Intelligent Transportation Systems Deployment Tracking Survey: 2020 Arterial Findings

Final Report

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16. Abstract

This report summarizes the Arterial 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 Arterial Management Survey was administered online from December 3, 2020 to March 31, 2021. The survey population included arterial 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 68 percent with 341 completed surveys by arterial management agencies.

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Acronyms

Acronym	Meaning
ASCT	Adaptive Signal Control Technology
CCTV	Closed-Circuit Television
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
RRFB	Rectangular Rapid-Flashing Beacons
TSP	Transit Signal Priority
TSMO	Transportation Systems Management and Operations
USDOT	United States Department of Transportation

Executive Summary

Introduction

This report summarizes the **Arterial Management Survey** (also referred to as the Arterial Survey in this Report) findings of the 2020 Intelligent Transportation Systems (ITS) Deployment Tracking Survey (DTS) administered by the John A. Volpe National Transportation Center (Volpe) in support of the United States Department of Transportation (USDOT) 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 Arterial Survey was administered to arterial management agencies (also referred to as arterial 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 Arterial 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). The survey was administered from December 3, 2020 to March 31, 2021 using an online survey instrument. The Arterial Survey achieved 341 completes with a response rate of 68 percent, exceeding its data collection goal of 60 percent.

Key Findings for Arterial Management Agencies

This section describes key findings from the Arterial Survey.

Several ITS technologies used at intersections show growth.

Nearly all surveyed arterial agencies (95 percent) use *detection technologies* at intersections, including large majorities that have adopted *inductive loops* (89 percent) and *video imaging* (82 percent). In addition, 60 percent report use of *radar or microwave* technologies at signalized intersections.

ITS technologies such as *adaptive signal control technology (ASCT)*, *closed-circuit television (CCTV)*, and *transit signal priority (TSP)* have shown steady growth since 2013.

- Adoption of *ASCT* has grown by 11 percentage points since 2013, with growth split relatively evenly across the two survey cycles. While this growth represents 60 percent more agencies using ASCT since 2013, the technology is used by fewer than one-third of arterial agencies overall. Agencies tend to deploy these technologies at a small portion of their intersections, with most agencies that deploy ASCT (59 percent) reporting use at less than 10 percent of their reported signalized intersections.

- Use of *CCTV* at intersections has grown by seven percentage points between 2013 to 2016 (from 45 percent to 52 percent) and by another eight percentage points in the last survey cycle, with 60 percent of agencies using this technology in 2020.
- *TSP*, which is currently adopted by 28 percent of arterial agencies, shows a similar growth pattern to ASCT. Usage grew fairly evenly across the last two survey cycles, with a total increase of 10 percentage points among arterial agencies since 2013.

Pedestrian safety systems experienced significant growth.

The 2020 Arterial Survey shows growth in ITS safety system adoption, as USDOT and state agencies continue to emphasize safety as a top goal. Use of *pedestrian warning systems* is driving growth in safety systems, up 13 percentage points since 2016 to 47 percent.

Nearly one-half of arterial agencies collect real time data on arterial roadways.

While most arterial agencies use *real-time data collection* at intersections (95 percent) a smaller proportion use *real-time data collection* on arterial roadways (45 percent). Use of real-time data collection on roadways, which includes both *roadside infrastructure* and *vehicle probe readers*, shows moderate growth, increasing by three percentage points from 2013 to 2016 and then by six percentage points from 2016 to 2020.

- *Roadside infrastructure* use is up 10 percentage points since 2013, reaching 40 percent in 2020. Growth has been evenly distributed across the survey cycles (2013 to 2016 and 2016 to 2020).
- *Vehicle probe readers* have seen similar growth in usage, up 12 percentage points since 2013 to 25 percent in 2020, although most of the growth was between 2013 to 2016. *Bluetooth* remains the most commonly used vehicle probe reader technology for arterial agencies with 20 percent usage.[1]

External data are widely used.

The survey results suggest that external data are emerging as another source of real-time traffic collection data. A majority of arterial agencies (59 percent) report using *external data* from any source.

Mobile application (app) usage is up.

Arterial agencies are increasingly deploying *custom-built* or *third-party applications (*collectively, *mobile apps). Mobile apps* were the only traveler information dissemination method to experience a significant increase in usage since 2016, which may reflect travelers' increasing utilization of their mobile phones for real-time information en route.

- Among arterial agencies, *mobile app* use grew significantly (10 percentage points) since 2016, with 22 percent of arterial agencies currently reporting use.
- While *social media* and *websites* are still the two most common methods of disseminating traveler information among arterial agencies (38 percent and 35 percent, respectively), these methods saw declines in usage since 2016. Two of the more traditional and least used methods, *511* and *highway advisory radio (HAR)***,** also experienced notable usage declines.

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

- Use of *permanent dynamic message signs (DMS)* for traveler information remains relatively uncommon among surveyed arterial agencies. Roughly one-quarter of agencies report use of this technology in each survey from 2013 to 2020.

Open data feeds are not widespread among arterial agencies, with 20 percent of agencies *providing an open data feed* (e.g., to app developers, information service providers, or the public) and another 13 percent *planning to do so.*

Both wired and wireless telecommunications play a role.

Eighty-one percent of arterial agencies report use of at least one telecommunication technology, and 56 percent indicate use of both wired and wireless telecommunication technologies in providing communications between any of their ITS devices, and/or between ITS roadside devices and a central processing location.

- On average, arterial agencies indicate the use two to three different telecommunication technologies (2.5 on average), with wired technologies (75 percent) more commonly used than wireless technologies (62 percent).
- *Fiber optic cable* is the most commonly used wired technology (70 percent), and *Cellular (LTE-4G)* (40 percent) is the most commonly used wireless technology.

Use of CCTV for incident detection or verification continues to grow, but at a slower pace since 2016.

Since 2013, *CCTV* use for incident detection or verification has increased 14 percentage points to 42 percent, with a majority of the growth coming between 2013 and 2016 and plateauing since 2016.

Fifteen percent of arterial agencies report using *external data sources* for incident detection or verification in 2020, the first year it was measured, while *computer algorithms* have seen low use over the years (around 4 percent).

About one-fifth of arterial agencies use automated enforcement.

Among surveyed arterial agencies, 18 percent report using *automated enforcement.* The most common technology is *cameras*, with 16 percent of agencies reporting use. Trends in arterial automated enforcement technologies are relatively flat between 2016 and 2020.

Less than one-half of arterial agencies report being actively engaged in ITS cybersecurity planning.

About one-quarter of arterial agencies have a documented *ITS-specific cybersecurity policy* (24 percent) and an additional 15 percent are *developing a policy*. Among surveyed arterial agencies, 10 percent report experiencing a cybersecurity event affecting *Information Technology (IT) systems* in the last three years, and 3 percent report experiencing a cybersecurity event affecting *transportation operations.*

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

Roughly two-thirds (65 percent) of surveyed arterial agencies plan to *expand or upgrade* their current ITS in the next three years, and nearly one-half plan to *invest in new* ITS (47 percent).

Conclusions

The 2020 Arterial Survey provides some high-level insights that agencies can use to determine where technical assistance or outreach may be needed to increase adoption of ITS technologies. The survey responses and data trends also raise some questions that may merit further research and investigation.

The 2020 Arterial Survey shows that a number of ITS technologies experienced increasing levels of adoption since 2016. Among arterial agencies, the use of *pedestrian warning systems* increased significantly. However, deployment of other safety-related ITS remains relatively low.

The adoption of *detection technologies* at signalized intersections is nearly universal among arterial agencies (95 percent), with a large majority of agencies reporting the use of *inductive loops* and *video imaging* detection. For other technologies, such as *ASCT* and *TSP*, growth has generally been steady, but overall, less than one-third of surveyed arterial agencies have deployed these technologies. It would be helpful to understand agencies' perceived need for these technologies, and the challenges or barriers they face in deploying them in order to understand the opportunity for growth.

With respect to real-time traveler information methods, the use of *mobile apps* has increased, 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 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. Future surveys may want to address this question.

On cybersecurity, one-quarter of surveyed arterial agencies have an *ITS-specific cybersecurity policy*, and an additional 15 percent are currently *developing a policy*. Ten percent of agencies report experiencing a cybersecurity event that affected their *IT systems* and/or *transportation operations* in the last three years. Given the relatively large number of agencies that have not developed an *ITS-specific cybersecurity policy*, there is room for growth in this area.

Chapter 1. Introduction

Purpose of the Report

This report summarizes the **Arterial Management Survey** (also referred to as the Arterial 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 ITS Deployment Tracking Survey (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 one to two years during the goal measurement period. Following the goal period, the survey was conducted less regularly on a roughly three 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 a baseline 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 also was 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 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 Arterial Survey was administered to arterial management agencies (also referred to as arterial 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 appropriate respondent for the 2020 DTS. Replacement contacts were obtained when necessary.

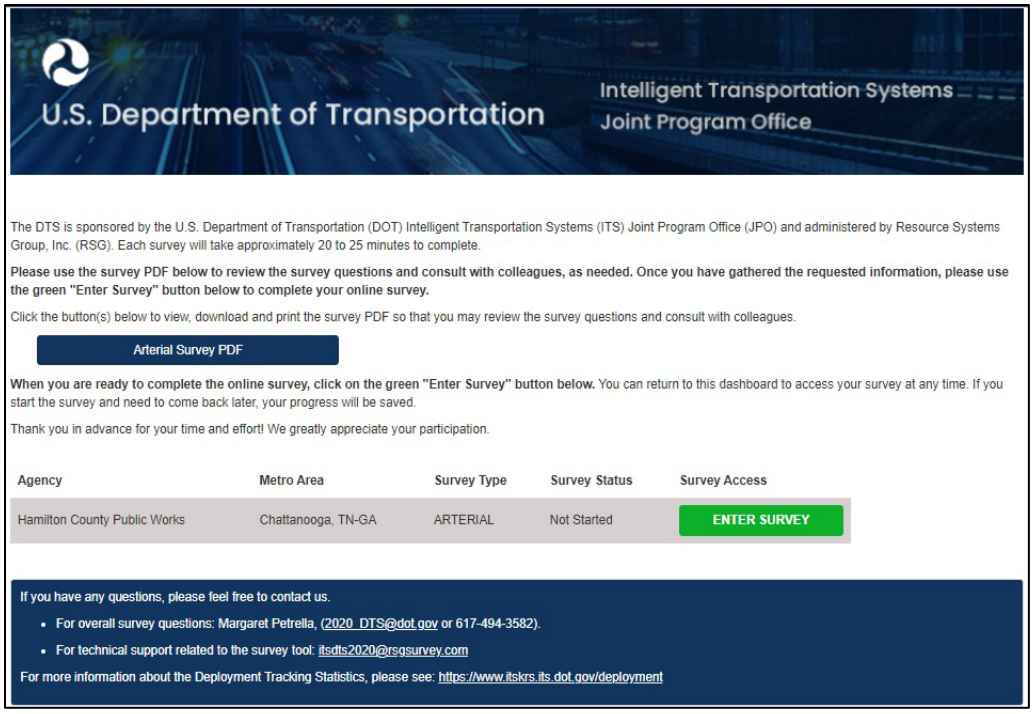
Survey Instruments

The 2020 Arterial 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 2020 Arterial Survey include real-time data collection, sources of external data, traffic signal management technologies, 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 Arterial Survey was administered using an online survey instrument and 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 an Arterial Survey dashboard).

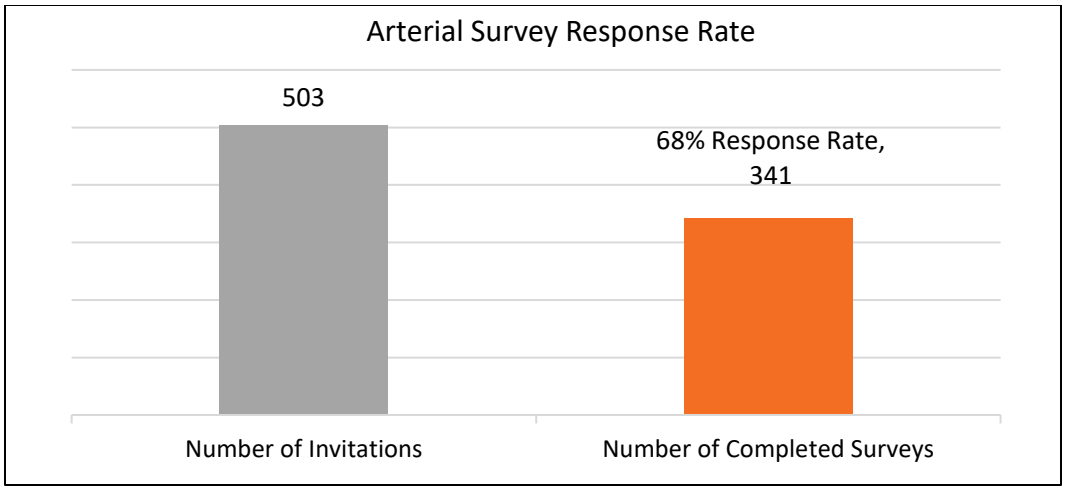


Source: USDOT

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 arterial contacts (i.e., soft launch) on December 3, 2020, prior to the full launch of the Arterial Survey. The full launch of the survey occurred on December 8, 2020. In total, 503 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 341 completes and a response rate of 68 percent (Figure 2).



Source: USDOT

Figure 2. Arterial 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 arterial findings. The 2010 data are not presented because the arterial survey was administered to a subset of agencies during that survey cycle, so the data are not comparable to other years. There also are cases where the question wording changed substantially over time, so it is not possible to show the trend. For most survey questions, trend is reported over the last three surveys (2013, 2016, 2020), and for a smaller subset of questions longer term trend is available (i.e., 2002-2020, excluding 2010). In some cases, to create a comparable trend to the 2020 survey, questions or response options were combined for previous surveys. Sample sizes for all survey years are provided in Appendix B and are not provided in longer trend charts due to space constraints. Table 1 describes how different magnitudes of change in the trend data are interpreted, providing a unform way of describing trend data.

Table 1. Interpretation of Trend Data

Change (positive or negative)	Growth (or Decline) Category
Zero percentage points	No growth or 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. Arterial Management Survey Findings

This chapter presents the 2020 Arterial 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 (i.e., percent of agencies) unless otherwise noted.

