing to other *freeway management agencies*. Slightly less than half of freeway agencies are providing *incident information* to *arterial management agencies* (49 percent), *public transit agencies* (42 percent), and *other agencies* (45 percent).

Fewer freeway agencies are providing *traffic information.* The majority of freeway agencies report providing *traffic information* to *law enforcement agencies* (58 percent), other *freeway management agencies* (53 percent), and *fire rescue agencies* (50 percent). Slightly less than half of freeway agencies are providing *traffic information* to *arterial management agencies* (49 percent), *public transit agencies* (45 percent), and *other agencies* (40 percent).

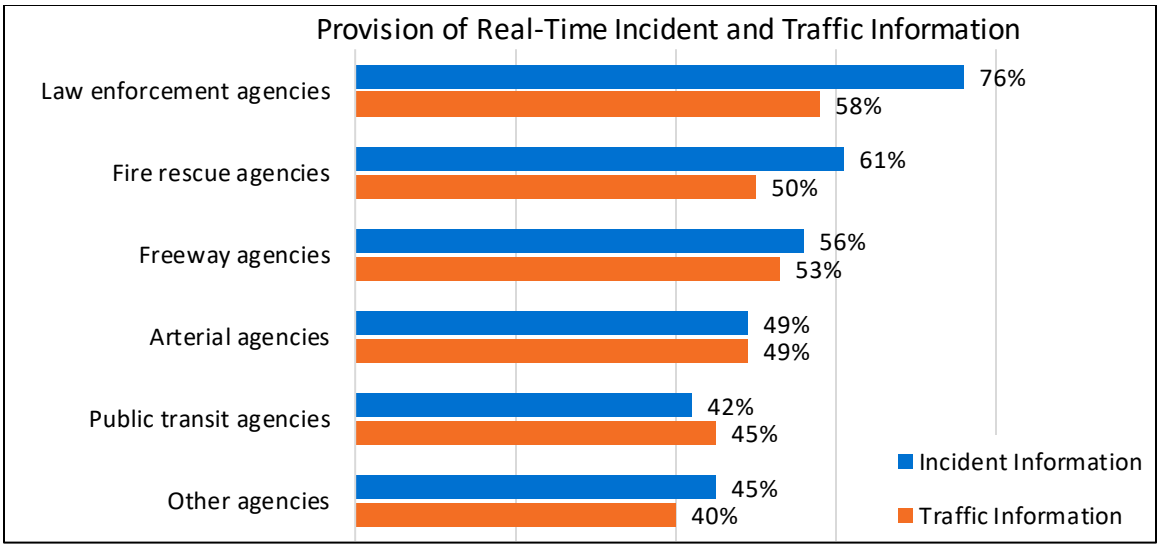


Figure 25. Provision of Real-Time Incident and Traffic Information

Figure 26 shows the trend on freeway agency sharing of real-time *incident information.* The sharing of incident information with *law enforcement*, *fire rescue,* and *public transit agencies* remains relatively steady since 2013. There has been a recent decline in the sharing of such information with *freeway management agencies* (from 71 percent in 2016 to 56 percent in 2020) as well as *arterial management agencies* (from 68 percent in 2016 to 49 percent in 2020).

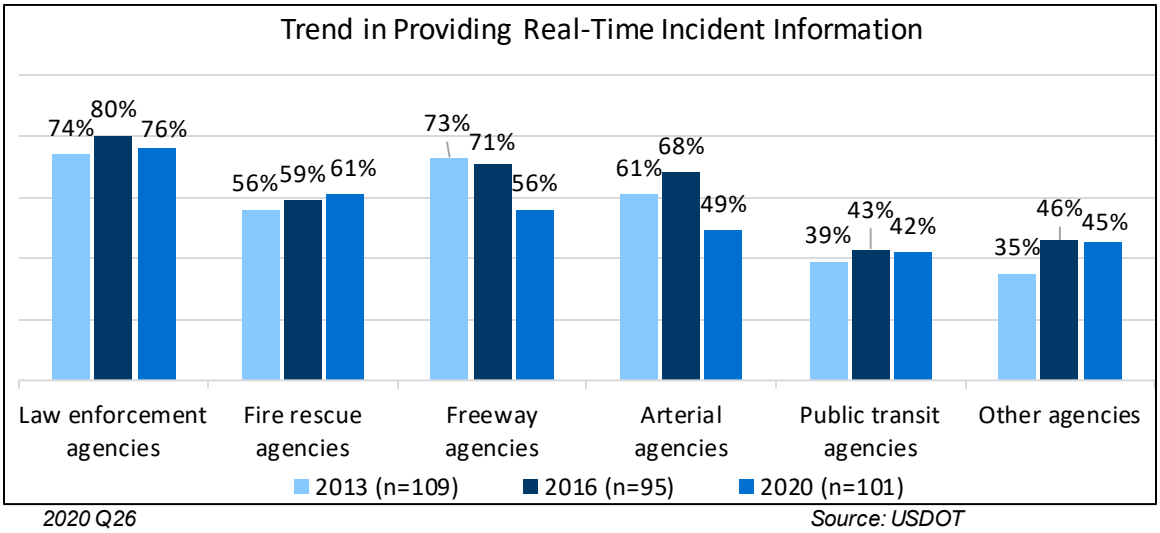


Figure 26. Trend in Providing Real-Time Incident Information

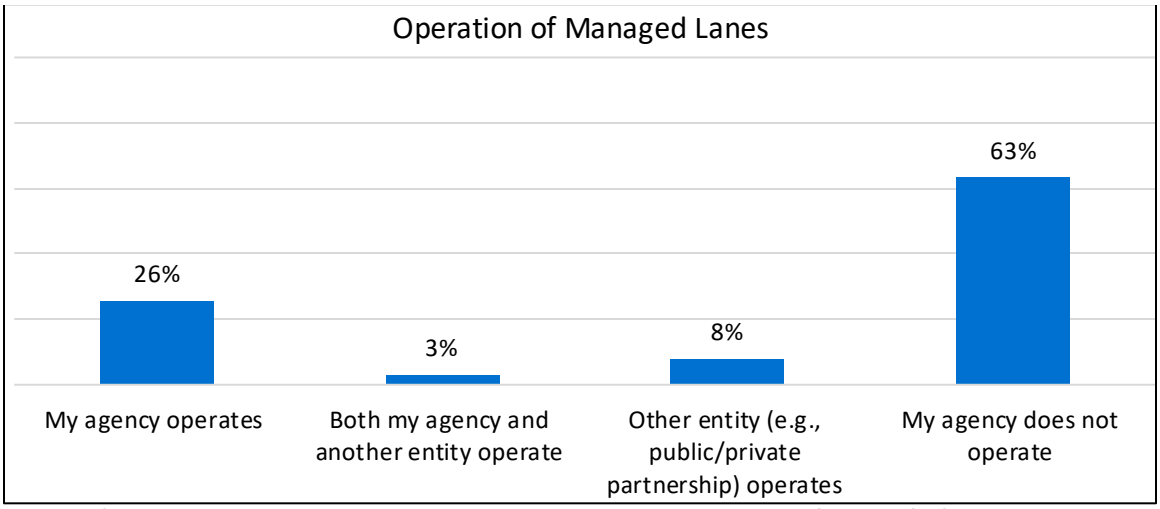
With regard to the sharing of real-time *traffic information*, the trends are relatively flat, so the data is not shown.

