Intelligent Transportation Systems Deployment Tracking Survey: 2023 Arterial Management Survey Findings

Final Report

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Final Report – October 11, 2024
FHWA-JPO-24-142

U.S. Department of Transportation

Produced by Intelligent Transportation Systems Joint Program Office
U.S. Department of Transportation
Office of the Assistant Secretary for Research and Technology

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-JPO-24-142		

4. Title and Subtitle	5. Report Date
Intelligent Transportation Systems Deployment Tracking Survey: 2023 Arterial Management Survey Findings	October 2024
	6. Performing Organization Code
	V321
7. Author(s)	**8. Performing Organization Report No.**
Evelyn Aaron, Samuel Lynch, Margaret Petrella, Sarah Plotnick, Claire Roycroft, Lora Chajka-Cadin, Arielle Herman	
9. Performing Organization Name and Address	**10. Work Unit No. (TRAIS)**
U.S. Department of Transportation Volpe National Transportation Systems Center 220 Binney Street Cambridge, MA 02142	**11. Contract or Grant No.** IAA 693JJ321N300045
12. Sponsoring Agency Name and Address	**13. Type of Report and Period Covered**
U.S. Department of Transportation Intelligent Transportation Systems Joint Program Office (ITS JPO) 1200 New Jersey Avenue, SE Washington DC 20590	Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report summarizes the Arterial Management Survey findings of the 2023 Intelligent Transportation Systems (ITS) Deployment Tracking Survey. From 1999 to 2020, the ITS Joint Program Office (JPO) used the ITS Deployment Tracking Survey on an ongoing basis to collect information about ITS deployment in a subset of metropolitan areas across the United States by surveying state and local transportation agencies. With this most recent 2023 ITS Deployment Tracking Survey, a new survey methodology was implemented, which greatly expanded the geographic coverage of the ITS Deployment Tracking Survey to include smaller urban and rural areas in addition to large metropolitan areas.

The 2023 Arterial Management Survey was administered online from October 3, 2023 to January 19, 2024. The report presents findings separately for the two distinct Arterial Management Survey populations – State DOT districts managing arterials and local arterial management agencies. Among State DOT districts managing arterials, the survey achieved a response rate of 78 percent with 276 completed surveys. Among local arterial management agencies, the survey achieved a response rate of 47 percent with 423 completed surveys. Where comparable data are available, trends are shown for the subset of local arterial management agencies from large metropolitan areas.

The ITS JPO and other stakeholders may use the resulting data to inform strategic planning and investment decisions, identify opportunities to accelerate the deployment of ITS, establish baseline deployment for newer ITS technology deployments, document shifts in ITS deployment patterns and ITS market evolution, and identify opportunities for knowledge transfer and technical assistance.

17. Keywords	18. Distribution Statement
Intelligent Transportation Systems (ITS), arterial management agency, ITS safety systems, work zone ITS, road weather ITS, adaptive signal control, signal preemption technologies, real-time traveler information, real-time data collection, cybersecurity, telecommunications, connected vehicles, automated vehicles.	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	204	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Acknowledgements

The Volpe Center would like to thank all the agency staff who took the time to complete this survey; your responses are greatly appreciated. The Volpe Center also would like to thank Marcia Pincus, Intelligent Transportation Systems (ITS) Deployment Evaluation Program Manager, for her insights and support throughout this survey project. Additionally, the Volpe Center is grateful for the valuable feedback and review provided by Noblis. Finally, the Volpe Center would like to thank ITS Joint Program Office staff and ITS stakeholders who provided input on the survey instrument.

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Acronyms

Acronym	Meaning
ASCT	adaptive signal control technology
AV	automated vehicle
BIL	Bipartisan Infrastructure Law
CCTV	Closed-circuit television
CV	connected vehicle
DMS	dynamic message signs
DOT	Department of Transportation
ESS	Environmental Sensor Stations
ICM	integrated corridor management
ITS	Intelligent Transportation Systems
ITS JPO	Intelligent Transportation Systems Joint Program Office
MPO	metropolitan planning organization
RSU	roadside unit
RWIS	Road Weather Information Systems
SME	subject matter expert
TMDD	Traffic Management Data Dictionary
TSMO	Transportation Systems Management and Operations
TSP	transit signal priority
USDOT	United States Department of Transportation
WZDx	Work Zone Data Exchange

Executive Summary

Introduction

This report summarizes the **Arterial Management Survey**[1] findings of the 2023 Intelligent Transportation Systems (ITS) Deployment Tracking Survey. The United States Department of Transportation's (USDOT) Intelligent Transportation Systems Joint Program Office (ITS JPO) conducts these surveys to track ITS deployment. 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 JPO's ITS Deployment Evaluation Program administers the ITS Deployment Tracking Survey with assistance from USDOT's John A. Volpe National Transportation Systems Center (Volpe).