Signalized Intersection Technologies

Among surveyed arterial agencies, 95 percent report use of at least one detection technology at signalized intersections, with 4 percent of agencies reporting *no detection technologies* (and 1 percent missing a response). Figure 3 shows that 89 percent of agencies report using *inductive loop* detection, 82 percent report using *video imaging* detection and 60 percent report using *radar or microwave* detection. *Magnetometers*, a new response category for the 2020 survey, are used by 19 percent of surveyed agencies. In addition, 3 percent of agencies report using *infrared or thermal* detection, a category generated from responses to the *other* category,[2] and 1 percent of agencies reported *other* technologies.[3]

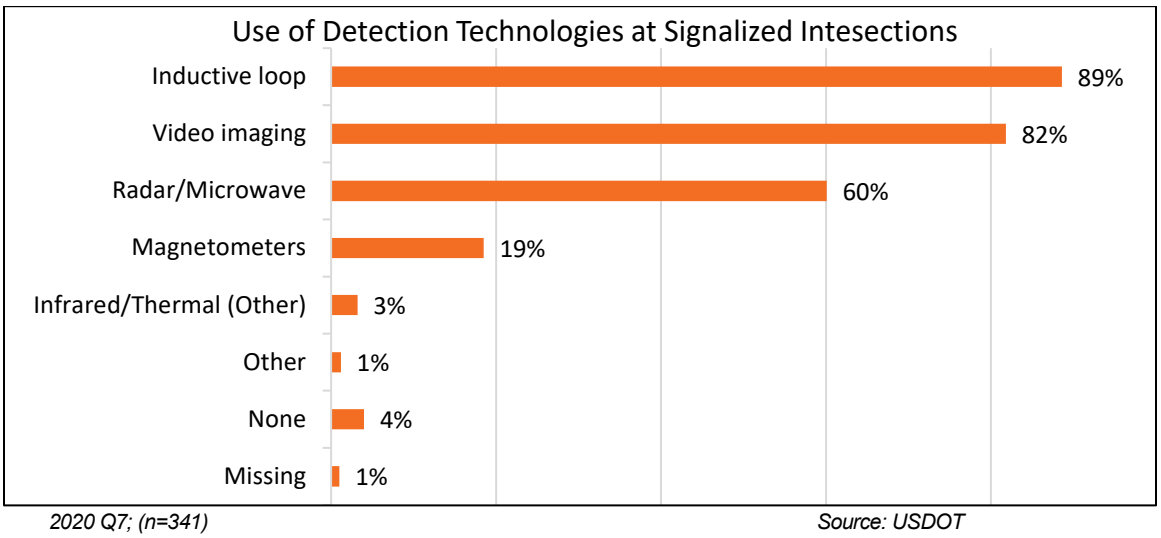
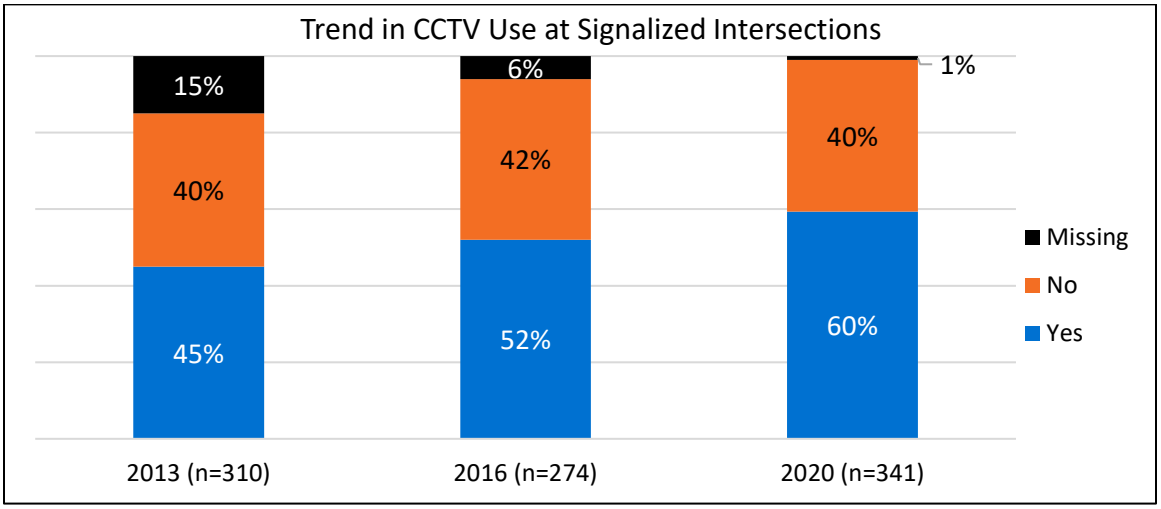


Figure 3. Use of Detection Technologies at Signalized Intersections

[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.

[3] Due to changes in question wording in 2020, trend is not shown for detection technologies at signalized intersections.

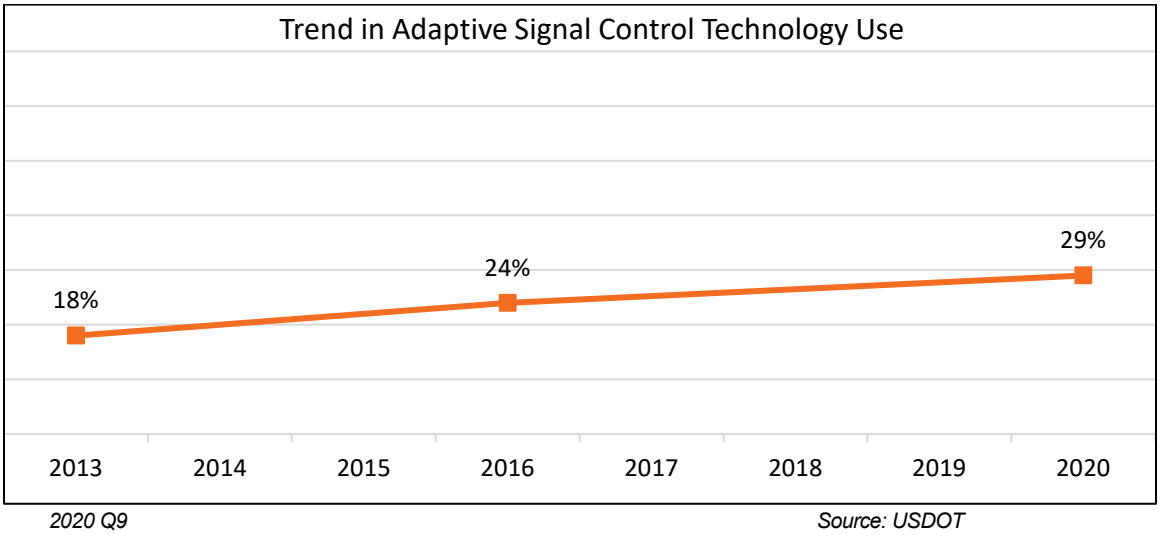
The use of *closed-circuit television (CCTV)* at intersections for traffic control shows steady growth since 2013 (Figure 4). Although the CCTV question changed in the 2020 survey, asking about general CCTV use (for traffic control) at intersections rather than requiring an estimate of the number of intersections covered by CCTV, the results still point to growth. *CCTV* use at intersections increased seven percentage points from 2013 to 2016 (from 45 percent to 52 percent) and eight percentage points from 2016 to 2020 (from 52 percent to 60 percent).



2020 Q8 *Source: USDOT*

Figure 4. Trend in CCTV Use at Signalized Intersections

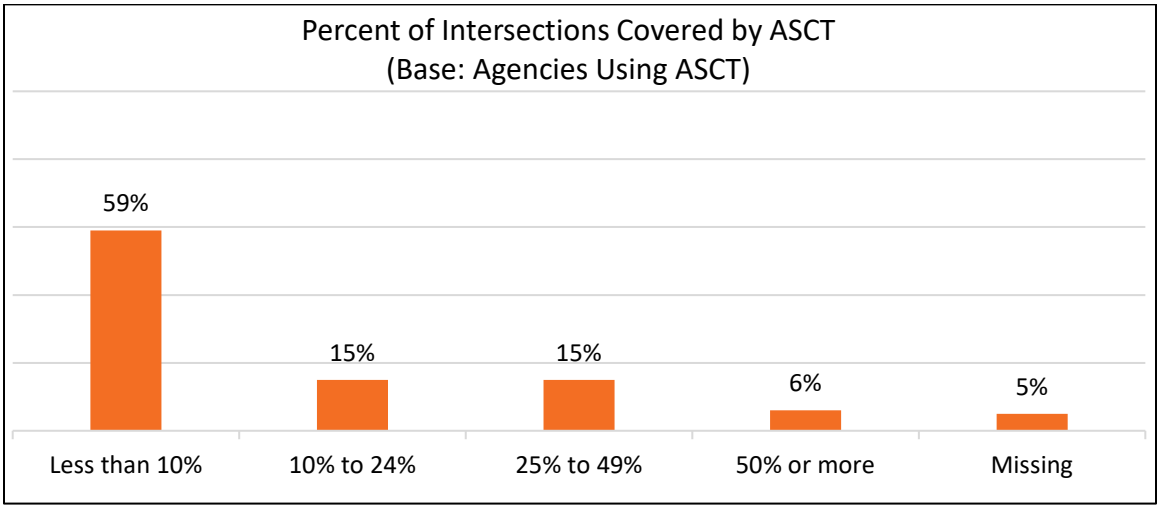
Figure 5 shows that use of *adaptive signal control technology (ASCT)* as an operational strategy to improve coordinated signal timing has seen increased adoption in recent years, increasing five to six percentage points in each of the two most recent survey cycles (2013 and 2016), from 18 percent in 2013 to 29 percent in 2020.



2020 Q9 *Source: USDOT*

Figure 5. Trend in Adaptive Signal Control Technology Use

Arterial agencies using ASCT tend to deploy these technologies at a small portion of their intersections (Figure 6), with most agencies reporting coverage of less than 10 percent of total signalized intersections.[4] Another 30 percent of agencies cover between 10 and 49 percent of signalized intersections, and 6 percent of agencies cover 50 percent or more of intersections. Future surveys may want to explore the extent to which agencies perceive a need for adopting and/or expanding ASCT in order to better understand the opportunity for growth for this technology.



2020 Q9a; (n=100) *Source: USDOT*

Figure 6. Percent of Intersections Covered by ASCT

As Figure 7 illustrates, *traffic signal preemption at rail crossings* (60 percent) shows moderate growth since 2013 (up six percentage points),[5] while adoption of *transit signal priority* has grown by a more significant 10 percentage points (to 28 percent) since 2013. Neither of these technologies, however, have seen notable growth in the last survey cycle. The adoption of *emergency vehicle preemption* has leveled off, with 75 percent indicating usage in 2020. Three percent of surveyed arterial agencies report deploying *truck signal priority* in 2020.[6]

[4] Coverage is calculated as the average across all agencies reporting ASCT of the number of reported intersections with ASCT divided by total reported signalized intersections. Missing responses indicate agencies which reported ASCT use but did not respond to the question regarding the number of intersections with ASCT.

[5] Previous surveys specified highway-rail grade crossings; the 2020 response option is a general rail grade crossing.

[6] Truck signal priority was not a response option in 2013.

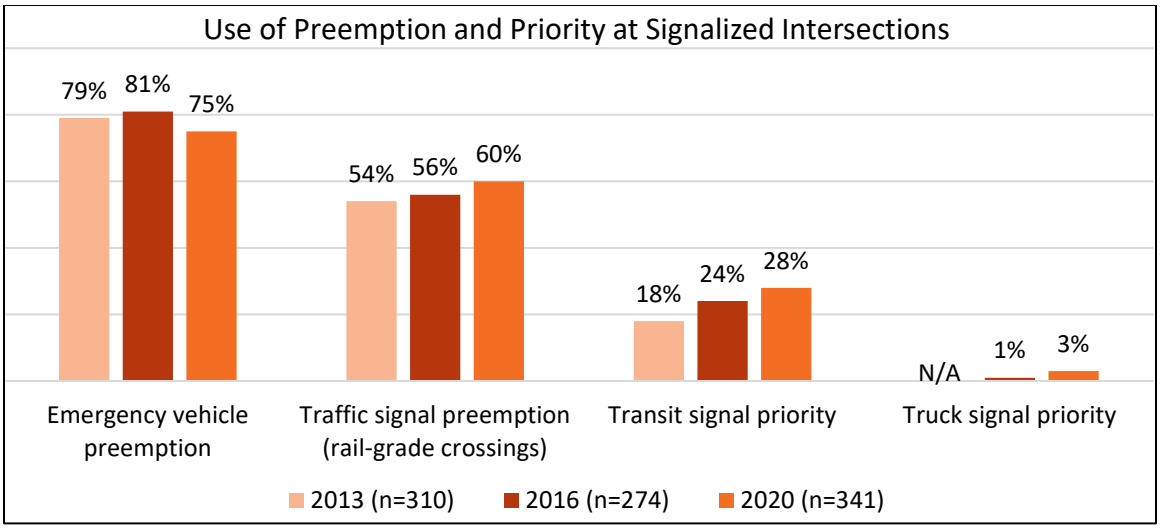


Figure 7. Use of Preemption and Priority at Signalized Intersections

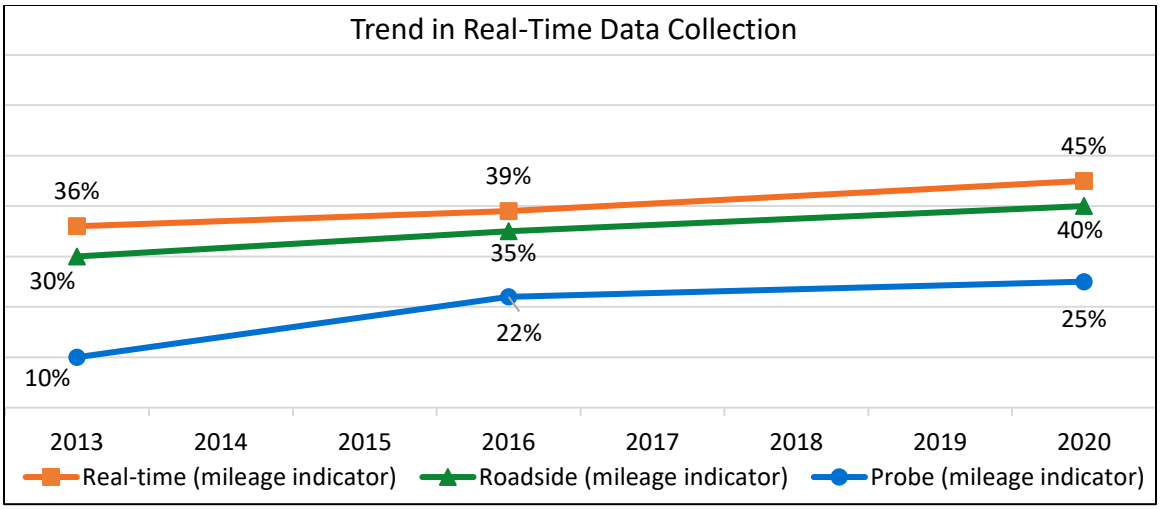
Approximately one-half of surveyed arterial agencies (52 percent) report participating in a regional program that actively coordinates traffic signals on arterials across jurisdictions (see Appendix C for additional survey results).

Real-Time Data Collection

Nearly one-half of surveyed arterial agencies (45 percent) report that some portion of their arterial centerline miles are covered by *real-time data collection*. 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 readers, license plate readers, Bluetooth readers, or in-vehicle GPS readers.