Traffic Management

This section of the report presents findings on different traffic management technologies and strategies, including managed lanes, ramp metering, and integrated corridor management (ICM).

Managed Lanes

Managed lanes is the concept of operating a set of freeway lanes separate from the general purpose lanes. This can be accomplished using a variety of operational strategies including pricing, vehicle eligibility, and access control to achieve optimal traffic conditions. Figure 27 shows about one-quarter of surveyed freeway agencies report *operating managed lanes* themselves (26 percent) and 3 percent report *both themselves and another entity* operate the managed lanes. Eight percent report that *some other entity* operates the managed lanes. In total, about 37 percent of surveyed freeway agencies report having managed lanes on the freeway. This leaves 63 percent of freeway agencies reporting that they *do not* operate managed lanes in any capacity (an 11 percentage point decrease from 2016).

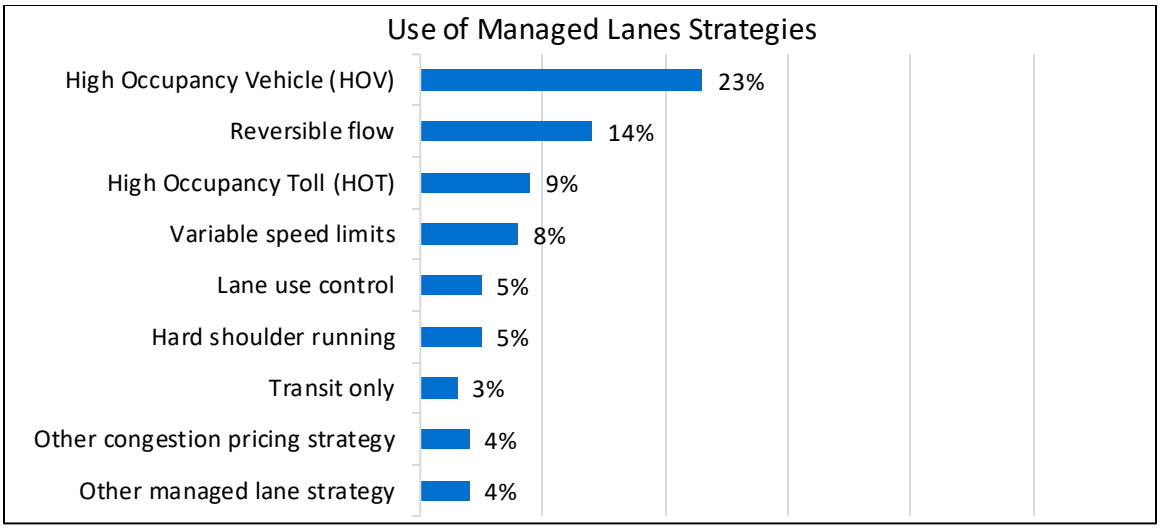


2020 Q8; (n=101) *Source: USDOT*

Figure 27. Operation of Managed Lanes

Figure 28 shows of different managed lanes operational strategies. About one-quarter of surveyed freeway agencies report using *high occupancy vehicle (HOV)* lanes (23 percent), followed by *reversible flow* lanes (14 percent), *high occupancy toll (HOT)* lanes (9 percent), and *variable speed limits* (8 percent). Few agencies report using the other techniques such as *lane use control* (5 percent), *hard shoulder running* (5 percent), *transit only* lanes (3 percent), *other congestion pricing* (4 percent), and *other managed lane strategy* (4 percent).[11] This question was modified since the 2016 survey, so it is not possible to report on the trend. However, the data do not suggest a significant change in the use of managed lane strategies from 2016 to 2020.

[11] There was an additional a response option for *truck only* lanes, with no freeway agencies reporting use.

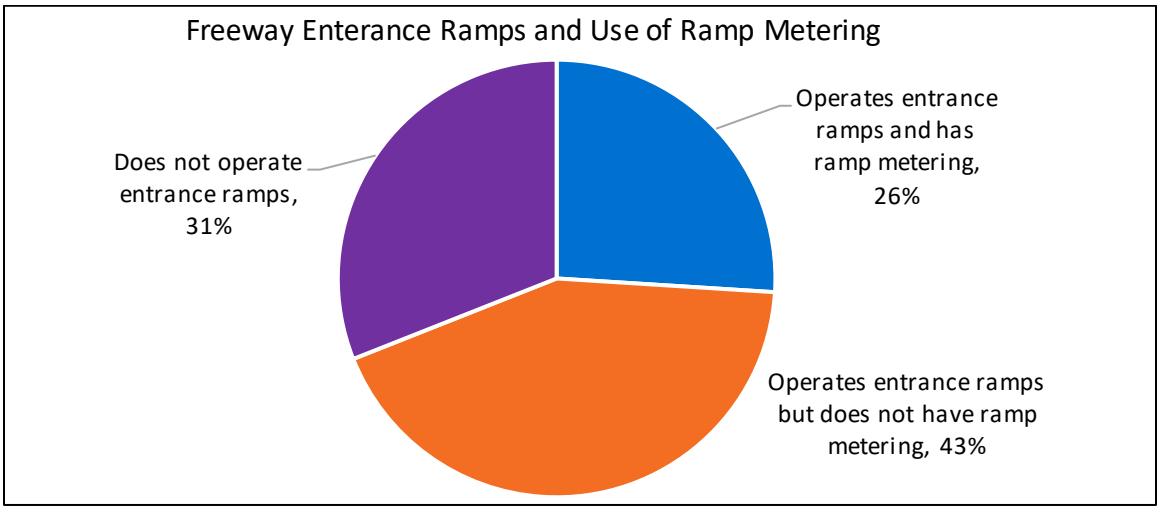


2020 Q9; (n=101) *Source: USDOT*

Figure 28. Use of Managed Lanes Strategies

Ramp Metering

About one-third of surveyed freeway agencies indicate that they *do not operate* entrance ramps (31 percent) as seen in Figure 29. Twenty-six percent report *operating entrance ramps* and *using ramp metering*, and 43 percent report *operating entrance ramps* and *not using ramp metering*. Twenty-six percent of agencies operating entrance ramps and using ramp metering is consistent with the previous three surveys.