The ITS JPO has been administering the ITS Deployment Tracking Survey to a subset of large metropolitan areas in the United States since 1999. **With this most recent 2023 Deployment Tracking Survey, a new survey methodology was implemented, which greatly expanded the geographic coverage of the ITS Deployment Tracking Survey to include smaller urban[2] and rural areas in addition to large metropolitan areas.** The change in methodology reflects a need to (1) obtain a better understanding of ITS deployment nationwide and (2) obtain ITS deployment information from communities of all sizes, not just from large metropolitan areas.

The ITS JPO and other stakeholders may use the resulting data to inform strategic planning and investment decisions, identify opportunities to accelerate the deployment of ITS, establish baseline deployment for newer ITS technology deployments, document shifts in ITS deployment patterns and ITS market evolution, and identify opportunities for knowledge transfer and technical assistance.

Methodology: Arterial Management Survey

The 2023 Arterial Management Survey was administered to **two distinct populations** – (1) State Department of Transportation (DOT) districts[3] that manage arterial roads and (2) local arterial management agencies. While these two populations each received the same survey questionnaire, the findings are reported separately due to the different sampling methodologies and potentially differing roles of each population in the management of arterial roadways.

[1] The survey defines arterials as all uncontrolled access roads, such as principal arterials, minor arterials, collectors, and local roads (i.e., functional classifications 3 through 6 per the Federal Highway Administration's Highway Functional Classification). See: https://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section00.cfm.

[2] This term is used to refer to small metropolitan and micropolitan areas.

[3] Some State DOTs refer to these regional offices as regions or divisions (rather than districts); however, for the purposes of reporting, we use the term "districts."

The **Arterial State DOT Survey** is a census of all State DOT districts managing arterials. The **Arterial Local Agency Survey** is a stratified random sample[4] of local arterial management agencies[5], also referred to as local agencies, that manage arterial roads. With the changes in survey methodology, more than four times as many State DOT districts managing arterials and more than twice as many local arterial management agencies received the Arterial Management Survey in 2023 compared to the 2020 survey.

A soft launch of the Arterial Management Survey occurred on October 3, 2023, with the full launch following on October 5, 2023. Survey invitations were sent to State DOT districts managing arterials and local arterial management agencies. The final number of eligible arterial management agencies was 1,251, which included 355 State DOT districts managing arterials and 896 local arterial management agencies.

During survey administration, multiple reminder efforts were undertaken to encourage survey response, including several rounds of reminders by email and telephone. The survey closed on January 19, 2024. The 2023 Arterial State DOT Survey received 276 responses for a response rate of 78 percent. The 2023 Arterial Local Survey received 423 responses for a response rate of 47 percent. Data from the Arterial Local Survey are weighted to adjust for potential nonresponse bias (see: the Arterial Local Survey Methodology).

In addition to presenting overall findings from the 2023 Arterial Local Agency Survey, trend charts are shown for questions that are the same (or very similar) across the 2023, 2020, and 2016 ITS Deployment Tracking Surveys. Since surveys prior to 2023 only included local arterial management agencies in large metropolitan areas, the trend analysis compares the responses of the 2023 local arterial management agencies in large metropolitan areas to responses from the previous 2020 and 2016 ITS Deployment Tracking Surveys. Where trend data are available, these results are presented in Chapter 5.

Key Arterial Management Survey Findings: State Department of Transportation Districts

Key findings for State DOT districts managing arterials are presented in this section.

Use of at least one ITS technology at signalized intersections is widespread among State DOT districts operating signalized intersections.

- Among State DOT districts operating signalized intersections, ITS detection at signalized intersections is nearly universal with 98 percent of these districts deploying at least one detection technology.

[4] Prior to sampling, places and counties were divided into strata based on population size (i.e., stratified). Then, a random sample was drawn from each different strata to ensure representation across various population groups.

[5] This term is used to refer to agencies associated with local governments, such as counties, cities, towns, villages, etc.

- *Inductive loops* (82 percent), *video imaging detection* (78 percent), and *radar/microwave detection* (77 percent) are each deployed by over three fourths of State DOT districts operating signalized intersections.

- A large majority of State DOT districts operating signalized intersections deploy *emergency vehicle preemption* (77 percent) and *signal preemption near a rail grade crossing* (70 percent), whereas substantially fewer State DOT districts operating signalized intersections reported deploying *transit signal priority* (*TSP)* (16 percent).

- Over one third of State DOT districts operating signalized intersections reported deploying *adaptive signal control technology (ASCT)* (36 percent).