Figure 8 shows that use of *real-time data collection* on arterial roadways is up nine percentage points since 2013, with growth occurring at a higher rate between 2016 and 2020 (six percentage points) compared between 2013 and 2016 (three percentage points).[7] Use of *roadside infrastructure* grew by a similar amount since 2013, increasing evenly across the two survey cycles from 30 percent in 2013 to 40 percent in 2020. The percent of agencies indicating *vehicle probe reader* use increased significantly from 2013 to 2016 (up 12 percentage points to 22 percent), but shows signs of leveling off, with minimal growth since 2016 (up three percentage points to 25 percent).

[7] All usage indicators in Figure 8 are "mileage indicators" based on open-numeric questions asking for the total number of miles covered by each technology category (total real-time data collection, roadside infrastructure detection, or probe readers). Agencies indicating more than zero miles are adopters of the technology category.



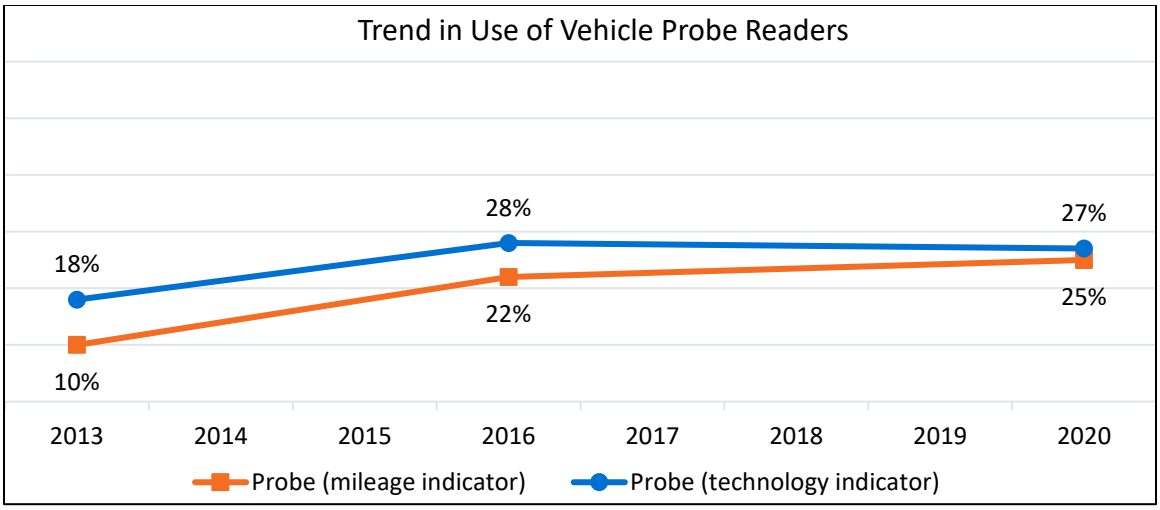
2020 Q3, Q4, Q5a *Source: USDOT*

Figure 8. Trend in Real-Time Data Collection

Vehicle Probe Readers

Figure 9 shows two measures for the percent of agencies using vehicle probe readers. One measure is derived from agencies reporting miles covered by vehicle probes (mileage indicator), and the other is derived from reported use of at least one vehicle probe reader technologies (technology indicator). In general, the mileage indicator tends to be less than the technology indicator, although both measures indicate that vehicle probe readers are used by roughly one-quarter of arterial agencies in 2020 (25 percent mileage indicator, 27 percent technology indicator). There is a significant increase in usage since 2013, with a 15 percentage point increase (mileage indicator) and a nine percentage point increase (technology indicator), although the trend in usage is relatively flat between 2016 and 2020.

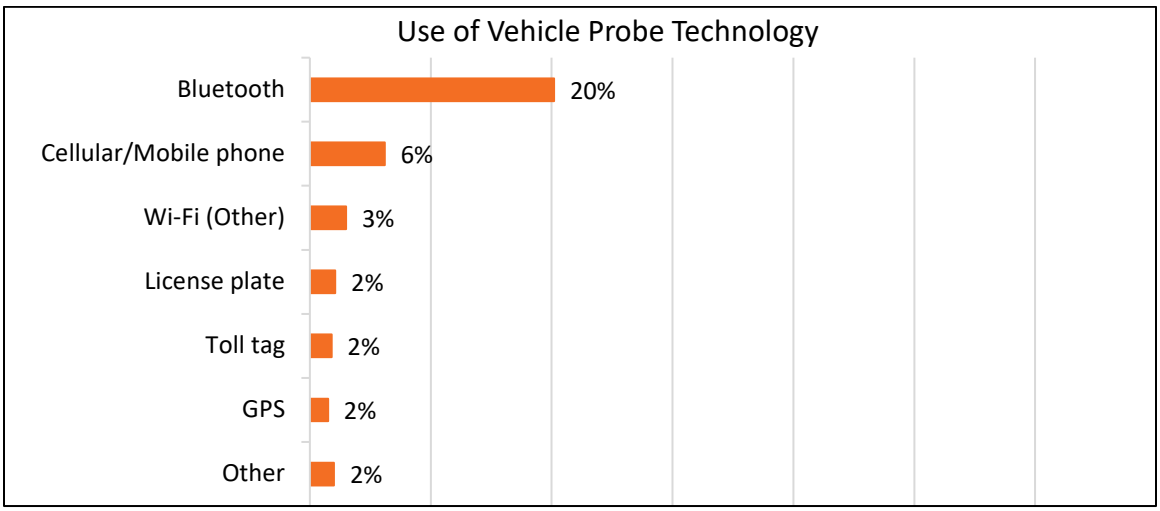
There has been some feedback from survey respondents indicating confusion as to whether to include purchased external data when reporting number of vehicle probe miles covered, so these results should be interpreted with caution. Future surveys will design measures that clearly distinguish agency deployment of their own vehicle probe technology versus agency use of external vehicle probe data.



2020 Q5a, Q5b *Source: USDOT*

Figure 9. Trend in Use of Vehicle Probe Readers

Among surveyed arterial agencies, *Bluetooth readers* (20 percent) are the most used vehicle probe technology for real-time data collection (Figure 10) and *cellular or mobile phone readers* are the second most commonly used (6 percent). All other vehicle probe technologies including *in-vehicle GPS*, *toll tag readers*, and *license plate readers* were each selected by 2 percent of arterial agencies. *Wi-Fi readers* (3 percent) is a response category developed based on the *other* responses, and a remaining 2 percent of agencies reported o*ther* which includes any respondents reporting *purchased data* (1 percent). Seventy percent of agencies report *no use of vehicle probe technologies*, and 3 percent of agencies were missing a response. Trend for vehicle probe technologies (not shown) is generally flat since 2013, apart from the trend in use of Bluetooth readers.[8]



2020 Q5b; (n=341) *Source: USDOT*

Figure 10. Use of Vehicle Probe Technology

[8] Adoption of Bluetooth readers increased significantly from 2013 to 2016 (a 10 percentage point increase from 10 percent to 20 percent), but there has been no change in deployment since 2016.

External Data Sources

A more comprehensive question was added to the 2020 DTS to capture the use of data collected outside of arterial agencies (external data). Results shown in Figure 11 suggest that external data are emerging as another source of real-time traffic collection data. Overall, 59 percent of agencies report using at least one external data source. *Publicly available mapping and traffic information applications* are the most used at 40 percent, closely followed by data from *third party commercial providers* (34 percent) and *notifications from the public* (34 percent). Use of information from *other transportation agencies (e.g., State DOT, MPOs, etc.)* was not an original response category, but 5 percent of arterial agencies wrote this option in under the *other* response. An additional 1 percent of agencies report using *other* external data sources. A sizeable number of surveyed arterial agencies (30 percent) selected the *don't know* option, and 11 percent indicate *no sources of external data* are used.

Future surveys may want to explore the ways in which agencies are using these data to complement or fill in the gaps of their own real time data collection, as well as how they are using these data to manage traffic and safety operations.

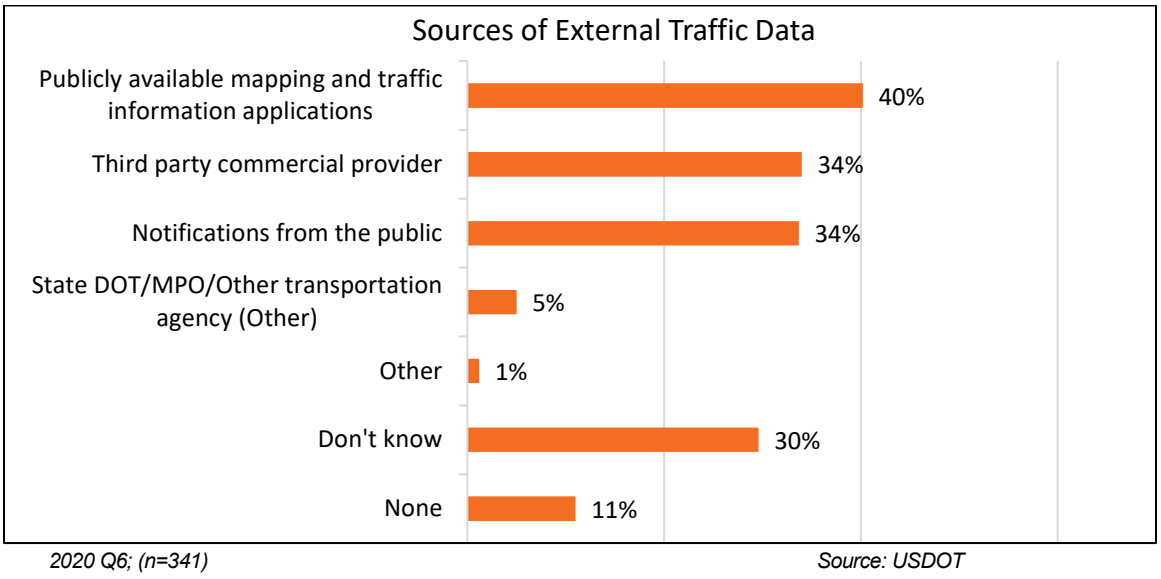


Figure 11. Sources of External Traffic Data

Traveler Information

Approximately one-half of surveyed arterial agencies (54 percent) disseminate real-time traveler information about arterials (Figure 12). The most common method is *social media* (38 percent). A similar number of arterial agencies report using *websites* (35 percent), and somewhat fewer report use of *dynamic message signs (DMS)* (27 percent). Twenty one percent of agencies use *email or text alerts,* and 15 percent are using *511*. Overall, about one-quarter (22 percent) of arterial agencies indicate use of either a *custom-built app* or a *third-party mobile app* (collectively, *mobile apps*). Individually, 17 percent report use of *third-party apps* and 10 percent report use of *custom-built apps*. Six percent are using *highway advisory radio (HAR)* and 2 percent report using *press release or other media* in the *other* category, and 1 percent report *other* traveler information dissemination methods. An additional 42 percent of agencies report *no real-time traveler information dissemination*, and 4 percent did not respond to this question.

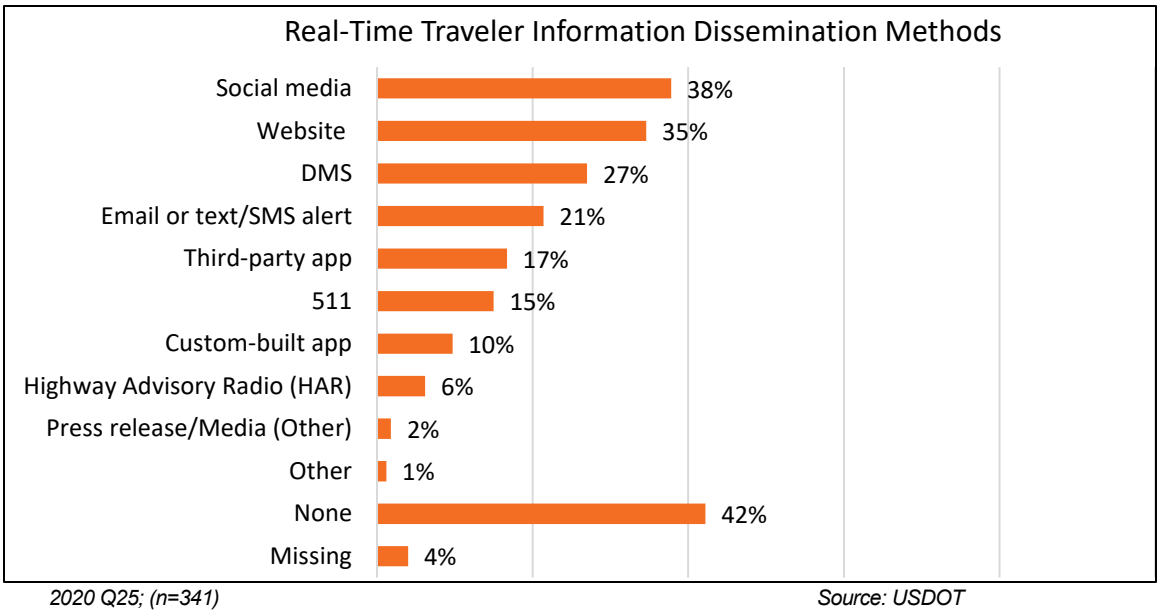
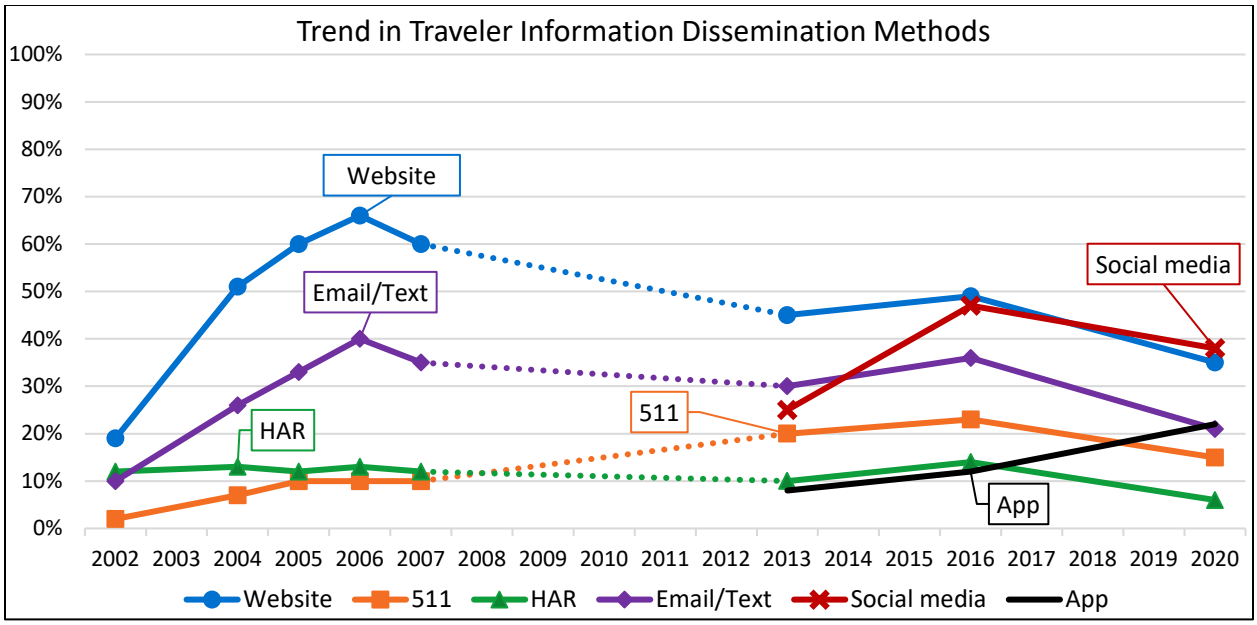


Figure 12. Real-Time Traveler Information Dissemination Methods

As seen in Figure 13, *mobile apps* are the only dissemination method showing increased usage by surveyed arterial agencies in 2020 (up 10 percentage points). All other surveyed dissemination methods show a decline from 2016 usage levels. While question wording changes may have contributed to some of the changes since 2016 (response options were updated and the question specifically asked about real-time information), the trend may also be due in part to the evolution of the information technology market overall.