2020 Q6, Q7a; (n=101) *Source: USDOT*

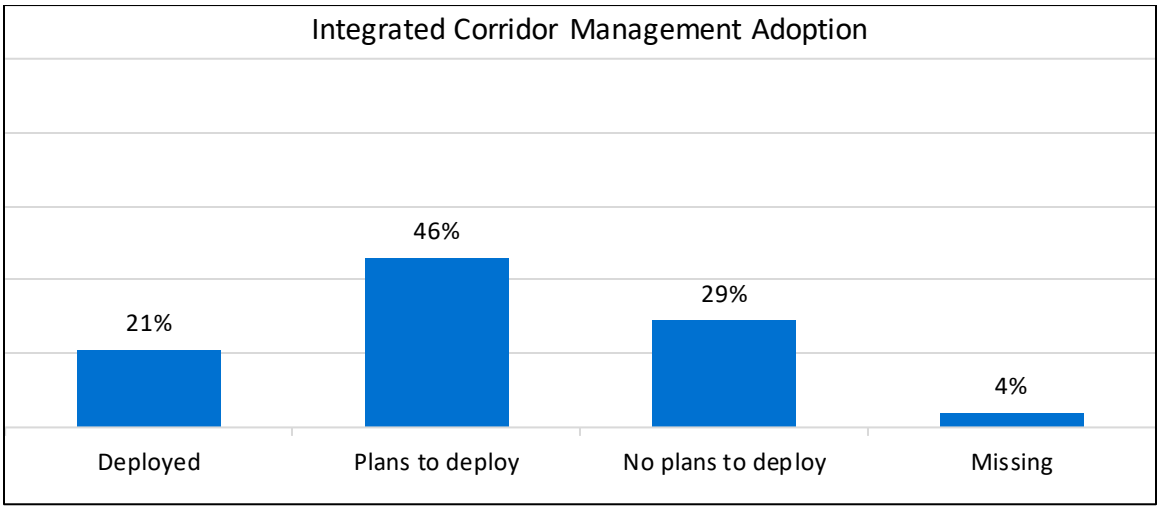
Figure 29. Freeway Entrance Ramps and Use of Ramp Metering

Integrated Corridor Management

Integrated Corridor Management (ICM) is an approach to manage a transportation corridor as a multimodal system, integrating operations such as traffic incident management, work zone management, traffic signal timing, and real-time traveler information to maximize the capacity of all facilities and modes across the corridor. A corridor was defined as including freeway, arterial, and public transit facilities with cross-facility connections.

Figure 30 shows 21 percent of surveyed freeway agencies report *deploying ICM*, and an additional 46 percent *plan to deploy*, suggesting there is a high level of interest in ICM among freeway agencies. Twenty-nine percent indicate *no plans to deploy* ICM and 4 percent were missing responses.

Due to survey length, the survey did not include follow-up questions on the nature of agencies' ICM deployment. As a result, the data do not include information on what technology deployments and operational strategies comprise their ICM. There may be a range of technologies in ICM deployments, with some agencies deploying more sophisticated systems than others. Additional data are needed to understand the nature of these ICM deployments, and the extent to which agencies are coordinating with other partner agencies in the corridor.

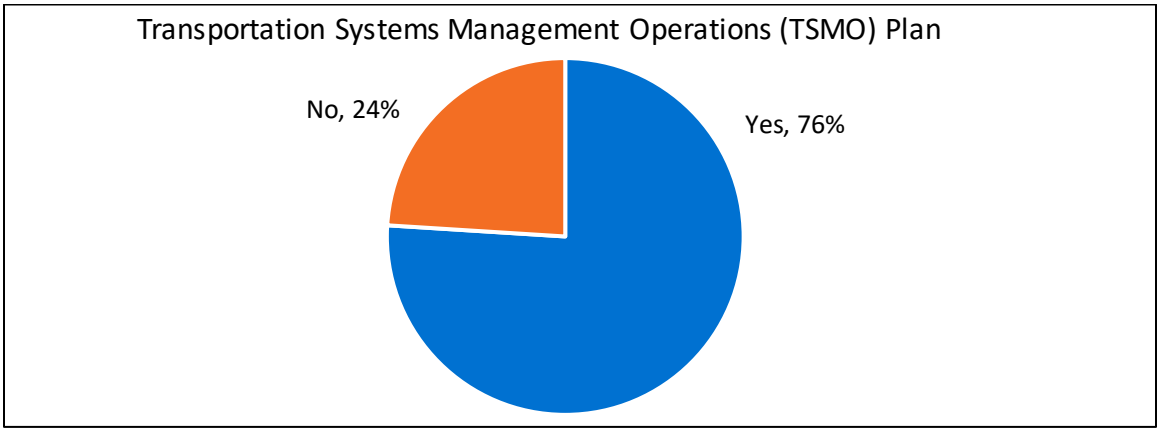


2020 Q23; (n=101) *Source: USDOT*

Figure 30. Integrated Corridor Management Adoption

Transportation Systems Management and Operations (TSMO) Plan

Figure 31 shows three-quarters (76 percent) of surveyed freeway agencies report having a Transportation Systems Management and Operations (TSMO) Plan. TSMO is a set of strategies that focus on operational improvements with the goal of maximizing performance of the existing transportation system. TSMO looks at performance from a systems perspective, in which strategies are coordinated across multiple jurisdictions, agencies, and modes.[12]

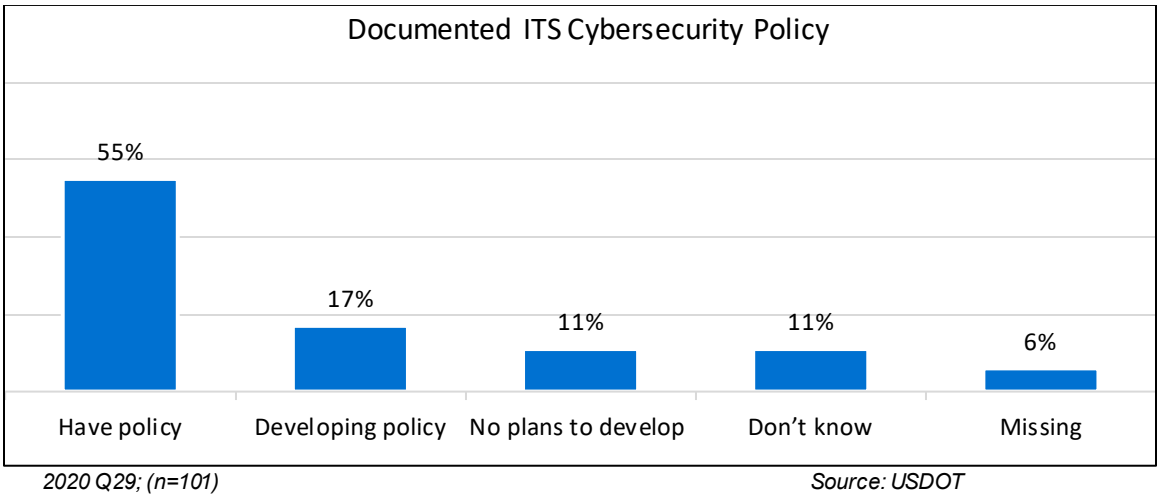


2020 Q24; (n=101) *Source: USDOT*

Figure 31. Transportation Systems Management Operations (TSMO) Plan

ITS Cybersecurity

Figure 32 shows that about one-half (55 percent) of surveyed freeway agencies have a documented *ITS-specific cybersecurity policy*, and another 17 percent *are developing* a policy. Eleven percent indicate they have *no plans to develop* a policy, 11 percent *don't know*, and 6 percent of responses are missing.