Use of ITS safety systems technologies, ITS for road weather management, closed-circuit Television (CCTV) for incident detection/verification, and work zone technologies are each deployed by a majority of State DOT districts managing arterials.

- Among all State DOT districts managing arterials, a large majority reported deploying at least one ITS safety systems technology (78 percent) on arterials, and these districts are deploying an average of 2.5 ITS safety systems technologies. However, none of the ITS technologies are deployed by more than 40 percent of districts. ITS safety systems technologies that are the most widely deployed include:
    - *Pedestrian warning systems* (40 percent)
    - *Speed feedback signs* (40 percent)
    - *Over-height warning systems* (19 percent)
    - *Intersection collision warning systems* (16 percent)
    - *Wrong way driving detection systems* (13 percent)

- Over two thirds of State DOT districts managing arterials reported using at least one type of ITS Road Weather Information Systems (RWIS)/Environmental Sensor Stations (ESS) (67 percent) to collect weather and road condition data for arterials.

- A majority of State DOT districts managing arterials use *CCTV* (61 percent) for incident detection or verification on arterials.

- About one half of State DOT districts managing arterials deploy at least one work zone ITS technology (51 percent), and these deployers use an average of 4.6 work zone ITS technologies. Work zone ITS technologies most widely deployed by State DOT districts managing arterials include:
    - *Portable dynamic message signs (DMS)* (46 percent)
    - *Temporary traffic signals* (40 percent)
    - *Portable dynamic speed feedback/speed radar trailers* (38 percent)
    - *Portable CCTV* (31 percent)

A majority of surveyed State DOT districts managing arterials deploy roadside infrastructure on arterials and use external data sources, whereas adoption of vehicle probe technologies is lower.

- About two thirds of State DOT districts managing arterials deploy at least one roadside ITS technology (65 percent), and these deployers use an average of 2.2 roadside ITS technologies.

Roadside ITS infrastructure most widely deployed by State DOT districts managing arterials include:
  - *Inductive loops* (47 percent)
  - *Radar/microwave detection* (46 percent)
  - *Video imaging detection* (29 percent)

- A large majority of State DOT districts managing arterials (80 percent) use at least one source of external data in support of arterial management. Just over one half report the use of:
  - *Publicly available mapping and traffic information apps* (54 percent)
  - *Notifications from the public via social media, email, text or phone* (54 percent)
  - *Purchased third-party commercial data* (54 percent)

- Vehicle probe readers are deployed by 28 percent of State DOT districts managing arterials with *Bluetooth readers* (22 percent) being the most common type deployed. Fewer than 10 percent indicated use of the other surveyed vehicle probe types.

State DOT districts use multiple methods to share real-time traveler information about arterials, with a majority using social media, DMS, websites, or 511.

- Nearly all surveyed State DOT districts managing arterials disseminate real-time traveler information about arterials (87 percent), and these districts use an average of 4.3 different methods/technologies to do so. A majority of State DOT districts managing arterials use the following methods to share real-time traveler information:
  - *Social media* (74 percent)
  - *DMS* (65 percent)
  - *Websites* (58 percent)
  - *511* (54 percent)

- A lower percentage of State DOT districts managing arterials use the following methods for real-time traveler information on arterials:
  - *Email or text/SMS alert*s (40 percent)
  - *Third party mobile apps* (33 percent)
  - *Agency-branded mobile applications* (28 percent)
  - *Highway Advisory Radio* (21 percent)

Fiber-optic cable (wired) and cellular LTE-4G (wireless) are the leading telecommunications technologies enabling ITS for State DOT districts managing arterials.

- Of the surveyed wired technologies, a large majority of surveyed State DOT districts managing arterials use *fiber-optic cable* (70 percent) to enable their ITS on arterials. A lower percentage of State DOT districts managing arterials use other surveyed wired technologies, including:
  - *Twisted copper pair/twisted wired pair* (25 percent)
  - *Data cable over modem* (23 percent)
  - *Digital subscriber line* (16 percent)
  - *Coaxial* (15 percent)

- Of the surveyed wireless technologies, a large majority of State DOT districts managing arterials are using *cellular (LTE-4G)* (72 percent) to enable their ITS on arterials. A lower percentage of State DOT districts managing arterials use other surveyed wireless technologies, including:
    - *Microwave* (27 percent)
    - *5G New Radio and small cell infrastructure* (21 percent)
    - *LTE-CV2X*[6] (16 percent)
    - *Wi-Fi (*12 percent)
    - *Dedicated short range communication* (11 percent)

While nearly half of State DOT districts managing arterials are either currently developing, testing or deploying connected vehicle (CV) technologies or planning to do so, State DOT districts managing arterials reported fewer activities related to automated vehicle (AV) testing and deployment.