Social media is the most used method of traveler information dissemination, despite declining 11 percentage points to 38 percent since 2016. *Website* usage declined even further (14 percentage points), as did *email or text alerts*, which declined by 15 percentage points (from 36 percent to 21 percent since 2016). Older technologies, such as *511* (15 percent) and *HAR* (6 percent) are the least used methods in 2020, each down eight percentage points since 2016.

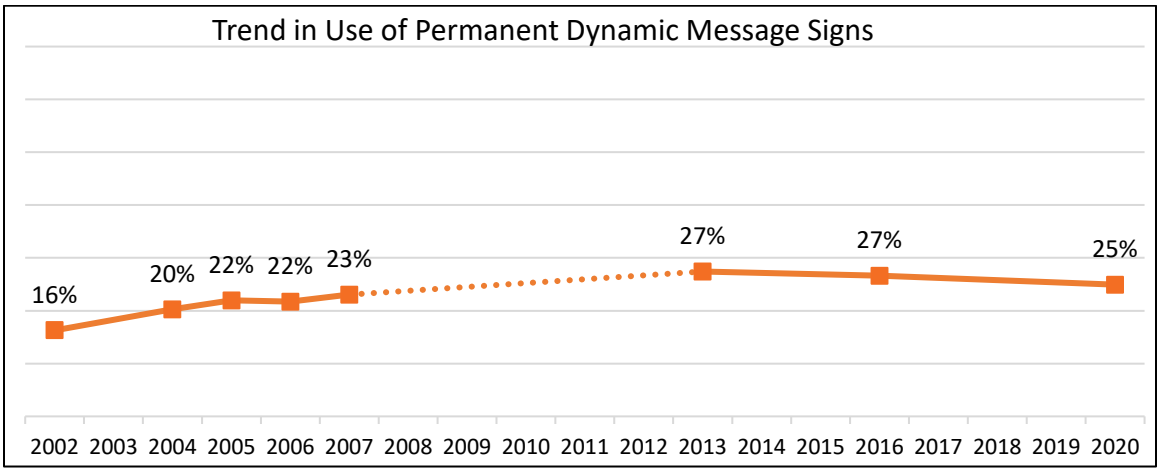


2020 Q25 *Source: USDOT*

NOTES: Dashed lines indicate data are not available or are not comparable.

Figure 13. Trend in Traveler Information Dissemination Methods

In a separate question on the number of *permanent DMS* deployed for traveler information, 25 percent of surveyed arterial agencies report use of this technology in 2020.[9] While usage increased from 16 percent in 2002 to 23 percent in 2008, it has remained stable since then with roughly one-quarter of agencies reporting use of this technology (Figure 14).



2020 Q24 *Source: USDOT*

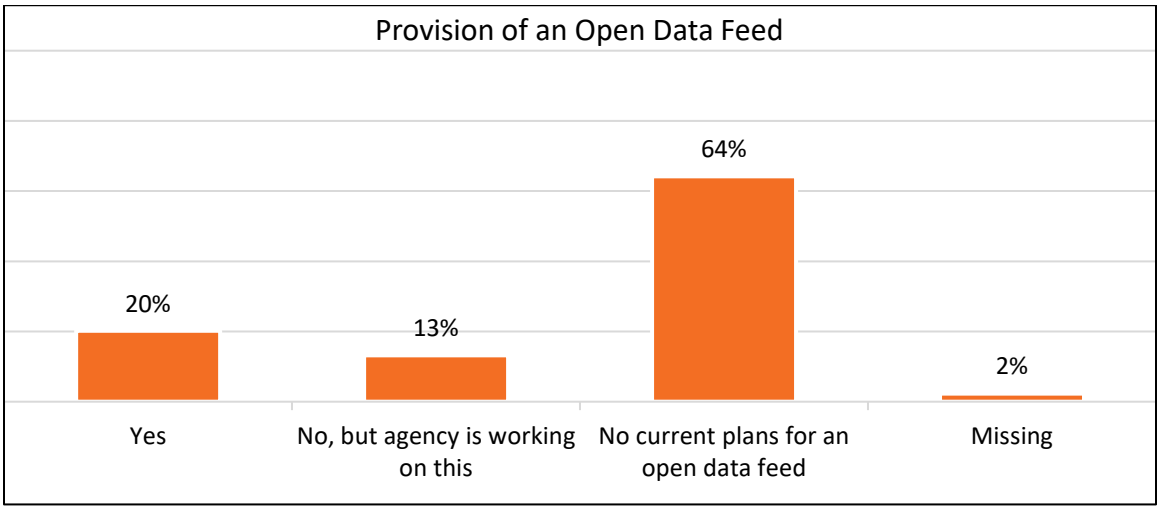
NOTE: Dashed lines indicate data are not available or are not comparable

Figure 14. Trend in Use of Permanent Dynamic Message Signs

[9] This value is an indicator variable for the percent of agencies that report deploying permanent DMS (25 percent). The percent of agencies that report deploying DMS for real-time traveler information in 2020 is slightly higher (27 percent). This difference may be due to slight differences in question wording (see Appendix A for questions).

Open Data Feed

Open data feeds are not widely used among surveyed arterial agencies, with 20 percent of agencies *providing an open data feed* (e.g., to app developers, information service providers, or the public) and another 13 percent *planning to do so* (Figure 15). A majority of arterial agencies (64 percent) report that they have *no current plans* for an open data feed. Monitoring of this trend could inform the timeline of when open data feeds will be deployed by the 13 percent of agencies who are currently working on using this method of information sharing.

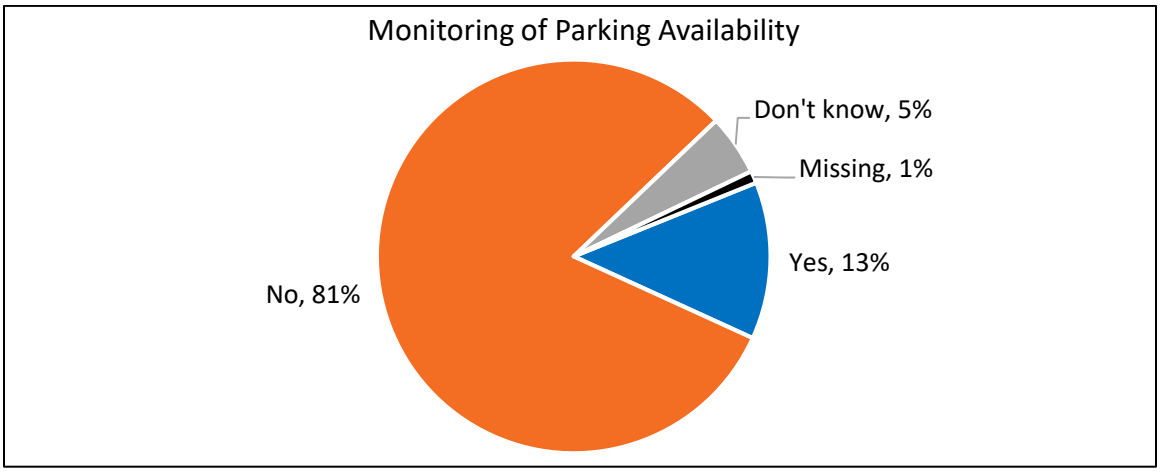


2020 Q26; (n=341) *Source: USDOT*

Figure 15. Provision of an Open Data Feed

Parking Management Systems

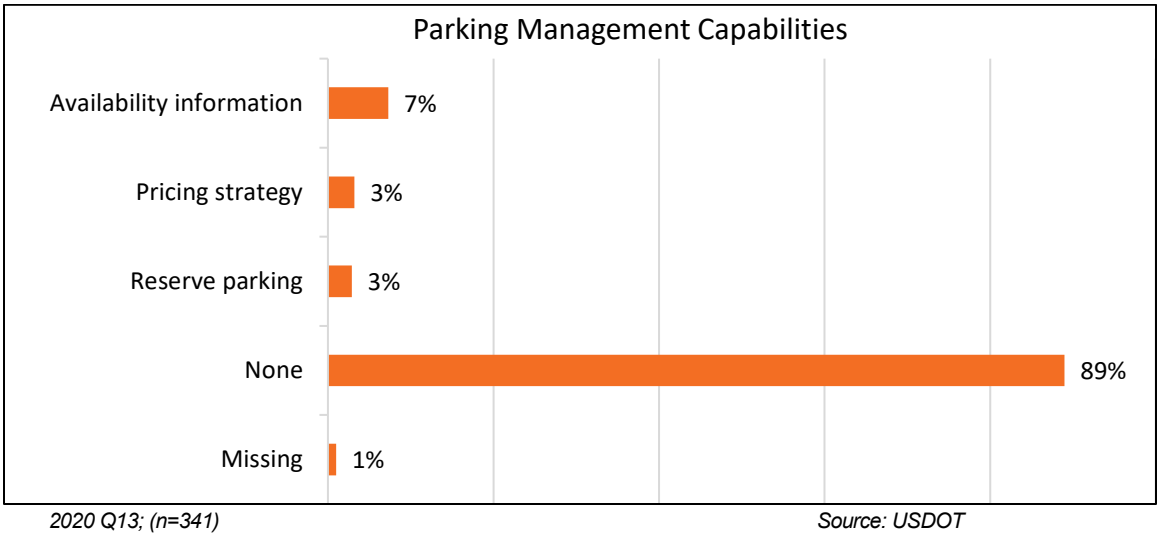
Use of parking management systems is relatively uncommon among surveyed arterial agencies. Thirteen percent of agencies report *monitoring parking availability* (Figure 16). It should be noted that these findings do not reflect the overall incidence of parking management systems in large and medium sized metropolitan areas, as the private sector also is involved in parking management.



2020 Q12; (n=341) *Source: USDOT*

Figure 16. Monitoring of Parking Availability

About 10 percent of agencies report using at least one type of parking management capability (Figure 17). The most common type is the dissemination of *parking availability information*, which is used by 7 percent of agencies. Approximately 3 percent of agencies report using a *pricing strategy,* and 3 percent of agencies report allowing drivers to *reserve parking*. Trend in parking management capabilities has been relatively flat since 2016 for all three technologies.



2020 Q13; (n=341) *Source: USDOT*

Figure 17. Parking Management Capabilities

Telecommunications

Among surveyed arterial agencies wired technologies (75 percent) are more commonly used than wireless technologies (62 percent) in providing communications between any of their ITS devices, and/or between ITS roadside devices and a central processing location (typically in data collection and dissemination). Among surveyed arterial agencies, 56 percent indicated use of both wired and wireless telecommunication technologies.[10] On average, arterial agencies indicate the use of 2.5 telecommunication technologies.

As is shown in Figure 18, the most common wired telecommunications technology is *fiber optic cable* (70 percent), which is used by more than twice as many agencies as the next most common wired technology, *twisted copper pair or twisted wire pair* (29 percent). Other wired telecommunications technologies used include *data cable over modem* (12 percent), *coaxial cable* (12 percent), and *Digital Subscriber* Line technology (8 percent).

The most common wireless technology among surveyed arterial agencies is *Cellular (LTE-4G)* (40 percent), followed by *Dedicated Short Range Communications (DSRC)* (18 percent), *Wi-Fi* (13 percent), *Cellular (GPRS – 2G or 3G)* (12 percent) and *microwave* technology (11 percent). Less commonly used technologies include *5G New Radio and small cell infrastructure*[11] (5 percent), *ultra-wideband* (3 percent), *LTE-Cellular V2X* (3 percent)[12] and *mobile or fixed service satellite* (2 percent). New response categories generated from the *other* category text responses were *900 MHz* (2 percent) and *4.9 GHz* communications (1 percent). An additional 9 percent of agencies report *other* wired or wireless telecommunications technologies. Notably, 19 percent of agencies were missing a response to this question and did not select any technologies.

[10] Six percent of agencies report only a wireless option. It is not clear if these agencies are able to operate all ITS systems using only wireless technology, or if the respondents did not understand the question.

[11] At this time, *5G New Radio* is not yet commercially available, but respondents may be using *small cell infrastructure* with 4G radios.