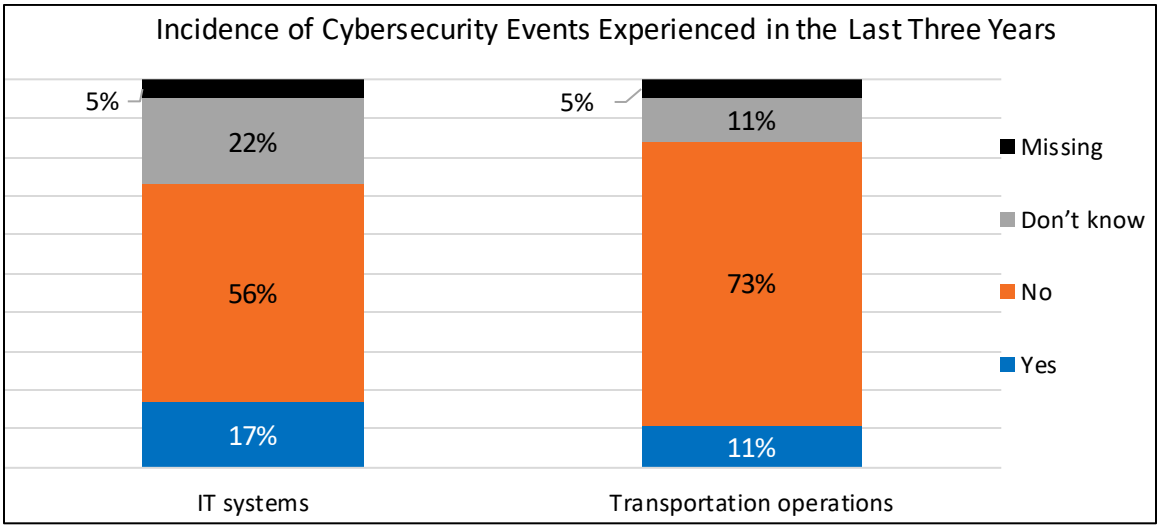


2020 Q29; (n=101) *Source: USDOT*

Figure 32. Documented ITS Cybersecurity Policy

[12] See Federal Highway Administration website: https://ops.fhwa.dot.gov/tsmo/#q1

Figure 33 shows nearly one-fifth (17 percent) of surveyed freeway agencies have experienced a cybersecurity event that affected their *IT systems* in the last three years, while 11 percent have experienced a cybersecurity event that affected *transportation operations* in the last three years. Overall, 18 percent of surveyed freeway agencies report experiencing a cybersecurity event.[13]



2020 Q30, Q31; (n=101) *Source: USDOT*

Figure 33. Incidence Cybersecurity Events in the Last Three Years

System Performance Measurement

Almost all surveyed freeway agencies (92 percent) are employing safety performance measures. On average, these agencies are employing 4.9 safety measures each. Figure 34 shows safety performance measures used by at least three-quarters of agencies include: *number of crashes, number of fatalities, crash severity* and *fatality rate.* Three measures related to injuries: *number of serious injuries, serious injury rate,* and *number of non-motorized fatalities and serious injuries*, are used by at least half of agencies. One new safety category related to *incident timeline/clearance/response time* was added due to the sufficient number of respondents who wrote this response as part of their *other* response.

While mobility measures are not as universal as safety measures, they are employed by 86 percent of surveyed freeway agencies. Agencies who employ mobility measures use 4.1, on average. Four measures related to travel time and delay are used by at least half of the surveyed freeway agencies: *travel time, travel time reliability, average speed,* and *delay per incident.* Other measures used by at least a quarter of agencies include, *traffic flow, truck volume, frequency of severe congestion, traffic density, and average delay per vehicle.* Measures that are less common include those related to HOV, *volume on HOV facilities and average speed on HOV facilities,* as well as *person throughput.*

[13] Most respondents who reported that a cybersecurity event affected their transportation operations also indicated an event that affected their IT systems (the data does not indicate whether it was the same or a different cybersecurity event).

Use of environmental measures is relatively rare. Less than one-quarter of surveyed agencies are using performance measures related to emissions.

Eleven percent report use of *other* performance measures, and 3 percent of respondents indicate their agency does not employ performance measures. One percent did not respond to the question.

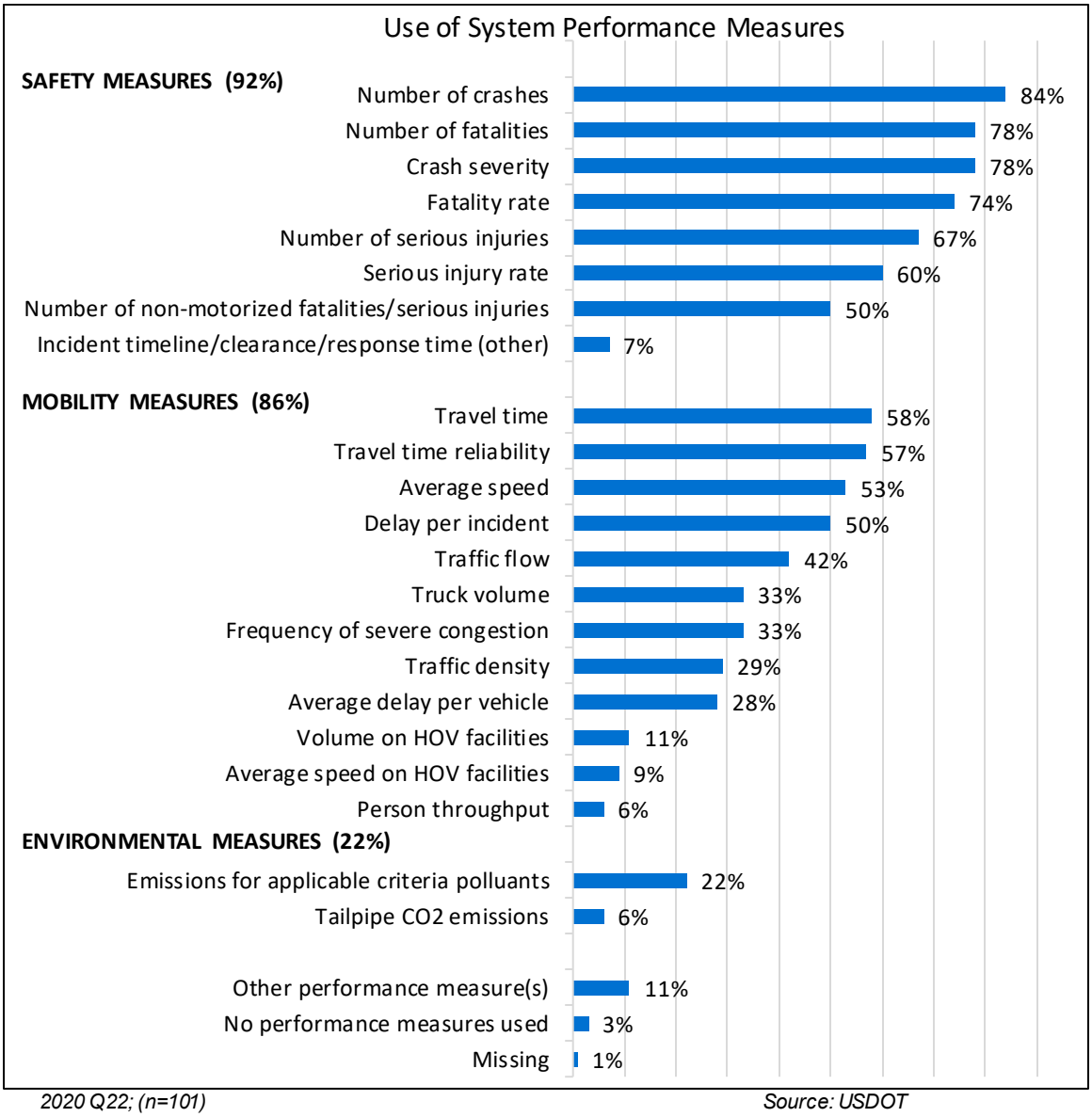
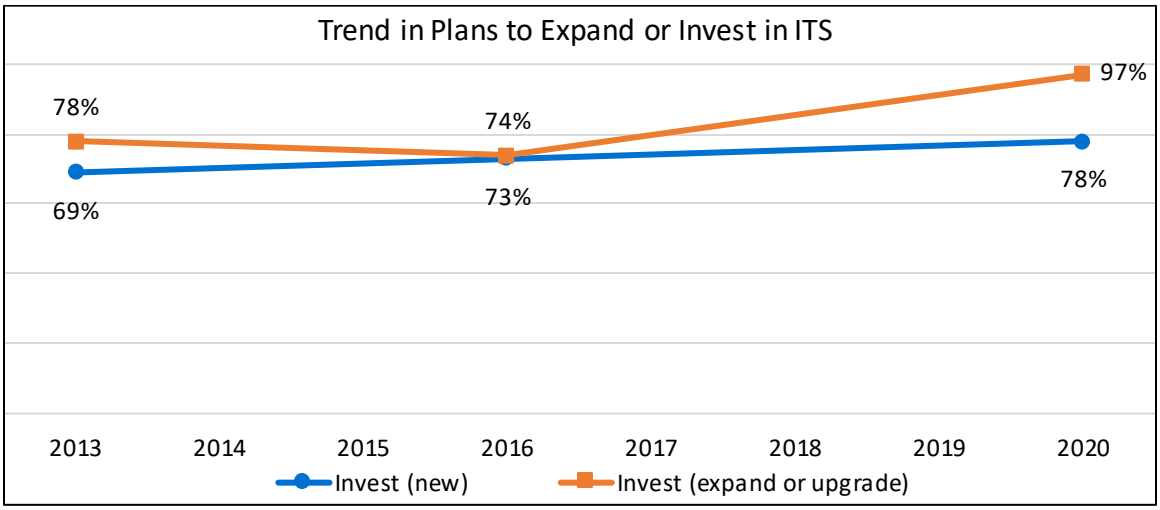