- About one fifth of responding State DOT districts managing arterials are *developing, testing, or deploying CV technology* (21 percent). Similarly, 24 percent of State DOT districts managing arterials reported *planning for CV*.

- Only 5 percent of State DOT districts managing arterials reported *leading AV testing/deployment* in the last five years, and 12 percent reported *supporting the planning or execution of an AV test/deployment* during that same period.

Some State DOT districts managing arterials reported using the same ITS technologies to address multiple types of transportation challenges, and different percentages of these districts use the technologies depending on the challenge.

- *Queue warning systems* are used by 9 percent of State DOT districts managing arterials as a safety system, and 15 percent use these systems at work zones.

- *Variable speed limits* are used by 12 percent of State DOT districts managing arterials as a safety system, and 8 percent use these systems at work zones.

- *DMS* deployment was reported by the highest percentage of State DOT districts managing arterials for real-time information dissemination (65 percent), and *DMS (portable and/or permanent)* is used by a similar percentage to manage adverse weather impacts (64 percent). Fewer State DOT districts managing arterials reported using *portable DMS* at work zones (46 percent).

[6] Connected vehicle-to-everything.

For several ITS technologies, deployment tends to be higher among State DOT districts managing arterials that have at least one large urban area[7] compared to State DOT districts without a large urban area, except for road weather ITS.

- State DOT districts managing signalized intersections with a large urban area are significantly more likely than State DOT districts without a large urban area to deploy *TSP* (27 percent compared to 7 percent).

- Similarly, State DOT districts managing arterials with a large urban area are significantly more likely than State DOT districts without a large urban area to:
    - Deploy *wrong way driving detection* (20 percent compared to 8 percent)
    - *Develop, test, or deploy CV technology* (29 percent compared to 14 percent)
    - *Support the planning or execution of an AV test/deployment* (19 percent compared to 7 percent)
    - *Have plans for integrated corridor management* (33 percent compared to 18 percent).

- By contrast, State DOT districts managing arterials without a large urban area are more likely than State DOT districts with a large urban area to deploy road weather ITS, including *permanent (stationary) systems* (73 percent compared to 54 percent), as well as *mobile (vehicle-mounted) systems* (28 percent compared to 15 percent).

Key Arterial Management Survey Findings: Local Agencies

Key findings for local arterial management agencies are presented in this section.

Deployment of ITS detection technologies at signalized intersections is widespread among local arterial management agencies operating signalized intersections.

- Nearly all local agencies operating signalized intersections reported deploying at least one ITS detection technology at signalized intersections (94 percent), including:
    - *Inductive loops* (78 percent)
    - *Video imaging detection* (60 percent)
    - *Radar/microwave detection* (28 percent).

A majority of local arterial management agencies operating signalized intersections deploy emergency vehicle preemption, while the deployment of other ITS at signalized intersections is limited.

- Over half of local arterial management agencies operating signalized intersections deploy *emergency vehicle preemption* (57 percent). Only about one fifth deploy *signal preemption near a rail grade crossing* (21 percent), and 7 percent deploy *TSP*.

[7] For the purposes of subgroup analysis, a large urban area was defined as either a city with a population greater than 100,000 or a county with a population greater than 950,000.

- One fourth of local agencies operating signalized intersections deploy *CCTV* at signalized intersections to monitor traffic flow (25 percent).

- About one fifth of local agencies operating signalized intersections reported deploying *ASCT* (21 percent).

Use of ITS safety systems technologies, CCTV for incident detection/verification, and work zone ITS technologies are each deployed by relatively few local arterial management agencies, indicating room for growth in the deployment of these technologies.

- Overall, 42 percent of local arterial management agencies deploy at least one ITS safety systems technology. The most widely deployed ITS safety systems include:
    - *Speed feedback signs* (32 percent)
    - *Pedestrian warning systems* (23 percent)

  All other surveyed ITS safety systems technologies are deployed by 2 percent or fewer local agencies.

- Nine (9) percent of local arterial management agencies are using *CCTV* for incident detection, and similarly, 8 percent are deploying at least one type of ITS for road weather management.

- Only 4 percent of local arterial management agencies are deploying any work zone ITS technologies. Among local agencies, the two most deployed surveyed work zone ITS technologies are *temporary traffic signals* (3 percent) and *portable DMS* (2 percent).

Nearly half of local arterial management agencies use external data for real-time data collection, while roadside infrastructure technologies are deployed by less than one fifth of local agencies managing arterials.