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

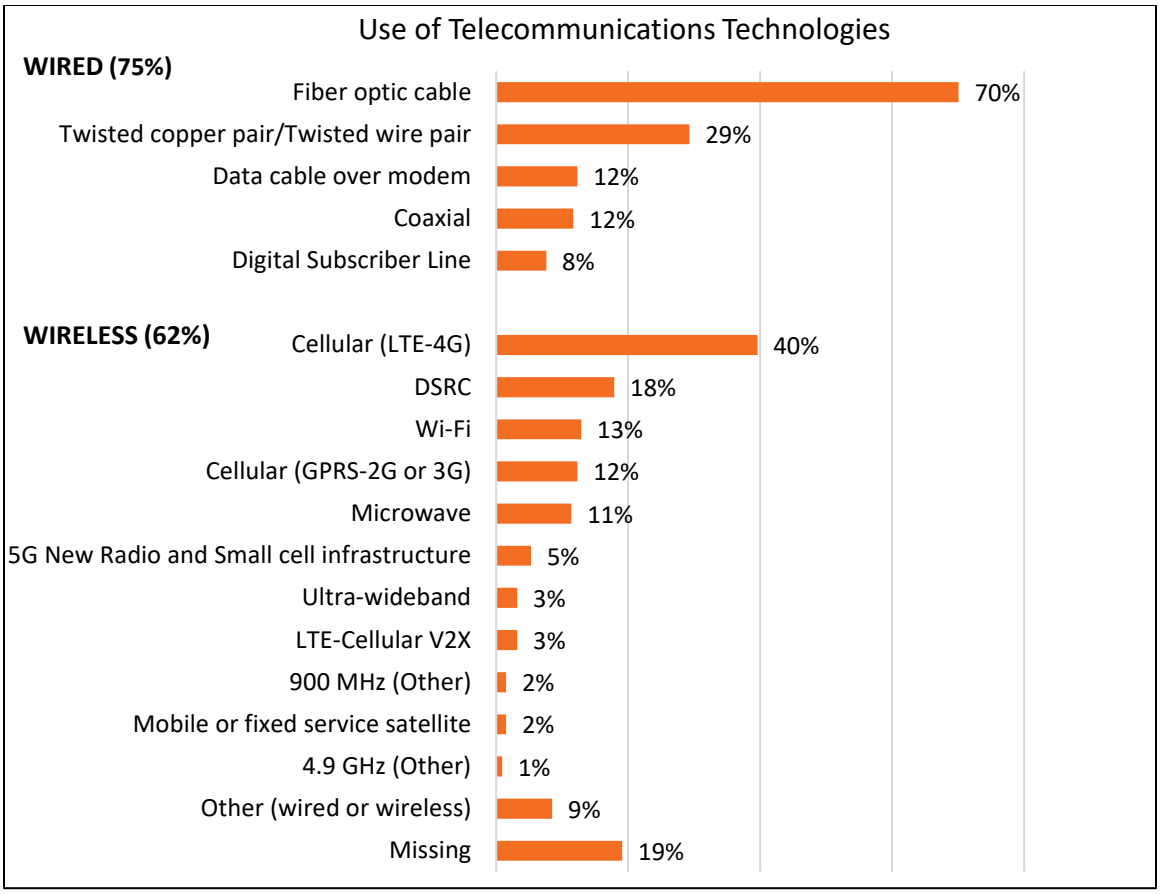
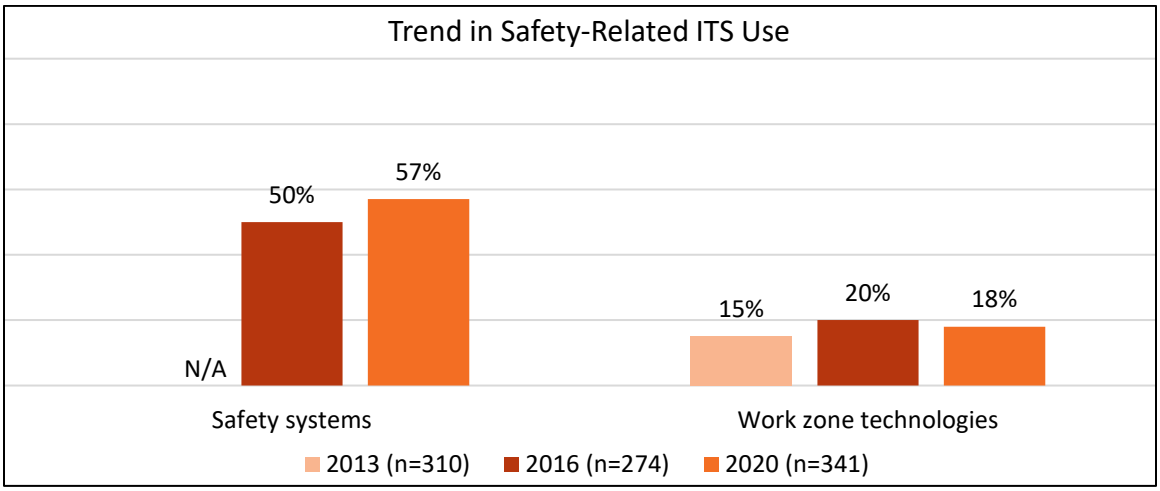


Figure 18. Use of Telecommunications Technologies

Safety-Related Technologies

Figure 19 shows that among surveyed arterial agencies there has been moderate growth in the use of safety systems technologies. In 2016, 50 percent of agencies reported use of at least one *safety system*, and in 2020, this increased to 57 percent of agencies.[13] Use of *work zone technologies* among arterial agencies is low, with 18 percent of agencies reporting use, and a relatively flat trend since 2013.



2020 Q17a, Q22 *Source: USDOT*

Figure 19. Trend in Safety-Related ITS Use

Safety Systems Technologies

The increase in arterial safety system technologies use is driven by a substantial increase in the use of *pedestrian warning systems* (Figure 20). Since 2016, use of *pedestrian warning systems* increased significantly, up 13 percentage points from 34 percent to 47 percent. Follow-up questions indicate that about two-thirds of agencies deploying *pedestrian warning systems* are doing so at intersections (see Appendix C for additional survey results), covering 10 percent of them, on average. Future surveys should continue to monitor both the use and coverage of pedestrian safety technologies to better understand the use and impact of these systems.

Aside from the increase in pedestrian warning systems, trends in arterial safety systems use are relatively flat since 2016. The 57 percent of arterial agencies who deploy safety systems report use of 1.7 technologies, on average. The next most common technologies, *dynamic curve warnings* and *over-height warnings*, are used by 9 percent of agencies in 2020. *Dynamic speed limits* (8 percent), *bicyclist warnings* (6 percent) and *queue warnings* (5 percent) are less commonly used by arterial agencies. Four percent of surveyed agencies report using *wrong way detection*, a new response category in 2020. The *dynamic speed feedback* (3 percent) response category was developed based on write-in responses to the *other*

[13] 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).

category. In addition, another 5 percent of agencies report use of *other* safety systems, which includes 2 percent of agencies reporting *rectangular rapid-flashing beacons (RRFB)*.[14]

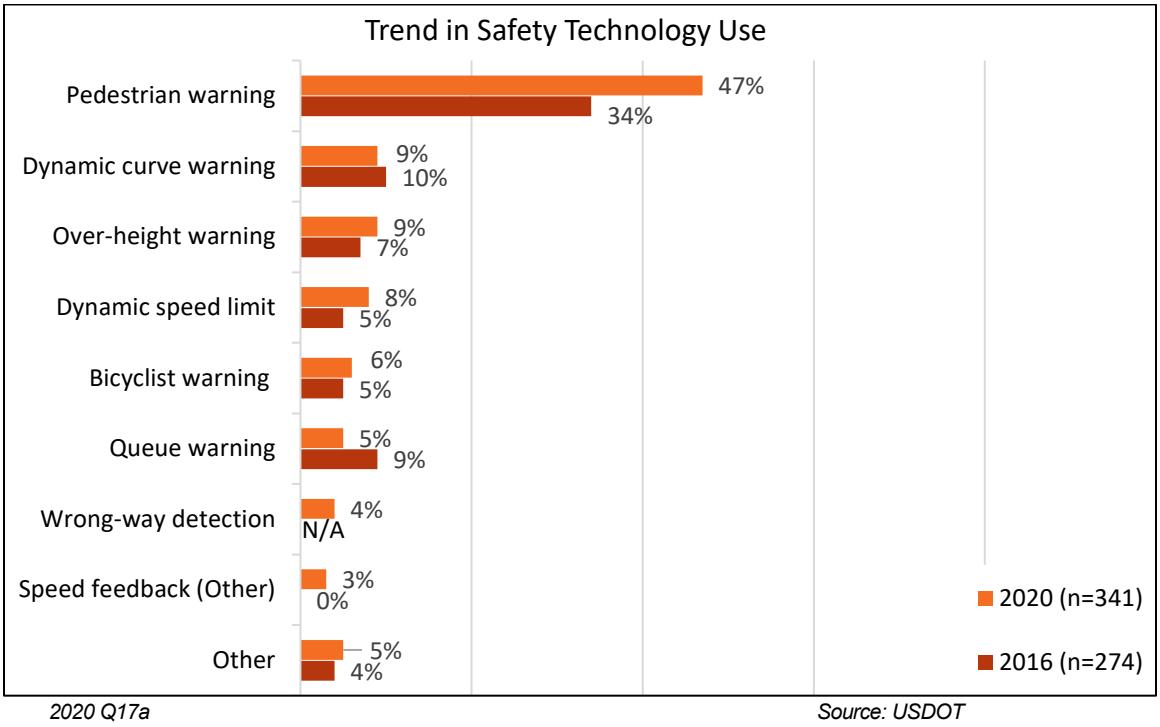


Figure 20. Trend in Safety Technology Use

[14] The 2020 survey included a response option for intrusion alarms, which was reported by 0 percent of agencies.

Work Zone Technologies

Work zone technology use is low among surveyed arterial agencies. In 2020, 18 percent indicate use of any work zone technology. Figure 21 shows the most common technologies deployed are *temporary traffic signals* (12 percent) and *portable CCTV* (7 percent). Other response options mentioned by no more than 5 percent of agencies were *portable traffic monitoring devices* (5 percent), *travel time systems* (4 percent), *queue detection* (3 percent), *variable speed limit* (2 percent) and *dynamic lane merge* (1 percent). *Portable DMS* (2 percent) was generated from responses to the *other* response option, and an additional 2 percent of agencies report some *other* work zone technology.

Most work zone technologies show relatively stable usage between 2013 and 2020. *Temporary traffic signals*, the most common work zone technology, was a new response category in the 2020 survey, so trend cannot be assessed.

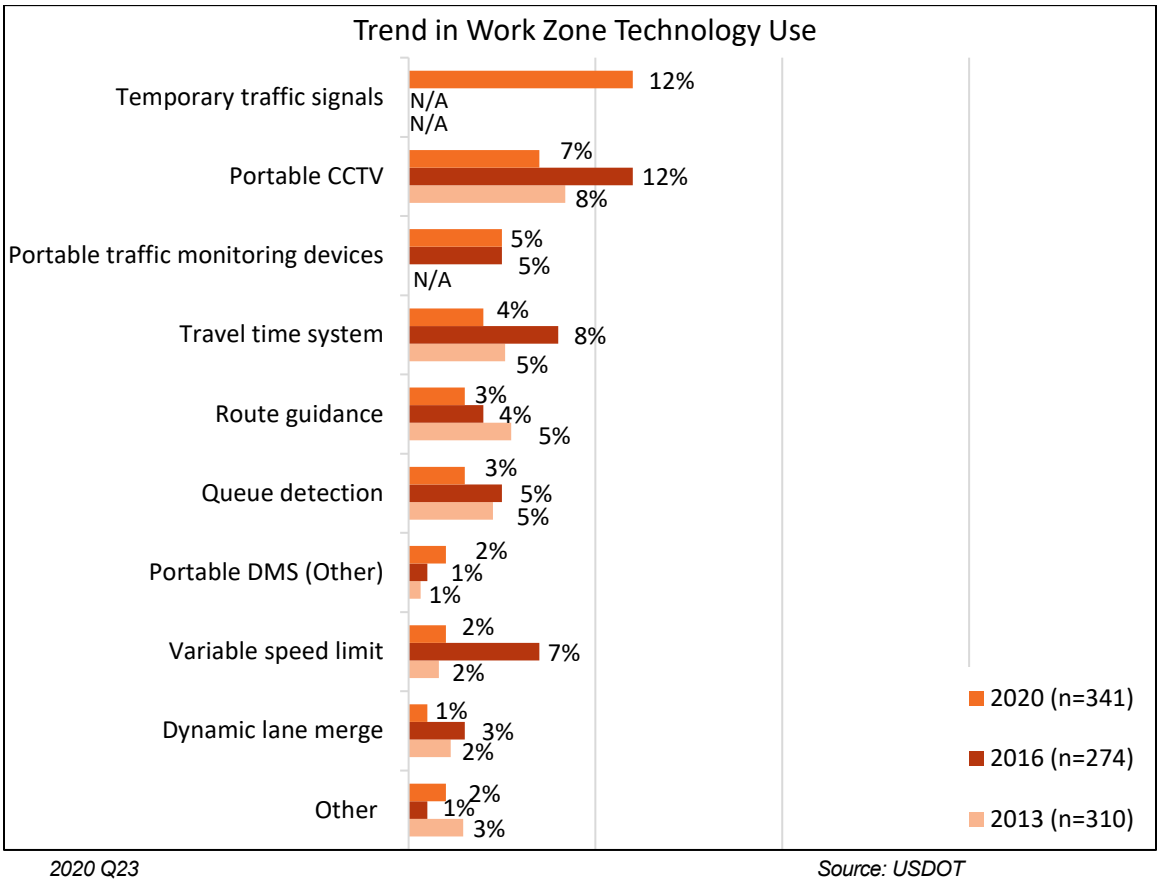
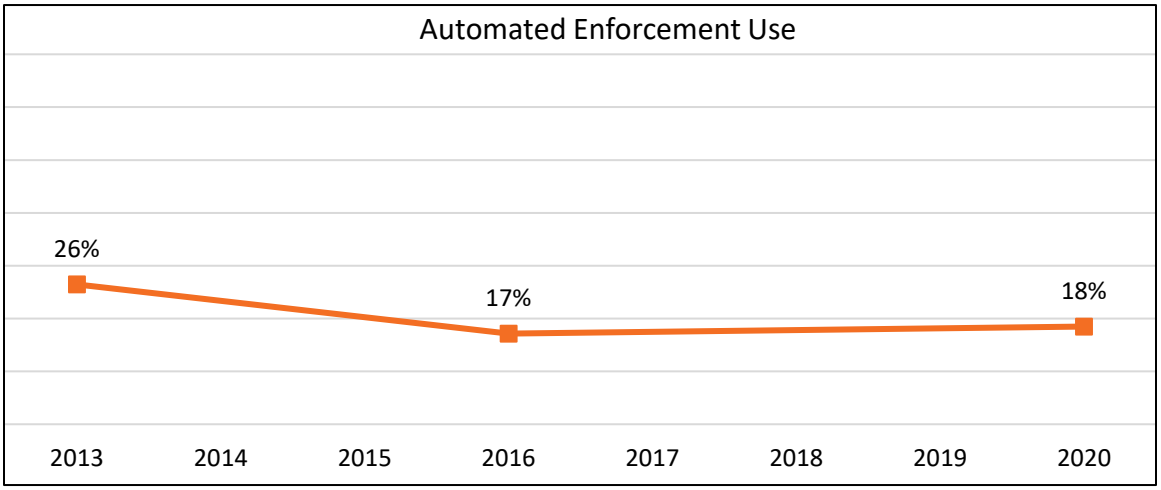


Figure 21**. Trend in Work Zone Technology Use**

Automated Enforcement

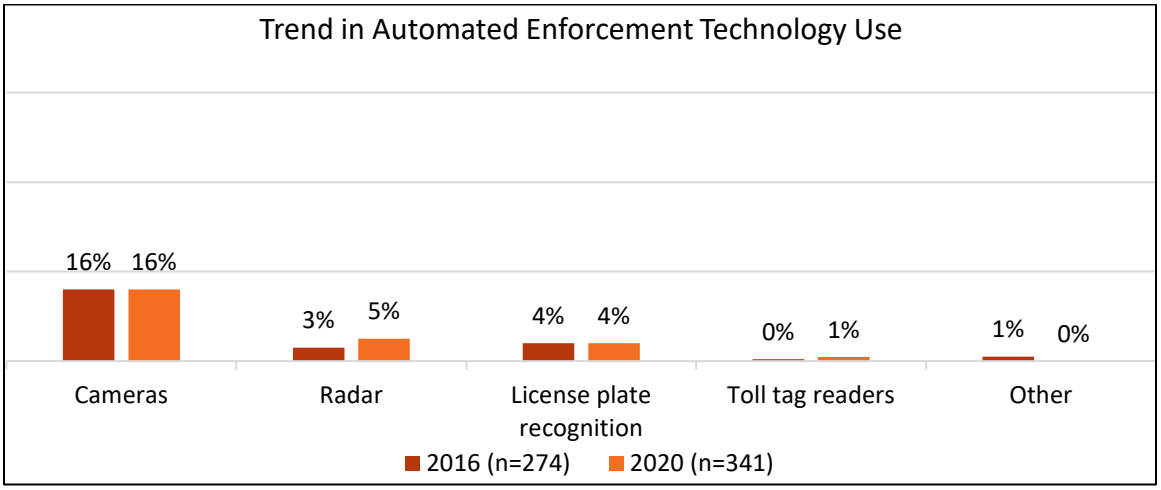
Among surveyed arterial agencies, 18 percent report using *automated enforcement* (Figure 22). Trends in arterial automated enforcement use show a significant decline between 2013 and 2016 (from 26 percent to 17 percent) and essentially no change between 2016 and 2020.