Figure 34. Use of System Performance Measures

Future ITS Investment

Figure 35 shows nearly all surveyed freeway agencies (97 percent), plan to *expand or upgrade their current ITS* in the next three years. A large majority also plan to *invest in new ITS* (78 percent). The percent of agencies planning to *expand or upgrade* their ITS grew by 23 percentage points since 2016, from 74 percent to 97 percent. There has been moderate growth in the number of freeway agencies planning to *invest in new* ITS, moving from 73 percent in 2016 to 78 percent in 2020.



2020 Q36, Q37 *Source: USDOT*

Figure 35. Trend in Plans to Expand or Invest in ITS

Chapter 4. Conclusions

The 2020 DTS is the latest survey in an ongoing effort by the USDOT ITS JPO to monitor the progress of ITS adoption and deployment among freeway, arterial, and transit agencies in 108 large and medium size metropolitan areas across the US. The surveys have been conducted for more than twenty years, and while the questions have evolved and new questions have been added over time, trend data are available for a majority of the technologies. The pandemic did not appear to significantly impact survey response rates; however, it is unclear what impact, if any, the pandemic has had or will have on ITS adoption or plans for adoption. Future surveys may add clarity and additional insight on this issue. The surveys provide insights on where agencies are deploying proven ITS as well as where technical assistance or outreach may be needed to increase adoption of newer ITS technologies. Survey responses and data trends can also raise questions that may merit further research and investigation.

Growth of Safety-Oriented Technologies

The 2020 Freeway Survey shows that a number of ITS technologies experienced increasing levels of adoption among freeway agencies since 2016. There was notable growth in the adoption of *work zone* and *safety system technologies*, with significant growth between each survey period (2013 to 2016 and 2016 to 2020). In general, adoption of ITS *safety systems* (85 percent) and *work zone technologies* (82 percent) is high among freeway agencies.

While overall deployment of these systems is high, there is still room for growth in the individual technologies deployed by agencies. There are a range of different safety technologies that serve different purposes, so agencies could adopt different types of safety technologies based on their specific needs.

Mature ITS Technologies

Adoption of *real-time data collection* among surveyed freeway agencies is high, at 85 percent and has changed little in the last two surveys. The use of *roadside infrastructure* technologies also is high, in part due to the widespread adoption of *radar/microwave detection,* which reflects the maturity of this technology in the market.

The Rise of Mobile Apps

For traveler information dissemination methods, the survey reveals that use of *mobile apps* by freeway agencies has increased dramatically, whereas other dissemination methods, such as *511, HAR, email or text alerts,* and *social media*, have experienced decreased use. The long-term trend shows how the use of traveler information methods has evolved, though it is unclear to what extent methods that provide information en route are replacing versus complementing other more traditional sources of traveler information, such as 511 and HAR.

Interest in Integrated Corridor Management

About two-thirds of freeway agencies demonstrate interest in ICM. It is important to note that ICM could comprise a range of technologies, depending on the needs of the agencies, and also may vary with respect to the extent of coordination across facilities and the level of automation of the ICM decision support system used to coordinate and activate response plans. Future surveys may want to gather more detailed data on what technologies agencies are deploying as part of their ICM, and the level of coordination and automation of their systems.

Use of External Data

The survey also found that a large number of freeway agencies are using external data sources, including *third-party commercial data*, such as probe data. Future surveys may want to explore the ways in which agencies are using this data to complement or fill in the gaps of their own real-time data collection.

Cybersecurity – an Area to Watch

On cybersecurity, about one-half of freeway agencies have a documented *ITS-specific cybersecurity policy*, and an additional 17 percent are *developing* a policy. In addition, nearly one-fifth (18 percent) of agencies report experiencing a cybersecurity event that affected their *IT systems* and/or *transportation operations* in the last three years. Future surveys may want to explore agencies' ITS cybersecurity planning in more detail, as cybersecurity continues to be a critical issue for federal, state, and local agencies.

Appendix A. Freeway Survey Instrument

Landing Page

Welcome to the 2020 Intelligent Transportation Systems Deployment Tracking Survey (DTS), sponsored by the U.S. Department of Transportation (DOT) Intelligent Transportation Systems (ITS) Joint Program Office (JPO) and administered by Resource Systems Group, Inc. (RSG).

The survey will take approximately 20 to 25 minutes to complete. We encourage you to review the questionnaire (see link below) and to consult with colleagues, as needed, to gather the requested information before completing the online survey.