- Nearly half of local arterial management agencies use at least one external data source (47 percent), including:
    - *Notifications from the public* (29 percent)
    - *Other transportation agency data* (28 percent)
    - *Publicly available mapping and traffic information apps* (21 percent)
    - *Purchased third-party commercial data* (3 percent)

- Overall, only 15 percent of local arterial management agencies are deploying any type of roadside ITS infrastructure on arterials, including
    - *Radar/microwave* (7 percent)
    - *Video imaging detection* (6 percent)
    - *Inductive loops* (5 percent).

About one fifth of local arterial management agencies reported the use of one or more telecommunications technologies; however, just over 40 percent reported they don't know the telecommunications technologies that enable their ITS.

- Overall, about one fifth of local arterial management agencies use at least one wired telecommunications technology (19 percent) to enable ITS with the highest percentage deploying *fiber-optic cable* (17 percent). All other surveyed wired technologies are deployed by 6 percent or fewer local arterial management agencies.

- Fourteen (14) percent of local arterial management agencies use at least one wireless telecommunications technology with the highest percentage using *cellular LTE-4G* (9 percent). All other surveyed wireless technologies are deployed by 5 percent or fewer local arterial management agencies.

- When asked about the telecommunications technologies used to enable ITS on arterials, nearly one half of local agencies reported *don't know* (41 percent), and one fifth reported *no telecommunications used to enable ITS* (20 percent).

Nearly one half of local arterial management agencies disseminate real-time traveler information.

- Overall, 47 percent of local arterial management agencies disseminate real-time traveler information. The most commonly used methods include:
    - *Social media* (39 percent)
    - *Websites* (26 percent)
    - *Email or text/SMS alerts* (23 percent)

Few local arterial management agencies reported plans to expand/upgrade their ITS or invest in new ITS, though the survey found that local arterial management agencies in large metropolitan areas are significantly more likely to have such plans.

- Among all surveyed local arterial management agencies, 11 percent *plan to expand or upgrade their current ITS*, and 11 percent have *plans to invest in new or emerging ITS*.

- Among local arterial management agencies in large metropolitan areas, 42 percent *plan to expand or upgrade their current ITS,* and 36 percent *plan to invest in new ITS*. Both percentages are significantly higher than those for local arterial management agencies in smaller urban and rural areas.

Local arterial management agencies in large metropolitan areas tend to have higher rates of ITS deployment than local agencies in smaller urban or rural areas.[8]

- With respect to ITS at signalized intersections, local arterial management agencies operating signalized intersections in large metropolitan areas are significantly more likely than those in smaller urban or rural areas to deploy:
    - *CCTV* at signalized intersections (56 percent compared to 13 percent)
    - *Emergency vehicle signal preemption* (76 percent compared to 50 percent)
    - *TSP* (17 percent compared to 3 percent).

[8] Large metropolitan areas include counties with a population over 50,000 and which the 2020 Census designates as a metropolitan area. All cities with a population over 50,000 people are also large metropolitan areas. All other areas (counties or places) are included in the “smaller urban and rural areas” group.

- Other ITS technologies which local arterial management agencies in large metropolitan areas tend to deploy at higher rates compared to agencies in smaller urban or rural areas, include:
    - *Pedestrian warning systems* (28 percent compared to 8 percent)
    - *Speed feedback signs* (37 percent compared to 15 percent)
    - *CCTV* for incident detection/verification (30 percent compared to 4 percent)

Among local arterial management agencies in large metropolitan areas, ITS deployment continues to increase for a range of ITS technologies.

Among local agencies in large metropolitan areas, it is possible to assess trends in ITS deployment. The trend data show that for these local arterial management agencies in large metropolitan areas there was statistically significant growth since 2020 in the deployment of several ITS technologies, including:

- **Incident detection and verification methods:** *external data* (from 15 percent in 2020 to 29 percent in 2023)

- **External data sources:** *publicly available mapping and traffic information apps* (from 38 percent in 2020 to 50 percent in 2023) and *notifications from the public* (from 32 percent in 2020 to 46 percent in 2023)

- **Vehicle probe readers:** *license plate readers* (from 2 percent in 2020 to 16 percent in 2023)

- **Telecommunications technologies:** *5G New Radio and small cell infrastructure* (from 5 percent in 2020 to 18 percent in 2023)

Conclusions

With the 2023 ITS Deployment Tracking Survey, the ITS JPO significantly expanded the geographic coverage of the Arterial Management Survey to include agencies in smaller urban and rural areas in addition to those in large metropolitan areas. The survey was administered to all State DOT districts that manage arterial roads, as well as to a random sample of local arterial management agencies, enabling the reporting of ITS deployment nationwide.

The survey finds that the deployment of ITS detection technologies at signalized intersections is nearly universal for both State DOT districts and local arterial management agencies operating signalized intersections. Emergency vehicle preemption is also widely deployed by both survey populations, whereas several other ITS technologies at signalized intersections, such as TSP and ASCT, have relatively lower levels of deployment.