2020 Q14 *Source: USDOT*

Figure 22. Automated Enforcement Use

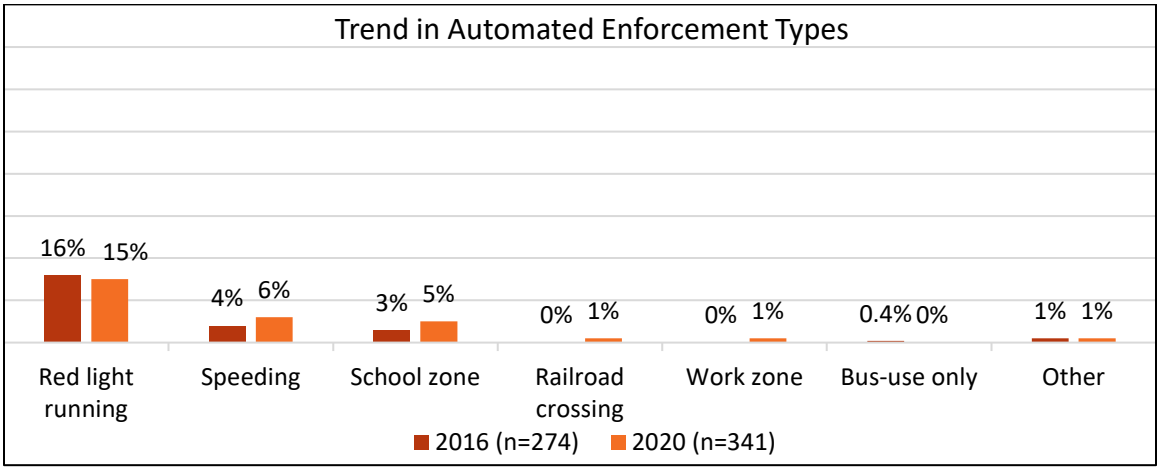
The most common automated enforcement technology is *cameras*, with 16 percent of agencies reporting use (Figure 23). Five percent of agencies report *radar*, followed by *license plate recognition* at 4 percent and *toll tag readers* at 1 percent. The trend is flat between 2016 and 2020.



2020 Q15 *Source: USDOT*

Figure 23. Trend in Automated Enforcement Technology Use

Figure 24 shows that the most common arterial automated enforcement type is *red light running* enforcement, with 15 percent of agencies reporting use. The second most common type is *speeding* enforcement (6 percent), followed by *school zone* enforcement (5 percent). Less commonly reported types of automated enforcement are *railroad crossing* (1 percent), *work zone* (1 percent), *bus-use only* (0 percent) and *other* (1 percent) enforcement. In 2020, usage levels are similar to those from 2016 for all surveyed automated enforcement types.

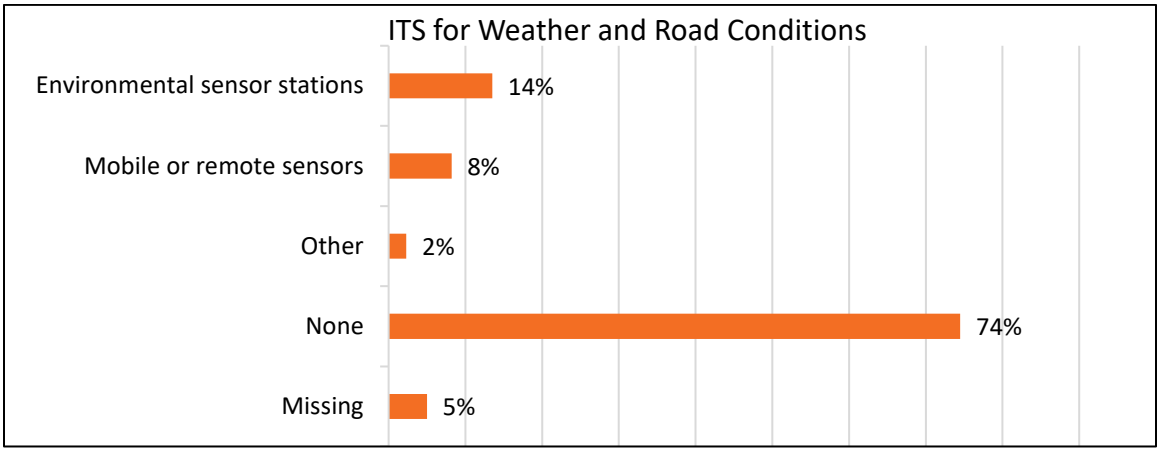


2020 Q16 *Source: USDOT*

Figure 24. Trend in Automated Enforcement Types

ITS for Weather and Road Conditions

Among surveyed arterial agencies, 74 percent report that they *do not* use ITS to collect weather and road condition information on arterials (Figure 25*). Environmental sensor stations* are the most common type of ITS used to collect weather and road condition information (14 percent), while *mobile or remote sensors* (8 percent) and *other* technologies (2 percent) are less common. In a separate question, 17 percent of arterial agencies report that they adjust traffic signal timing in response to inclement weather or road weather conditions (see Appendix C for additional survey results).

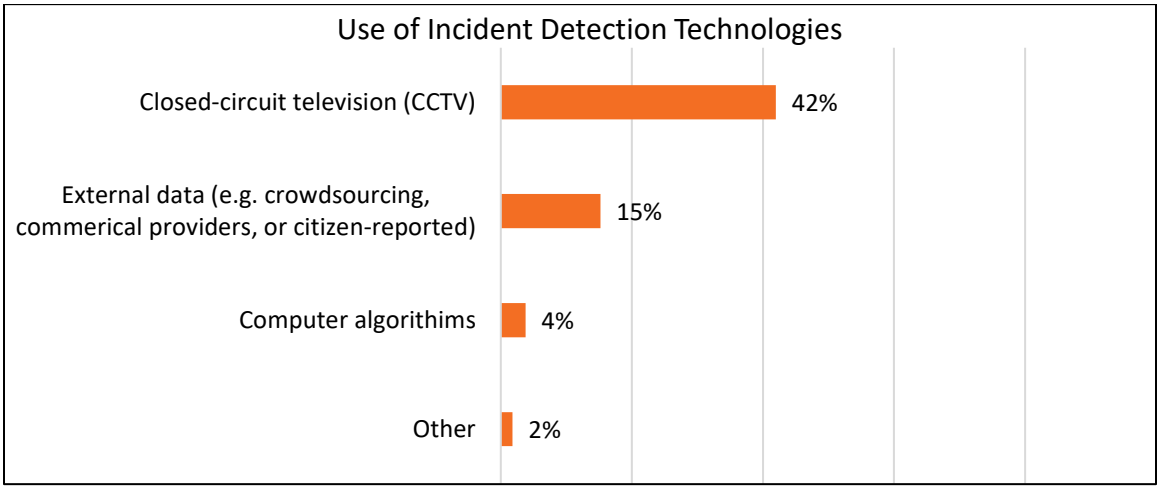


2020 Q18; (n=341) *Source: USDOT*

Figure 25. ITS for Weather and Road Conditions

Incident Detection and Verification

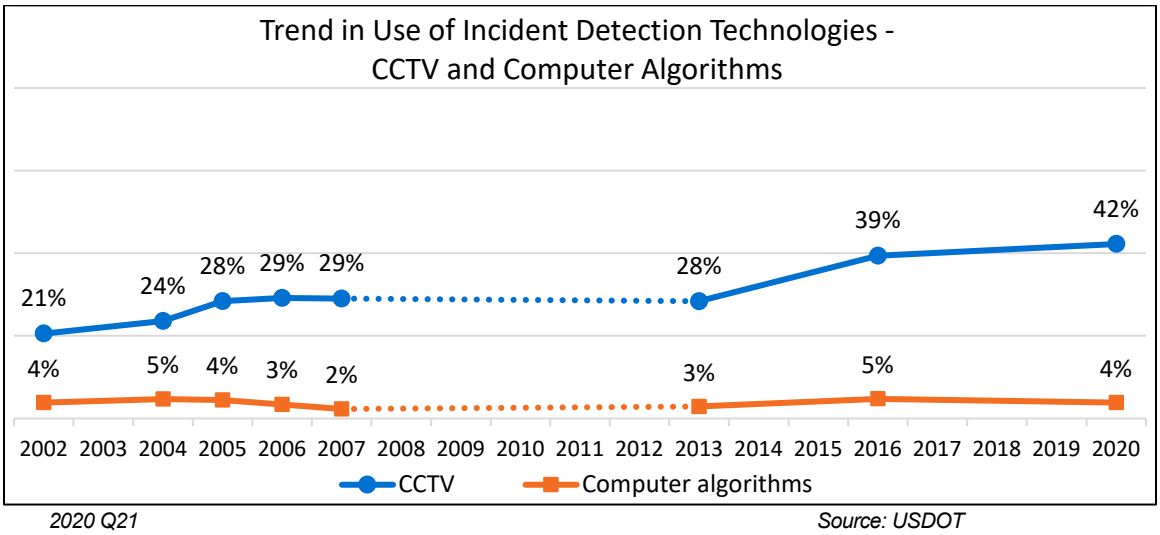
In 2020, 42 percent of surveyed arterial agencies report use of *CCTV,* and 15 percent of agencies report use of *external data sources* for incident detection or verification. Four percent report using *computer algorithms*, and 2 percent report using *other* incident detection or verification methods (Figure 26).



2020 Q21; (n=341) *Source: USDOT*

Figure 26. Use of Incident Detection Technologies

The trend in arterial incident detection or verification use has been flat for *computer algorithms* since 2013 (Figure 27). For *CCTV*, 28 percent of agencies report use in 2013, which increased to 39 percent in 2016. Since 2016, the trend has been flat, with 42 percent of agencies reporting use of *CCTV* for incident detection or verification in 2020.



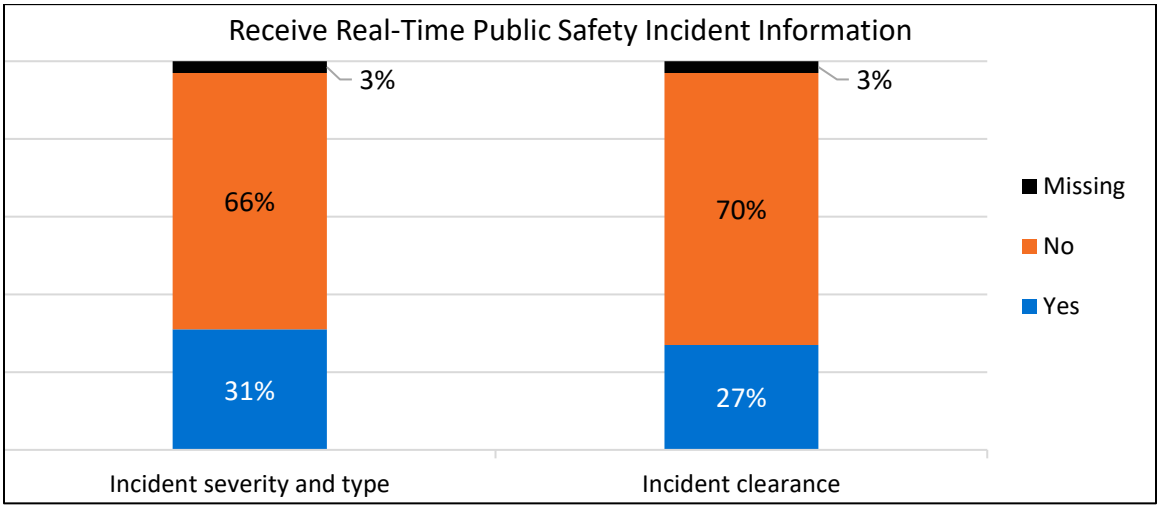
2020 Q21 *Source: USDOT*

NOTE: Dashed lines indicate data are not available or are not comparable

Figure 27. Trend in Use of Incident Detection Technologies – CCTV and Computer Algorithms

Agency Coordination

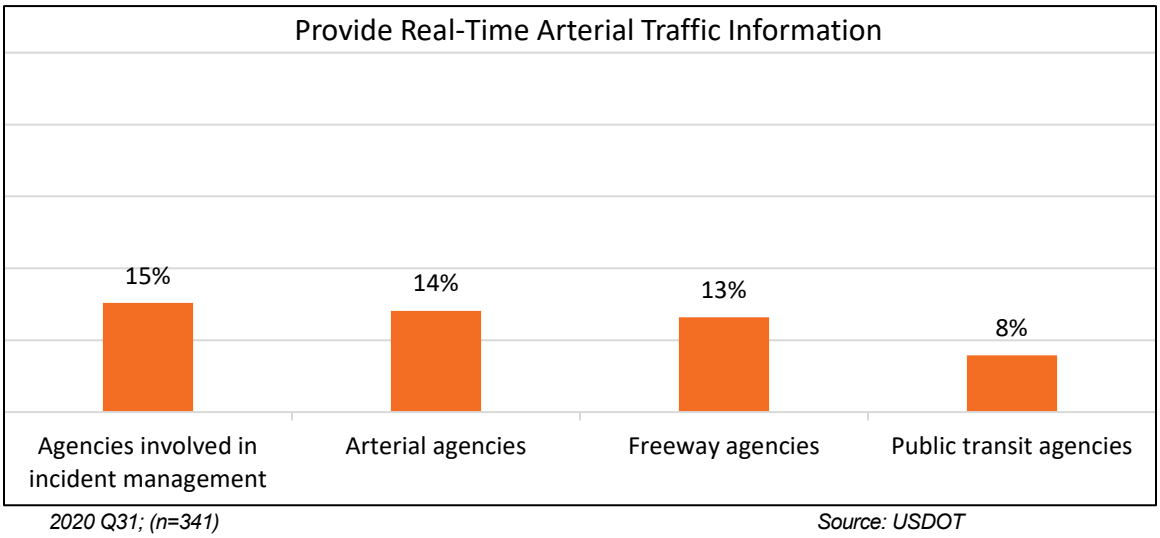
In 2020, 31 percent of surveyed arterial agencies report receiving *incident severity and type* information from a public safety agency, and 27 percent report receiving *incident clearance* information (Figure 28). The trend between 2016 and 2020 for these measures is flat (not shown).