You can return to this dashboard to access your survey at any time. If you start a survey and need to come back later, your progress will be saved.

Thank you in advance for your time and effort! We greatly appreciate your participation.

If you have any questions, please feel free to contact us:

- For overall survey questions: [CONTENT REMOVED]
- For technical support related to the survey tool: [CONTENT REMOVED]

For your reference, a PDF version of this online survey:
https://rsgsurvey.com/its_dts_dashboard/pdfs/ITSDTS_FreewaySurvey.pdf

For more information about the Deployment Tracking Statistics, please see:
https://www.itskrs.its.dot.gov/deployment

Privacy/Consent

Thank you for participating in this survey!

We are committed to protecting the confidentiality, integrity, and security of your personal information. We take this responsibility seriously. Our privacy documentation is intended to help you understand how we collect, share, and safeguard your information. Information about privacy for this study can be found here [LINK NO LONGER ACTIVE].

This study is conducted by RSG, an independent market research firm. RSG's privacy policy can be found here [LINK NO LONGER ACTIVE].

Use the “Next” and “Previous” buttons below to navigate the survey. Do **NOT** use your browser's “forward” and “back” buttons because your answers will **NOT** be recorded.

By clicking “Next”, I consent to participate in the survey.

Questionnaire

Thank you for completing the **Freeway Management** survey, administered on behalf of the U.S. Department of Transportation (DOT), Intelligent Transportation Systems (ITS) Joint Program Office (JPO).

Freeway Agency Characteristics

1. What is the total number of freeway centerline miles operated by your agency?

Number of miles: _____

Freeway Real-Time Traffic Data Collection

2. What is the total number of freeway centerline miles covered by any real-time traffic data collection technologies (see definition below)? *Do not include Closed Circuit Television cameras used only for visual verification, such as for incident management.*

If none, please enter '0.'

Number of miles: _____ [NUMBER OF MILES SHOULD NOT EXCEED Q. 1]

DEFINITION: Real-time data collection technologies include **roadside infrastructure** such as inductive loops, radar detectors, video imaging detection, or magnetometers, as well as **vehicle probe readers** such as toll tag, license plate, Bluetooth, GPS, etc.

3a. What is the total number of freeway centerline miles where real-time traffic data (e.g., volumes and speeds) are collected using roadside infrastructure such as inductive loops, radar/microwave detection, or video imaging detection?

If none, please enter '0.'

Number of miles: _____ [NUMBER OF MILES SHOULD NOT EXCEED Q. 2]

3b. Which of the following roadside infrastructure technologies does your agency deploy to collect real-time traffic data on freeways? *Please select all that apply.*

- ❑ Inductive Loop
- ❑ Radar/microwave detection
- ❑ Video imaging detection
- ❑ Magnetometers
- ❑ Other (please specify): _____
- ❑ None

4a. What is the total number of freeway centerline miles where real-time traffic data are collected by vehicle probe readers, using technology such as Bluetooth readers, toll tag readers, cell phone readers, etc.? *If none, please enter '0.'*

Number of miles: _____ [NUMBER OF MILES SHOULD NOT EXCEED Q. 2]

4b. Which type(s) of vehicle probe readers does your agency use to collect real-time traffic data on freeways? *Please select all that apply.*

- ❑ Toll tag readers
- ❑ License plate readers
- ❑ Bluetooth readers
- ❑ Cellular/mobile phone readers
- ❑ In-vehicle GPS readers
- ❑ Other readers (please specify): _____
- ❑ None

5. Which of the following sources of freeway traffic data collected outside your agency (e.g., data gathered through crowdsourcing or other means) does your agency use, if any? *Please select all that apply.*

- ❑ My agency uses notifications from the public (e.g., emails, texts, phone calls)
- ❑ My agency uses mapping and traffic information applications that are publicly available (e.g., Waze, Google Maps)
- ❑ My agency uses third-party commercial provider data (e.g., Inrix, HERE, Waze)
- ❑ Other (Please specify): _____
- ❑ My agency does not use freeway traffic data collected from outside sources
- ❑ Don't know

Ramp Control

6. What is the total number of freeway entrance ramps operated by your agency? *If none, please enter '0.'*

Number of ramps: _____ [IF Q6 =0 SKIP TO Q. 8]

7a. Does your agency have freeway entrance ramp metering? *Please select one.*

- ❑ Yes
- ❑ No [SKIP TO Q. 8]

7b. What is the total number of freeway entrance ramps equipped with ramp metering? *If none, please enter '0.'*

Number of ramps: _____ [NUMBER OF RAMPS SHOULD NOT EXCEED Q. 6]

Managed Lanes

8. Does your agency and/or another entity (e.g., public/private partnership) operate managed lanes (see definition below) on freeways? *Please select one.*

- ❑ Yes, my agency operates managed lanes
- ❑ Yes, other entity (e.g., public/private partnership) operates managed lanes
- ❑ Yes, both my agency and another entity operate managed lanes
- ❑ No, my agency does not operate managed lanes [SKIP TO Q. 10]

DEFINITION: Managed lane concept is typically a "freeway-within-a-freeway" where a set of lanes within the freeway cross section is separated from the general-purpose lanes. The operation of and demand on the facility is managed using a combination of tools and techniques (e.g., pricing, vehicle eligibility, and access control) in order to continuously achieve an optimal condition, such as free-flow speeds.

9. What is the estimated number of freeway centerline miles covered by each of the following types of managed lane strategies? *If none for a strategy, please enter '0' for that response.*

High Occupancy Vehicle (HOV) _____
Reversible flow _____
Lane use control (open/closed/direction arrow or chevron) _____
Truck only _____
Transit only _____
High Occupancy Toll (HOT) _____
Variable speed limits _____
Hard shoulder running _____
Other congestion pricing strategy _____
Other managed lane strategy (Please specify): _____

[FOR EACH RESPONSE, NUMBER OF MILES SHOULD NOT EXCEED Q. 1]

Automated enforcement

10. Does your agency deploy automated enforcement on freeways? *Please select one.*

- ❑ Yes
- ❑ No [SKIP TO Q. 12]

11. What automated enforcement technologies does your agency use on freeways? *Please select all that apply.*

- ❑ License plate recognition
- ❑ Cameras
- ❑ Toll tag readers
- ❑ Radar
- ❑ Other (Please specify): _____

Safety and Road Weather Management

12. Has your agency deployed any of the following ITS safety systems? *Please select all that apply.*

- ❑ Over-height warning system (e.g., bridge, tunnel, gantries)
- ❑ Lane use control on general purpose lanes
- ❑ Automated and/or manual freeway ramp gates
- ❑ Reference location signs
- ❑ Dynamic curve warning system
- ❑ Downhill truck speed warning
- ❑ Dynamic speed limits
- ❑ Queue warning system
- ❑ Wrong way driving detection system
- ❑ Wireless truck roadside inspection
- ❑ Other (Please specify): _____
- ❑ No ITS safety systems have been deployed

13. Does your agency use any of the following ITS to collect weather and road condition information on freeways? *Please select all that apply.*

- ❑ Mobile or remote sensors
- ❑ Environmental sensor stations
- ❑ Other (Please specify): _____
- ❑ ITS are not used to collect weather and road condition information

14. Is your agency using or planning to use a Maintenance Decision Support System (MDSS) for winter maintenance (see examples below)? *Please select one.*

- ❑ Yes, my agency uses an MDSS
- ❑ Yes, my agency is considering an MDSS
- ❑ No, my agency does not have an MDSS, but needs one
- ❑ No, my agency does not need an MDSS

Examples of MDSS include software systems that provide strategic and tactical weather forecasts, support treatment decision-making, and provide summaries, etc.