For most other surveyed ITS technologies, there are apparent differences in the ITS deployment rates for State DOT districts managing arterials compared to local arterial management agencies. For example, a significantly greater percentage of State DOT districts managing arterials, compared to local arterial management agencies, deploy ITS safety systems, work zone ITS technologies, ITS for road weather management, incident detection and verification methods, roadside ITS infrastructure, and telecommunications technologies on arterials. Nonetheless, even among State DOT districts managing arterials, there is room for growth in the deployment of ITS on arterials, particularly with respect to ITS safety systems and work zone ITS technologies.

For several ITS technologies, deployment tends to be higher among State DOT districts managing arterials that have at least one large urban area compared to districts without a large urban area (with the notable exception of ITS for road weather management). **Likewise, local agencies in large metropolitan areas tend to have higher rates of ITS deployment than local agencies in smaller urban or rural areas.**

Among local arterial management agencies in large metropolitan areas, the trend data show increased deployment for a limited number of ITS technologies since 2020. With the next ITS Deployment Tracking Survey, it will be possible to assess ITS trends for the entire sample of local arterial management agencies, as well as all State DOT districts managing arterials.

Chapter 1. Introduction

Purpose of the Report

This report summarizes the **Arterial Management Survey**[9] findings of the 2023 Intelligent Transportation Systems (ITS) Deployment Tracking Survey. The United States Department of Transportation's (USDOT) Intelligent Transportation Systems Joint Program Office (ITS JPO) administers these surveys to track ITS deployment. 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 JPO's ITS Deployment Evaluation Program administers the ITS Deployment Tracking Survey with assistance from USDOT's John A. Volpe National Transportation Systems Center (Volpe).

The ITS JPO has been administering the ITS Deployment Tracking Survey to a subset of large metropolitan areas in the United States since 1999. **With this most recent 2023 ITS Deployment Tracking Survey, a new survey methodology was implemented, which greatly expanded the geographic coverage of the ITS Deployment Tracking Survey to include smaller urban[10] and rural areas in addition to large metropolitan areas.** The change in methodology reflects a need to (1) obtain a better understanding of ITS deployment nationwide and (2) obtain ITS deployment information from communities of all sizes, not just from large metropolitan areas.

The ITS JPO and other stakeholders may use the resulting data to inform strategic planning and investment decisions, identify opportunities to accelerate the deployment of ITS, establish baseline deployment for newer ITS technology deployments, document shifts in ITS deployment patterns and ITS market evolution, and identify opportunities for knowledge transfer and technical assistance.

Background

Since 1999, the ITS JPO has used the ITS Deployment Tracking Survey to collect information about the extent of ITS deployment in a subset of large metropolitan areas across the United States. The surveys were, and continue to be, administered to State and local transportation agencies, including freeway, arterial, and transit management agencies. The ITS JPO initially developed the ITS Deployment Tracking Survey to track and manage progress made toward a ten-year ITS deployment goal announced by the U.S. Secretary of Transportation in 1996.[11] The Secretary's goal focused on tracking ITS deployment

[9] The survey defines arterials as all uncontrolled access roads, such as principal arterials, minor arterials, collectors, and local roads (i.e., functional classifications 3 through 6 per the Federal Highway Administration's Highway Functional Classification). See: https://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section00.cfm.

[10] This term is used to refer to small metropolitan and micropolitan areas.

[11] U.S. Transportation Secretary Peña's goal stated that the 75 largest metropolitan areas should be outfitted with an integrated ITS infrastructure in the next ten years.

rates in large metropolitan areas. At the time, ITS was a relatively new set of technologies that tended to be deployed in large metropolitan areas to address congestion, safety, and other transportation issues experienced most acutely by the nation's largest cities. The surveys were conducted every 1-2 years during the initial ten-year goal measurement period. Following the ten-year goal period, which ended around 2007, the surveys were conducted less frequently, on a roughly 3-year cycle, and continued to monitor the deployment of ITS in a subset of large metropolitan areas across the country.

However, in the years following the goal period, it became clear that the ITS Deployment Tracking Survey no longer provided the most complete picture of the extent and nature of ITS deployment in the U.S. During this time, ITS technologies became more mainstream and, as such, were increasingly deployed outside of large metropolitan areas. The ITS JPO's Benefits, Costs, and Lessons Learned databases[12] showed increasing numbers of examples of ITS deployments in smaller urban (i.e., small metropolitan and micropolitan) and rural areas.

The ITS JPO's 2019 **Small Urban and Rural Transit Provider Survey** further demonstrated the high rates of deployment of some ITS technologies among smaller urban and rural transit providers.[13] Based on these trends, the ITS JPO determined that an update to the survey methodology was necessary to address these important gaps in survey coverage and better reflect a full range of communities and situations where ITS are deployed.