2020 Q30; (n=341) *Source: USDOT*

Figure 28. Receive Real-Time Public Safety Incident Information

Overall, about one-fifth of arterial agencies provide real-time arterial traffic information to other agencies. In 2020, providing information to *agencies involved in incident management* (15 percent), *arterial management agencies* (14 percent) and *freeway management agencies* (13 percent) were more common than providing information to *public transit agencies* (8 percent) (Figure 29). The trends in providing real-time arterial traffic information to other agencies (not shown) have been flat since 2013.



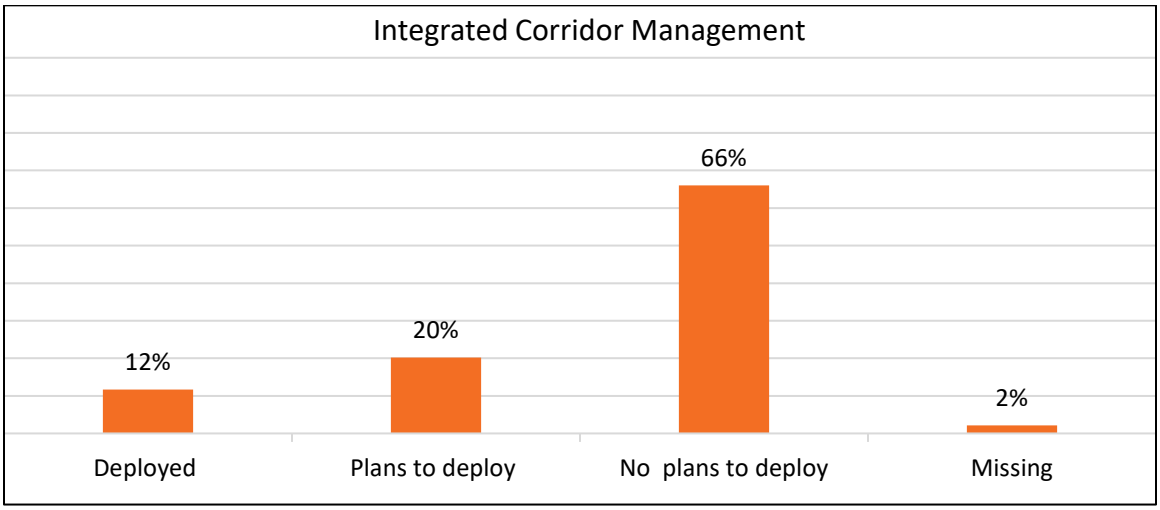
2020 Q31; (n=341) *Source: USDOT*

Figure 29. Provide Real-Time Arterial Traffic Information

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.

Among arterial agencies, 12 percent report having *deployed ICM*, and an additional 20 percent report having *plans to deploy* (Figure 30). Two-thirds (66 percent) of agencies report having *no plans to deploy* ICM. Due to survey length, the survey did not include questions on the nature of agencies' ICM deployment and therefore 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 Q28; (n=341) *Source: USDOT*

Figure 30. Integrated Corridor Management

Transportation Systems Management and Operations Plan

Just over one-quarter (28 percent) of surveyed arterial agencies report having a *Transportation Systems Management and Operations (TSMO) plan* (Figure 31). 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, such that strategies are coordinated across multiple jurisdictions, agencies, and modes.[15]

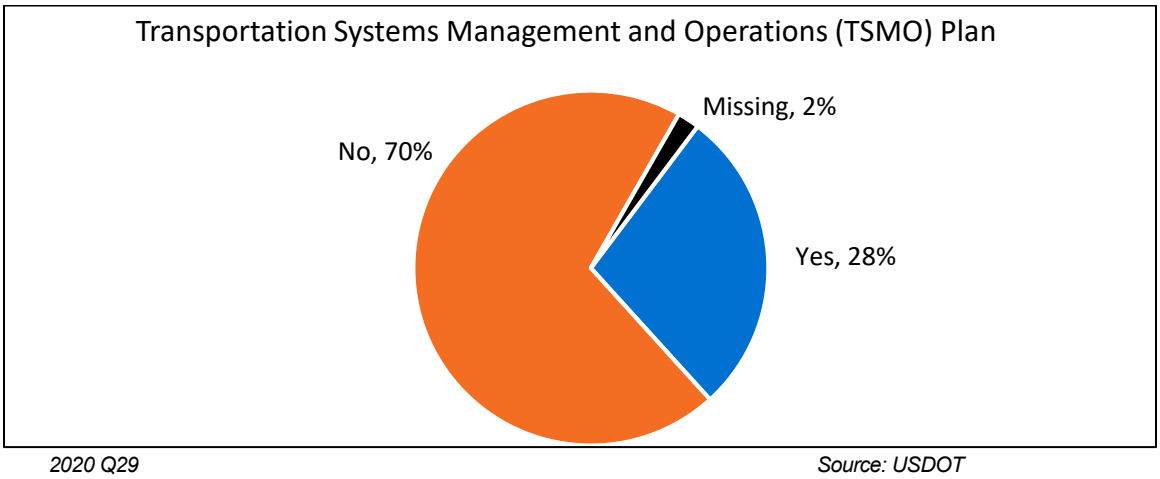
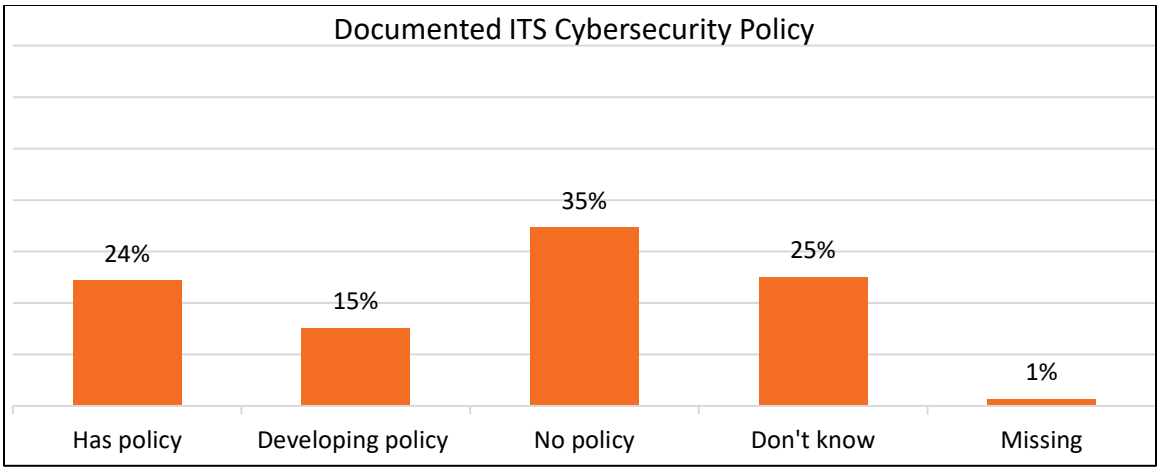


Figure 31. Transportation Systems Management and Operations Plan

ITS Cybersecurity

Figure 32 shows a majority of agencies, 60 percent, either *do not have* an ITS-specific cybersecurity policy (35 percent) or *don't know* (25 percent), while approximately 39 percent either *have an ITS-specific cybersecurity policy* (24 percent) or are *developing a policy* (15 percent).

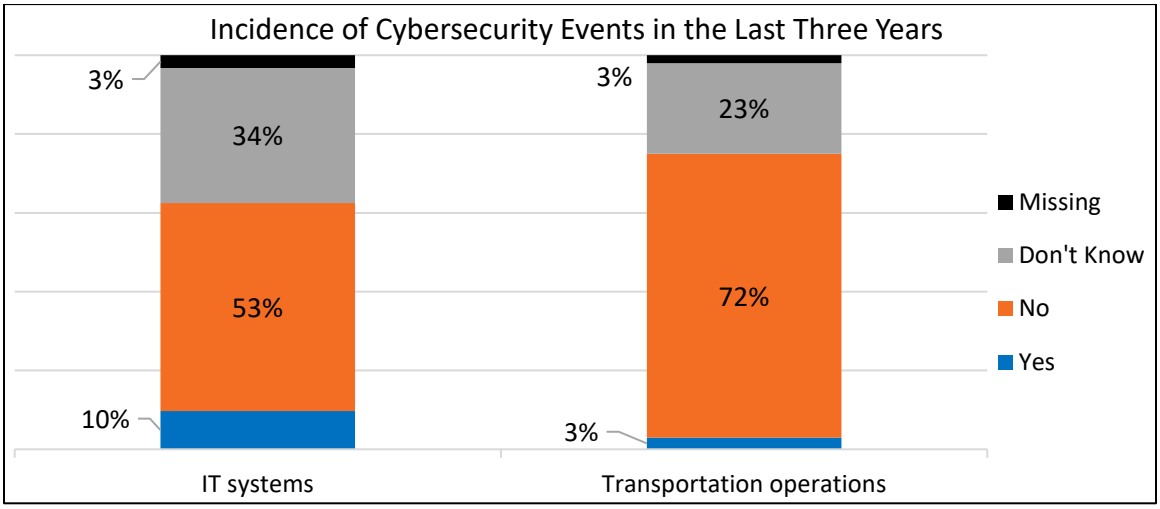
[15] See Federal Highway Administration website: https://ops.fhwa.dot.gov/tsmo/#q1



2020 Q33; (n=341) *Source: USDOT*

Figure 32. Documented ITS Cybersecurity Policy

Overall, 10 percent of agencies report experiencing a cybersecurity event affecting their *IT systems* and/or *transportation operations* in the last three years.[16] Figure 33 shows the results for the two different types of cybersecurity events. Ten percent of surveyed agencies report any cybersecurity events affecting *IT systems* in the last three years; about one-half (53 percent) report *no events*, and one-third (34 percent) report *don't know*. Fewer agencies (3 percent) report cybersecurity events affecting *transportation operations* (with most of these also reporting experiencing a cybersecurity event affecting their IT systems). About three-quarters of agencies report *no events* affecting transportation operations, and about one-quarter report *don't know.* (Figure 33).



2020 Q34, Q35; (n=341) *Source: USDOT*

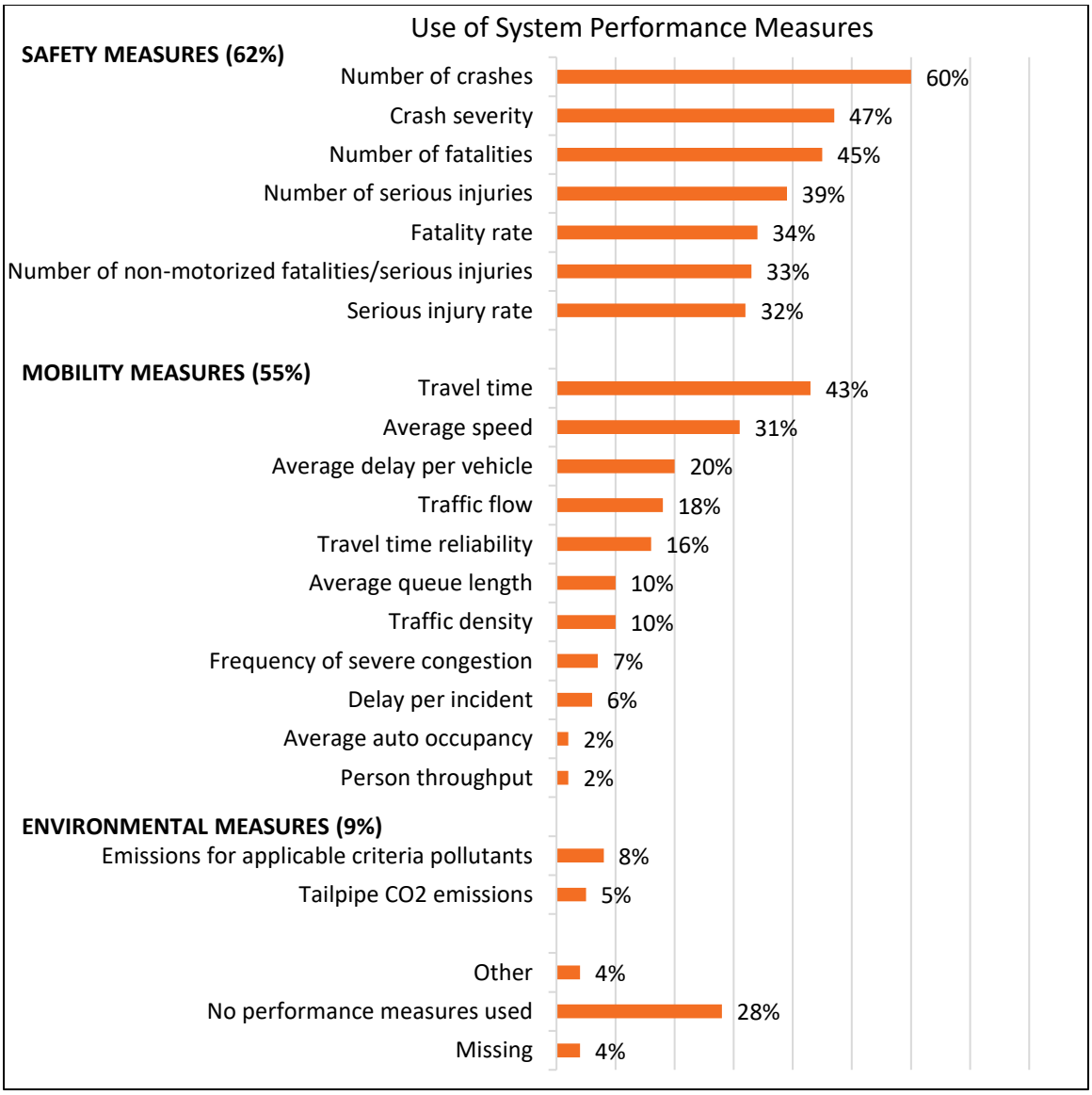
Figure 33. Incidence of Cybersecurity Events in the Last Three Years

[16] 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).

System Performance Measurement

Figure 34 shows the most common performance measures used by arterial agencies relate to safety (62 percent). These are *number of crashes* (60 percent), *crash severity* (47 percent), *number of fatalities* (45 percent), *number of serious injuries* (39 percent), *fatality rate* (34 percent)*, number of non-motorized fatalities and serious injuries* (33 percent), and *serious injury rate* (32 percent).

Mobility performance measures are used by 55 percent of arterial agencies. The most common are *travel time*, which is used by 43 percent of agencies, and *average speed* (31 percent). All other measures are used by 20 percent or less of agencies. Overall, environmental measures are used by significantly fewer agencies (9 percent). Among surveyed agencies, 28 percent report using *no performance measures*.