Incident Management/Work Zone Management

15. What is the total number of freeway centerline miles covered by service patrols? *If none, please enter '0.'*

Freeway centerline miles: _____ [NUMBER OF MILES SHOULD NOT EXCEED Q. 1]

16. What is the total number of freeway centerline miles covered by each of the following incident detection/verification methods? *If none for a particular method, please enter '0' for that response.*

Number of Freeway centerline miles
Closed Circuit Television (CCTV) _____
Call boxes _____
Computer algorithms to detect incidents _____
External data (e.g., data provided by crowdsourcing, commercial providers, or citizen-reported) _____
Other (Please specify): _____ _____
[FOR EACH RESPONSE, NUMBER OF MILES SHOULD NOT EXCEED Q. 1]

17. Does your agency deploy ITS technology at work zones? *Please select one.*

- ❑ Yes
- ❑ No [SKIP TO Q. 19]

18. Which of the following ITS technologies does your agency deploy at work zones (on freeways)? *Please select all that apply.*

- ❑ Intrusion alarm
- ❑ Dynamic lane merge system
- ❑ Queue detection and alert system
- ❑ Variable speed limit
- ❑ Travel time system
- ❑ Route guidance around work zones
- ❑ Portable traffic monitoring devices
- ❑ Portable CCTV
- ❑ Temporary ramp metering
- ❑ Other (please specify): _____

Traveler Information

19. What is the total number of permanent Dynamic Message Signs (DMS) deployed on freeways? *If none, please enter '0.'*

Number of permanent DMS _____

20. What methods does your agency use to disseminate real-time traveler information about freeways? *Please select all that apply.*

- ❑ 511
- ❑ Social media (e.g., Twitter, Facebook)
- ❑ Email or text/SMS alert
- ❑ Mobile app custom-built for agency
- ❑ Third party mobile app (e.g., Google Maps, Waze)
- ❑ Dynamic Message Signs
- ❑ Website
- ❑ Highway Advisory Radio

- ❑ Other (please specify): _____
- ❑ Agency does not disseminate real-time traveler information about freeways

21. Does your agency provide an open data feed (e.g., to app developers, information service providers, or the public)? *Please select one.*

- ❑ Yes
- ❑ No, but my agency is working on this
- ❑ No current plans for an open data feed

State Performance Measurement

22. Which of the following measures does your agency use to report on the performance of the freeway system? *Please select all that apply.*

Mobility
- ❑ Average speed
- ❑ Average delay per vehicle
- ❑ Delay per incident
- ❑ Frequency of severe congestion
- ❑ Volume on HOV facilities
- ❑ Average speed on HOV facilities
- ❑ Truck volume
- ❑ Travel time
- ❑ Travel time reliability
- ❑ Traffic density (e.g., vehicles per lane per mile)
- ❑ Traffic flow (e.g., vehicles per lane per hour, passenger cars per lane per hour)
- ❑ Person throughput (e.g., per lane per hour or per hour)

Safety
- ❑ Number of crashes
- ❑ Crash severity (e.g., property damage only, fatality)
- ❑ Fatality rate (e.g., per 100 Million VMT)
- ❑ Number of fatalities
- ❑ Serious injury rate (e.g., per 100 Million VMT)
- ❑ Number of serious injuries
- ❑ Number of non-motorized fatalities and serious injuries

Environment
- ❑ Emissions for applicable criteria pollutants
- ❑ Tailpipe CO_2 emissions

Other
- ❑ Other performance measure(s) used by your agency
- ❑ (Please specify): _____
- ❑ No performance measures used

Integrated Corridor Management

This question focuses on Integrated Corridor Management (ICM). ICM is an approach that manages a transportation corridor as a multimodal system (freeway, arterial, and public transit), integrating operations such as traffic incident management, work zone management, traffic signal timing, managed lanes, real-time traveler information, and active traffic management to maximize the capacity of all facilities and modes across the corridor.

For the purposes of this survey, a corridor is defined as: a largely linear geographic band and a bounded travel shed of (mostly) commute and daily trips. The corridor must include **freeway**, **arterial**, and **public transit facilities**, with cross-facility connections.

You can find more information about ICM at https://rosap.ntl.bts.gov/view/dot/38816

23. Has your agency deployed Integrated Corridor Management (ICM) in one or more corridors (i.e., integrating operations across freeway, arterial, and public transit networks) to actively manage travel demand and capacity in the corridor as a whole? *Please select one.*

- ❑ Yes, my agency has deployed ICM
- ❑ No, but my agency plans to deploy ICM
- ❑ No, my agency has no plans to deploy ICM

Agency Coordination

24. Does your agency have a Transportation Systems Management and Operations (TSMO) Plan? *Please select one.*

- ❑ Yes
- ❑ No

25. Does your agency receive the following incident information in real-time from any public safety agency? *Please select one response for each item.*

	Yes	*No*
Incident clearance	o	o
Incident severity and type	o	o

26. Does your agency provide real-time incident information (e.g., type, severity) to the following types of agencies? *Please select one response for each agency type.*

	Incident Information	
	Yes	*No*
Freeway management agencies	*o*	*o*
Arterial management agencies	*o*	*o*
Public transit agencies	*o*	*o*
Law enforcement public safety agencies	*o*	*o*
Fire rescue public safety agencies	*o*	*o*
Other agencies	*o*	*o*

27. Does your agency <u>provide real-time freeway traffic information</u> (e.g., travel times, speed and condition) to the following types of agencies? *Please select one response for each agency type.*

	Freeway traffic information	
	Yes	*No*
Freeway management agencies	*o*	*o*
Arterial management agencies	*o*	*o*
Public transit agencies	*o*	*o*
Law enforcement public safety agencies	*o*	*o*
Fire rescue public safety agencies	*o*	*o*
Other agencies	*o*	*o*

Telecommunications

28. What type(s) of telecommunications does your agency use to communicate between any ITS devices, and/or between ITS roadside devices and a central processing location? *Please select all that apply.*

Wired:

- ❑ Coaxial
- ❑ Fiber optic cable
- ❑ Twisted copper pair/Twisted wire pair
- ❑ Digital subscriber line (DSL)
- ❑ Data cable over modem

Wireless:

- ❑ 5G New Radio and Small cell infrastructure
- ❑ Cellular (LTE-4G)
- ❑ Cellular (GPRS – 2G or 3G)
- ❑ LTE-Cellular V2X (LTE-CV2X)
- ❑ Wi-Fi
- ❑ Dedicated short range communications (DSRC)
- ❑ Mobile or Fixed service satellite (FSS)
- ❑ Ultra-wideband (UWB)
- ❑ Microwave
- ❑ Other telecommunications (wired and/or wireless) (please specify): _____