The ITS JPO's ITS Deployment Evaluation Program began initial investigations into the development of a new survey approach and methodology following the 2016 ITS Deployment Tracking Survey. At that time, the ITS Deployment Evaluation Program began exploring potential sampling approaches with input from stakeholders, subject matter experts (SMEs), and survey statisticians. In 2022, a **Pilot Survey** of State Departments of Transportation (DOT) and smaller urban and rural local arterial management agencies was conducted to test the new sampling approach. The **Pilot Survey** showed that smaller urban and rural local arterial management agencies were willing and able to participate in the ITS Deployment Tracking Survey.

The ITS JPO decided to execute its new survey methodology starting with the 2023 ITS Deployment Tracking Survey, thereby expanding its geographic coverage to include smaller urban and rural areas in addition to large metropolitan areas. The methodology for each survey type (Freeway Management, Arterial Management, Transit Management) is highlighted below:

- **Freeway Management Survey**
  - Surveys all State DOT districts and toll authorities that manage freeways.

- **Arterial Management Survey (two distinct populations)**[14]
  - **Arterial State DOT Survey**: surveys all State DOT districts[15] that manage arterials.

[12] For more information about the ITS Benefits, Costs, and Lessons Learned Databases, see: https://www.itskrs.its.dot.gov/

[13] See: https://www.itskrs.its.dot.gov/deployment/othersurveys_surta_2019

[14] Detailed information about the Arterial Survey methodology can be found in Chapter 2. For detailed information about the survey methodology for the Freeway and Transit Surveys, please see each of the respective reports (see: https://www.itskrs.its.dot.gov/deployment/2023DTS).

[15] Some State DOTs refer to these regional offices as regions or divisions (rather than districts); however, for the purposes of reporting, we use the term "districts."

  - **Arterial Local Survey:** surveys a random sample of places and counties of varying population sizes (i.e., local agencies across metropolitan, micropolitan and rural areas) that manage arterial roads.

- **Transit Management Survey**
  - Surveys a random sample of transit agencies across large urban, small urban and rural areas from the National Transit Database.[16]

In addition to providing more comprehensive data about the extent of ITS deployment nationwide, the new ITS Deployment Tracking Survey methodology positions the ITS JPO to also baseline and, over time, track the growing pipeline of ITS projects that are currently being (and will be) deployed as a result of the Infrastructure Investment and Jobs Act (IIJA), also known as the Bipartisan Infrastructure Law (BIL).[17] Grant programs established under the BIL provide numerous funding opportunities for a wide variety of projects in communities of all sizes and location types. Several of the BIL grant programs offer opportunities to fund ITS deployments to help communities solve transportation challenges.

[16] The NTD is a legislative requirement (see Title 49 U.S.C. 5335(a)). This statute requires that recipients or beneficiaries of grants from the Federal Transit Administration (FTA) under the Urbanized Area Formula Program (§5307) or Other than Urbanized Area (Rural) Formula Program (§5311) submit data to the NTD. See: https://www.transit.dot.gov/ntd.

[17] See: https://www.transportation.gov/bipartisan-infrastructure-law.

Chapter 2. Methodology

This chapter describes the process for implementing the new ITS Deployment Tracking Survey methodology for the Arterial Management Survey, which was administered to **two distinct populations** – State DOT districts managing arterials and local arterial management agencies.

Sample Development

The two Arterial Management Survey populations – **State DOT districts managing arterials** and **local arterial management agencies** – were surveyed using different methodologies, and as a result, the findings are presented separately (in Chapter 3 and Chapter 4, respectively).

The Arterial State DOT Survey uses a census approach, surveying all State DOT districts that manage arterials. The Arterial Local Agency Survey uses stratified random sampling[18] of places and counties of varying population sizes (using the 2020 Census) that manage arterials. The term "places" is used to define cities, towns, villages, townships, and boroughs. "Place" agencies together with "county" agencies are referred to collectively as "local arterial management agencies" or "local agencies" in this report.

Historically, from 1999 to 2020, the ITS Deployment Tracking Survey surveyed State DOT districts managing arterials and local arterial management agencies in a subset of large metropolitan areas. With the expansion in geographic coverage to include smaller urban and rural areas, the ITS JPO has significantly increased the number of State DOT districts managing arterials (from about 80 to more than 350), as well as the number of local agencies (from about 430 to nearly 900) receiving the Arterial Management Survey.

For more details about the sampling methodology for each survey population, see Arterial State DOT Survey Methodology and Arterial Local Survey Methodology.