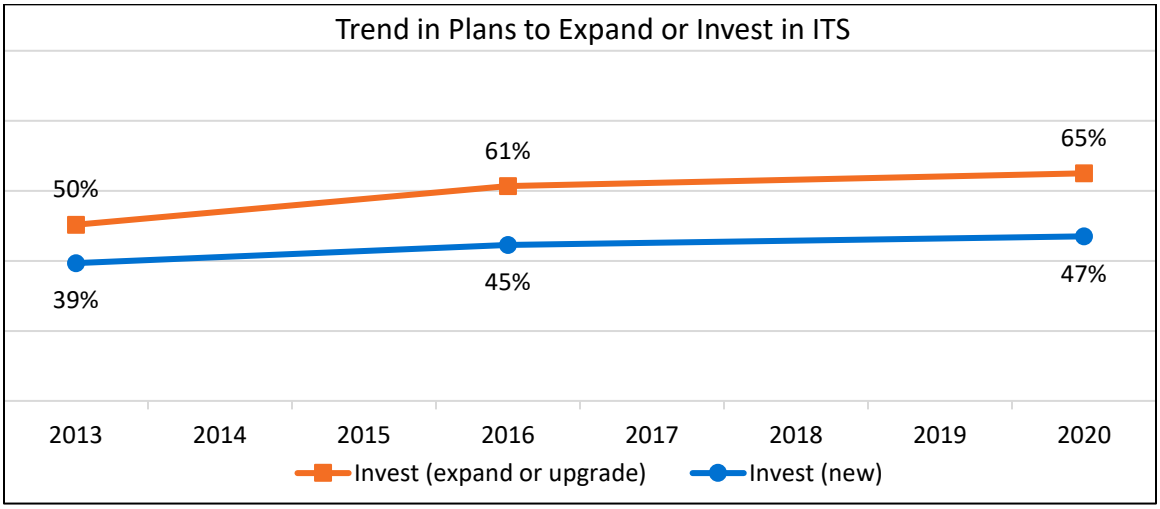


2020 Q27; (n=341) *Source: USDOT*

Figure 34. Use of System Performance Measures

Future ITS Investment

Among surveyed arterial agencies, more agencies plan to *expand or upgrade* current ITS (65 percent) than *invest in new ITS* (47 percent). However, trends in both types of investment plans are increasing since 2013 (Figure 35). The number of agencies with plans to *expand or upgrade current ITS* has grown significantly, from 50 percent in 2013 to 65 percent in 2020 (with most of the increase occurring between 2013 and 2016). The number of agencies with plans to *invest in new ITS* has grown moderately, from 39 percent in 2013 to 47 percent in 2020.



2020 Q39, Q40 *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 survey has 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 survey provides insights on which technologies are mature, as well as where technical assistance or outreach may be needed to increase adoption of newer ITS technologies. The survey responses and data trends also raise questions that may merit further research and investigation.

Growth of Pedestrian Safety Technologies

The 2020 Arterial Survey shows that a number of ITS technologies experienced increasing levels of adoption since 2016. Among arterial agencies, the use of *pedestrian warning systems* increased significantly. However, adoption of other safety-related technologies, including safety systems and work zone technologies, remains relatively low, and there may be opportunities for growth in the adoption of these technologies. Additional research may be needed to understand barriers or challenges to deployment.

Mature ITS Technologies

Among arterial agencies, the adoption of detection technologies at signalized intersections is very high (95 percent in 2020 and 94 percent in 2016), with large majorities using *inductive loops* (89 percent) and *video imaging* (82 percent). The use of these technologies is nearly universal, pointing to the maturity of these technologies.

Rise of Mobile Apps

Among arterial agencies, more than one-half use some form of traveler information (58 percent), while 42 percent indicate they do not disseminate real-time traveler information. *Mobile apps* are the only dissemination method that saw growth in use for traveler information since 2016. While *social media* and *websites* are still the most widely adopted traveler information dissemination methods among arterial agencies, each of these experienced a decline in usage since 2016. Likewise, use of *511, HAR, and email or text/SMS alerts* also decreased. The long-term trend on traveler information methods demonstrates how technologies evolve, as new technologies enter the market and capabilities improve. However, it is unclear to what extent technologies that provide information en route are replacing versus complementing more traditional sources of traveler information. Future surveys may want to examine this evolution more closely.

Opportunities for Growth

For other technologies, such as arterial agency adoption of *ASCT* and *TSP*, growth has generally been steady, but deployment remains relatively low overall, with fewer than one-third of agencies adopting these technologies (29 percent and 28 percent, respectively). Future surveys may want to explore agencies' perceived need for these technologies as well as the barriers to adoption to obtain a better picture of the growth potential for ASCT and TSP adoption.

Cybersecurity – an Area to Watch

On cybersecurity, about one-quarter of arterial agencies have an *ITS-specific cybersecurity policy*, and 15 percent are currently *developing a policy*. Overall, 10 percent of arterial agencies report experiencing a cybersecurity event that affected their *IT systems* and/or *transportation operations* in the last three years. Given the relatively large number of agencies that have not developed an *ITS-specific cybersecurity policy*, there is room for growth in this area.

Appendix A. Arterial Management 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: [CONTENT REMOVED]

For your reference, a PDF version of this online survey: [CONTENT REMOVED]

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.

Arterial Management Survey

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

Arterial Agency Characteristics

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

If none, please enter '0.'

Number of miles: _____

2. What is the total number of signalized intersections operated by your agency?

If none, please enter '0.'

Number of intersections: _____

Arterial Real Time Traffic Data Collection

3. What is the total number of arterial 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.

4. What is the total number of arterial 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. 3]

5a. What is the total number of arterial 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. 3]

5b. Which type(s) of vehicle probe readers does your agency use to collect real-time traffic data on arterials? *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

6. Which of the following sources of arterial 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 arterial traffic data collected from outside sources
- ❑ Don't know

Hardware Characteristics of Signalized Intersections

7. Does your agency deploy any of the following detection technologies at signalized intersections? *Please select all that apply.*

- ❑ Inductive Loop
- ❑ Video imaging detection
- ❑ Radar/microwave detection
- ❑ Magnetometers
- ❑ Other (please specify): _____
- ❑ No detection technologies deployed at signalized intersections

8. Does your agency equip signalized intersections with Closed Circuit Television (CCTV) cameras for the purpose of monitoring traffic flow? *Please select one.*

- ❑ Yes
- ❑ No

Traffic Signal Control Operation Strategies

9. Does your agency use adaptive signal control technology (ASCT) as an operational strategy to improve coordinated signal timing? *Please select one.*

- ❑ Yes
- ❑ No [SKIP TO Q. 10]

9a. What is the total number of signalized intersections under adaptive signal control technology (ASCT)?

Number of signalized intersections under ASCT: _____

[NUMBER OF SIGNALIZED INTERSECTIONS SHOULD NOT EXCEED Q. 2]

10. Does your agency participate in a regional program managed by the State Department of Transportation, Metropolitan Planning Organization (MPO), or other regional authority that actively coordinates traffic signals on arterials across jurisdictional boundaries? *Please select one.*

- ❑ Yes
- ❑ No

Traffic Signal Preemption and Priority

11. Does your agency deploy any of the following technologies at signalized intersections? *Please select all that apply.*

- ❑ Emergency vehicle signal preemption
- ❑ Transit signal priority
- ❑ Truck signal priority
- ❑ Signal preemption near a rail grade crossing
- ❑ None of the above

Parking Management Capabilities

12. Does your agency monitor the availability of parking (including on-street spaces or off-street lots or garages)? *Please select one.*

- ❑ Yes, my agency and/or agency contractor(s) monitor
- ❑ No
- ❑ Don't know

13. Does your agency do any of the following? *Please select all that apply.*

- ❑ Disseminate parking availability information to drivers
- ❑ Use a parking pricing strategy (e.g., peak period surcharges) to manage congestion
- ❑ Allow drivers to reserve a parking space at a destination facility on demand to ensure availability
- ❑ None of the above

Automated Enforcement

14. Does your agency deploy automated enforcement on arterials (e.g., speed, red light running, school zones, work zones, bus-use only, etc.)? *Please select one.*

- ❑ Yes
- ❑ No [SKIP TO Q. 17a]

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

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

16. What types of automated enforcement are covered on arterials? *Please select all that apply.*

- ❑ Speeding
- ❑ Red light running
- ❑ School zone
- ❑ Work zone
- ❑ Bus-use only
- ❑ Railroad crossing
- ❑ Other (please specify): _____

Safety and Road Weather Management

17a. Has your agency deployed any of the following ITS safety systems on arterials? *Please select all that apply.*

- ❑ Pedestrian warning system (e.g., Pedestrian Hybrid beacon, passive pedestrian sensors at signalized intersections) [ANSWER Q. 17b]
- ❑ Bicyclist warning system
- ❑ Over-height warning system (e.g., bridge, tunnel, gantries)
- ❑ Queue warning system
- ❑ Wrong way driving detection system
- ❑ Dynamic curve warning system
- ❑ Dynamic speed limits
- ❑ Other (please specify): _____
- ❑ No ITS safety systems deployed

17b. What is the total number of signalized intersections equipped with ITS pedestrian crossing technology? *If none, please enter '0.'*

Number of signalized intersections: _____

[NUMBER OF SIGNALIZED INTERSECTIONS SHOULD NOT EXCEED Q. 2]

18. Does your agency use any of the following ITS to collect weather and road condition information on arterials? *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

19. Does your agency adjust traffic signal timing in response to inclement weather or road weather conditions? *Please select one.*

- ❑ Yes
- ❑ No

Incident Management/Work Zone Management

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

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

21. What is the total number of arterial centerline miles covered by each of the following real-time incident detection/verification methods? *If none for a particular method, please enter '0.'*

	Number of Arterial Centerline Miles
Closed Circuit Television (CCTV)	_____
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]

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

- ❑ Yes
- ❑ No [SKIP TO Q. 24]

23. Which of the following ITS technologies does your agency deploy at work zones (on arterials)? *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 traffic signals
- ❑ Other (please specify): _____

Traveler Information

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

Total Number of DMS: _____

25. What methods does your agency use to disseminate real-time traveler information about arterials? *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 arterials

26. 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

System Performance Measurement

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

Mobility

- ❑ Average speed
- ❑ Average delay per vehicle
- ❑ Delay per incident
- ❑ Frequency of severe congestion
- ❑ Travel time
- ❑ Travel time reliability
- ❑ Traffic density (e.g., vehicles per lane per mile)
- ❑ Traffic flow (e.g., vehicles per lane per hour; passenger car per lane per hour)
- ❑ Person throughput (e.g., per lane per hour or per hour)
- ❑ Average auto occupancy
- ❑ Average queue length

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 next 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

28. 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

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

- ❑ Yes
- ❑ No

30. 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

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

	Incident Information	
	Yes	*No*
Agencies involved in incident management	*o*	*o*
Freeway management agencies	*o*	*o*
Arterial management agencies	*o*	*o*
Public transit agencies	*o*	*o*

Telecommunications

32. What type 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

33. 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

34. 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

35. 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. 36 IF: (Q. 33=HAS OR IS DEVELOPING POLICY) AND (Q. 34 AND/OR Q. 31=YES)]

36. Has your agency's policy on cybersecurity 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 Arterial ITS Technology

37. 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

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

- ❑ Agency staff [ANSWER Q. 38a]
- ❑ Contractor(s) [ANSWER Q. 38b]
- ❑ Other (please specify): _____

38a. 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)? *Please select all that apply.*

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

38b. 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

39. 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

40. 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. 41]
- ❑ Don't know [SKIP TO Q. 41]

40a. Please describe new or emerging ITS technologies:

Additional Comments

41. 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.

42a. 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. 43]

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

42b. Your preferred phone number. If this is not your preferred email, please type in your preferred email address:

42c. Your preferred email address. If this is not your preferred email, please type in your preferred email address:

43. 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 Sample Sizes

Table 2. Survey Sample Sizes

Survey Year	Arterial
2002	516
2004	508
2005	423
2006	470
2007	434
2010	290[17]
2013	310
2016	274
2020	341

[17] Arterial survey data for 2010 are not presented because the survey was administered to a subset of agencies during that cycle; the data are not comparable to other years.

Appendix C. 2020 DTS Frequencies

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

Q10. Does your agency participate in a regional program managed by the State Department of Transportation, Metropolitan Planning Organization (MPO), or other regional authority that actively coordinates traffic signals on arterials across jurisdictional boundaries?

Table 3. Regional Program

Regional Program	Percent of Arterial Agencies
Yes	52%
No	47%
Missing	1%

n=341 *Source: USDOT*

Q17b. What is the total number of signalized intersections equipped with ITS pedestrian crossing technology?

Table 4. Signalized Intersections with ITS Pedestrian Crossing Technology

Signalized Intersections with ITS Pedestrian Crossing Technology	Percent of Arterial Agencies Base: Agencies with Pedestrian Warning Systems
Yes	67%
No	27%
Missing	6%

n=159 *Source: USDOT*

Q19. Does your agency adjust traffic signal timing in response to inclement weather or road weather conditions?

Table 5. Adjust Traffic Signal Timing

Adjust Traffic Signal Timing	Percent of Arterial Agencies
Yes	17%
No	82%
Missing	1%

n=341 *Source: USDOT*

Q20. What is the total number of arterial centerline miles covered by service patrols?

Table 6. Use of Service Patrols

Use of Service Patrols	Percent of Arterial Agencies
Yes	15%
No	77%
Missing	9%

n=341 *Source: USDOT*

Q36. Has your agency's policy on cybersecurity changed since the cybersecurity event(s) took place?

Table 7. Cybersecurity Plan

Cybersecurity Plan	Percent of Arterial 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)	25%
Yes, policy has been updated as a result of the event(s)	35%
No, events did not have impact on policy (mutually exclusive option)	15%
Don't know (mutually exclusive option)	25%
Missing	5%

n=20 *Source: USDOT*

Q37. Does your agency utilize an asset management system to track ITS inventory and/or related maintenance and operations activity?

Table 8. Asset Management Systems

Asset Management Systems	Percent of Arterial Agencies
Yes, system tracks only ITS inventory	12%
Yes, system tracks only ITS maintenance and operations activity	8%
Yes, system tracks both	26%
No, my agency does not have an ITS asset management system	52%
Missing	2%

n=341 *Source: USDOT*

Q38. Who installs, inspects, maintains, and repairs your agency's ITS equipment in the field?

Table 9. Installs, Inspects, Maintains, and Repairs ITS Equipment

Installs, Inspects, Maintains, and Repairs	Percent of Arterial Agencies
Agency Staff	70%
Contractors	55%
Other	3%
Missing	14%

n=341 *Source: USDOT*

Q38a. 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 10. Types of Agency Staff

Types of Agency Staff	Percent of Arterial Agencies Base: Agencies with Agency Staff working with ITS equipment in the field
Engineer	44%
Electrician	36%
IT Specialist	30%
Software engineer	3%
Traffic signals technician	83%
GIS Specialist	4%
Field Technician	41%
Planner	1%
Other	6%
Don't Know (mutually exclusive option)	0%
Missing	0.4%

n=239 *Source: USDOT*

Q38b. Approximately what percentage of all ITS field equipment work (i.e., installation, inspection, maintenance, and repair) is contracted out?

Table 11. Percentage of ITS Field Equipment Work Contracted Out

Percentage of ITS Field Equipment Work Contracted Out	Percent of Arterial Agencies Base: Agencies with Contractors working with ITS equipment in the field
0% to 25%	26%
26% to 50%	15%
51% to 75%	16%
76% to 100%	34%
Don't Know	8%
Missing	1%

n=186 *Source: USDOT*

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FHWA-JPO-21-892

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