Cybersecurity

29. Does your agency have a documented cybersecurity policy specific to ITS equipment? ***Please select one.***

- ❑ Yes, my agency has a policy
- ❑ No, but my agency is developing a policy
- ❑ No, my agency does not have/is not developing a policy
- ❑ Don't know

30. Has your agency had any cybersecurity events (e.g., ransomware, data breach, etc.) affecting IT systems in the last three years? *Please select one.*

- ❑ Yes
- ❑ No
- ❑ Don't know

31. Has your agency had any cybersecurity events (e.g., ransomware, data breach, tampering of field devices, etc.) affecting transportation operations in the last three years? *Please select one.*

- ❑ Yes
- ❑ No
- ❑ Don't know

[ASK Q. 32 IF: (Q.29=HAS OR IS DEVELOPING POLICY) AND (Q. 30 AND/OR Q. 31=YES)]

32. Has your agency's policy on cybersecurity (specific to ITS equipment) changed since the cybersecurity event(s) took place? *Please select all that apply.*

- ❑ Yes, policy was developed or is being developed as a result of the event(s)
- ❑ Yes, policy has been updated as a result of the event(s)
- ❑ No, event(s) did not have an impact on policy
- ❑ Don't know

Maintenance of Freeway ITS devices

33. Does your agency utilize an asset management system to track ITS inventory and/or related maintenance and operations activity? *Please select one.*

- ❑ Yes, system tracks only ITS inventory
- ❑ Yes, system tracks only ITS maintenance and operations activity
- ❑ Yes, system tracks both
- ❑ No, my agency does not have an ITS asset management system

34. Who installs, inspects, maintains, and repairs your agency's ITS equipment in the field? *Please select all that apply.*

- ❑ Agency staff [ANSWER Q. 35a]
- ❑ Contractor(s) [ANSWER Q. 35b]
- ❑ Other (please specify) _____

35a. Which job titles best describe the agency staff that perform this work (i.e., install, inspect, maintain, and repair your agency's ITS equipment in the field)? *Select all that apply.*

- ❑ Engineer
- ❑ Electrician
- ❑ IT Specialist
- ❑ Software Engineer
- ❑ Traffic Signals Technician
- ❑ GIS Specialist
- ❑ Field Technician
- ❑ Planner
- ❑ Other (Please specify):_____
- ❑ Don't know

35b. Approximately what percentage of all ITS field equipment work (i.e., installation, inspection, maintenance, and repair) is contracted out? *Please select one.*

- ❑ 0% to 25%
- ❑ 26% to 50%
- ❑ 51% to 75%
- ❑ 76% to 100%
- ❑ Don't know

Future Deployment Planning

36. Does your agency plan to expand or upgrade current ITS during the next three years (2021 through 2023)? *Please select one.*

- ❑ Yes
- ❑ No
- ❑ Don't know

37. Does your agency plan to invest in new or emerging ITS during the next three years (2021 through 2023)? *Please select one.*

- ❑ Yes
- ❑ No [SKIP TO Q. 38]
- ❑ Don't know [SKIP TO Q. 38]

37a. Please describe new or emerging ITS technologies:

Additional Comments

38. Please use the space below to provide any additional comments regarding your agency's deployment, operations, or maintenance of ITS. Please be as specific as possible when commenting on particular ITS technologies.

39a. Can we contact you if we have any follow-up questions about your agency's experience deploying ITS? *Please select one.*

- ❑ Yes
- ❑ No [SKIP TO Q. 40]

How can we best reach you if we have follow-up questions about your agency's experience deploying ITS?

39b. Your preferred phone number. If this is not your preferred phone number, please type in your preferred phone number:

39c. Your preferred email address. If this is not your preferred email, please type in your preferred email address:

40. Please confirm if you are ready to submit your responses. *Please select one.*

- ❑ Yes, I have completed the survey and I would like to submit my final responses (Note: if you click this button, you will not be able to return to the survey).
- ❑ No, I am still working on the survey and will complete it later.

Thank you for your time and effort in completing this survey! The ITS JPO and the U.S. DOT Volpe Center greatly appreciate your participation.

Appendix B. Survey Year Sample Sizes

Table 2. Survey Sample Sizes

Survey Year	Freeway Sample
2002	146
2004	133
2005	103
2006	129
2007	123
2010	122
2013	109
2016	95
2020	101

Appendix C. 2020 DTS Frequencies

This Appendix includes the frequencies for questions that are not reported in the main body of the Report.

Q15. What is the total number of freeway centerline miles covered by service patrols?

Table 3. Use of Service Patrols

Use of Service Patrols	Percent of Freeway Agencies
Yes	80%
No	18%
Missing	2%

n=101 *Source: USDOT*

Q32. Has your agency's policy on cybersecurity changed since the cybersecurity event(s) took place?

Table 4. Change in Cybersecurity Policy

Change in Cybersecurity Policy	Percent of Freeway Agencies Base: Agencies who have/are developing a policy AND have experienced a cybersecurity event
Yes, policy was developed or is being developed as a result of the event(s)	42%
Yes, policy has been updated as a result of the event(s)	75%
No, events did not have impact on policy (mutually exclusive option)	17%
Don't know (mutually exclusive option)	0%
Missing	0%

n=12 *Source: USDOT*

Q33. Does your agency utilize an asset management system to track ITS inventory and/or related maintenance and operations activity?

Table 5. Asset Management Systems

Asset Management Systems	Percent of Freeway Agencies
Yes, system tracks only ITS inventory	16%
Yes, system tracks only ITS maintenance and operations activity	8%
Yes, system tracks both	55%
No, my agency does not have an ITS asset management system	20%
Missing	1%

n=101 *Source: USDOT*

Q34. Who installs, inspects, maintains, and repairs your agency's ITS equipment in the field?

Table 6. Installs, Inspects, Maintains, and Repairs ITS Equipment

Installs, Inspects, Maintains, and Repairs	Percent of Freeway Agencies
Contractors	83%
Agency Staff	73%
Other	1%
Missing	2%

n=101 *Source: USDOT*

Q35a. Which job titles best describe the agency staff that perform this work (i.e., install, inspect, maintain, and repair your agency's ITS equipment in the field)?

Table 7. Types of Agency Staff

Types of Agency Staff	Percent of Freeway Agencies Base: Agencies with Agency Staff working with ITS equipment in the field
Field Technician	77%
Engineer	55%
Traffic Signals Technician	53%
IT Specialist	43%
Electrician	38%
Software Engineer	10%
GIS Specialist	5%
Planner	4%
Other	8%
Don't know (mutually exclusive option)	0%
Missing	0%

n=74 *Source: USDOT*

Q35b. Approximately what percentage of all ITS field equipment work (i.e., installation, inspection, maintenance, and repair) is contracted out?

Table 8. Percentage of ITS Field Equipment Work Contracted Out

Percentage of ITS Field Equipment Work Contracted Out	Percent of Freeway Agencies Base: Agencies with Contractors working with ITS equipment in the field
0% to 25%	6%
26% to 50%	18%
51% to 75%	19%
76% to 100%	50%
Don't Know	6%
Missing	1%

n=84 *Source: USDOT*

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