Contact Development

Contact development for the Arterial Management Survey included the identification of State DOT districts managing arterials and local arterial management agency contacts for eligible agencies (i.e., agencies that manage arterial roads).

[18] Prior to sampling, places and counties were divided into strata based on population size (i.e., stratified). Then, a random sample was drawn from each different strata to ensure representation across various population groups.

The survey team researched and identified those State DOT districts that do not manage arterial roads and removed them from the survey population (i.e., ineligible agencies). This determination was based on research conducted during the development of the updated methodology plan and during the contact confirmation process.

Following the enumeration of all State DOT districts managing arterials, the survey team identified a survey contact for each agency. The contact confirmation process involved online research to find an appropriate point of contact, such as a district engineer or ITS engineer, as well as the collection of other relevant information (e.g., whether the agency appeared to manage ITS).

For local arterial management agencies, the survey team identified the agency that manages arterial roads for the sampled place or county and then identified an appropriate survey contact. Common points of contact for local agencies include positions such as director of public works or city/county engineer.

Using the contact information available (either a specific contact or general agency phone number or email), the survey team reached out to every agency via email to describe the survey's purpose and agency eligibility criteria (i.e., agency must manage arterial roads to be within the survey population) and to confirm the contact's suitability to respond to the survey. Those who did not respond to the initial email received up to four phone calls coupled with follow-up emails to identify a suitable point of contact.

Table 1 shows the results of the contact confirmation process for both the State DOT districts managing arterials and local arterial management agencies. The survey team sent a survey to every eligible agency with contact information, including confirmed and unconfirmed contacts. Thus, 355 survey invitations were sent to State DOT districts managing arterials and 836 survey invitations were sent to local arterial management agencies (i.e., the first two rows shown in Table 1). Agencies with unknown contact information and agencies which indicated "do not contact" to the survey team during contact confirmation were not sent a survey.[19] Agencies that were deemed ineligible because they do not manage arterials are outside of the survey population were also removed from the sample.

Table 1. Summary of Arterial Agency Contact Confirmation

Sample Disposition	State DOT Districts Managing Arterials (Original Sample = 357)	Local Arterial Management Agencies (Original Sample = 1,030)
Points of Contact Confirmed	326	674
Unconfirmed, but Contact Information on File	29	162
Unknown Contact Information	0	53
Do Not Contact	0	10
Ineligible	2	131

Source: USDOT

[19] For the purposes of calculating response rates, however, agencies with unknown contact information and agencies indicating do not contact were still deemed eligible and included in the eligible sample, as the survey team did not have enough information to classify them as ineligible.

Data Collection and Processing

Survey Questionnaire

Key topics covered by the 2023 Arterial Management Survey include ITS technologies at signalized intersections, safety-related ITS technologies, incident detection and verification, real-time data collection, telecommunications, connected vehicles, automated vehicles, traffic management, traveler information, Regional (or State) ITS Architecture, agency coordination, ITS cybersecurity, and future deployment planning.

The 2023 Arterial Management Survey is a modified version of the 2020 survey. One key change between 2020 and 2023 is that the questions about ITS coverage (i.e., number of arterial miles covered by X technology) were either transformed into an adoption question (i.e., whether the agency has adopted X technology) or were eliminated (if an adoption question already existed) due to their high respondent burden. Another key change from the 2020 survey to the 2023 survey was the addition of several new questions on connected vehicles and automated vehicles, as these emerging technologies had not been included in an ITS JPO survey effort since 2019.[20]

Other substantive changes to the questionnaire were largely driven by the input of SMEs. In addition, minor modifications were made to some questions to improve clarity. New response options were also added to some questions, based on either common respondent input to open-ended responses ("Other") in the 2020 survey, or the need to include ITS technologies thought to be relevant to smaller urban or rural areas (e.g., wildlife crossing warning systems). Another noteworthy change is the increased use of definitions (via "hover boxes") for ITS technologies and other terms to assist respondents in filling out the survey. The full questionnaire with new questions identified is shown in Appendix D.

Respondent Dashboard

An online personalized dashboard (see Figure 1) was developed to administer the ITS Deployment Tracking Survey to each respondent. The online dashboard provided details on the survey effort, including information about the survey sponsor, frequently asked questions, and the survey contractor's privacy policy. The online dashboard also allowed respondents to download a PDF version of the survey questionnaire(s) and included unique links to access their survey(s). Some individual respondents were assigned two or more surveys, as they represented multiple State DOT districts managing arterials and/or more than one type of survey (e.g., freeway and arterial). If respondents exited the survey prior to completion, responses to any completed questions were saved automatically and were accessible by respondents if they returned to the survey.

[20] See: https://www.itskrs.its.dot.gov/deployment/othersurveys_surta_2019.

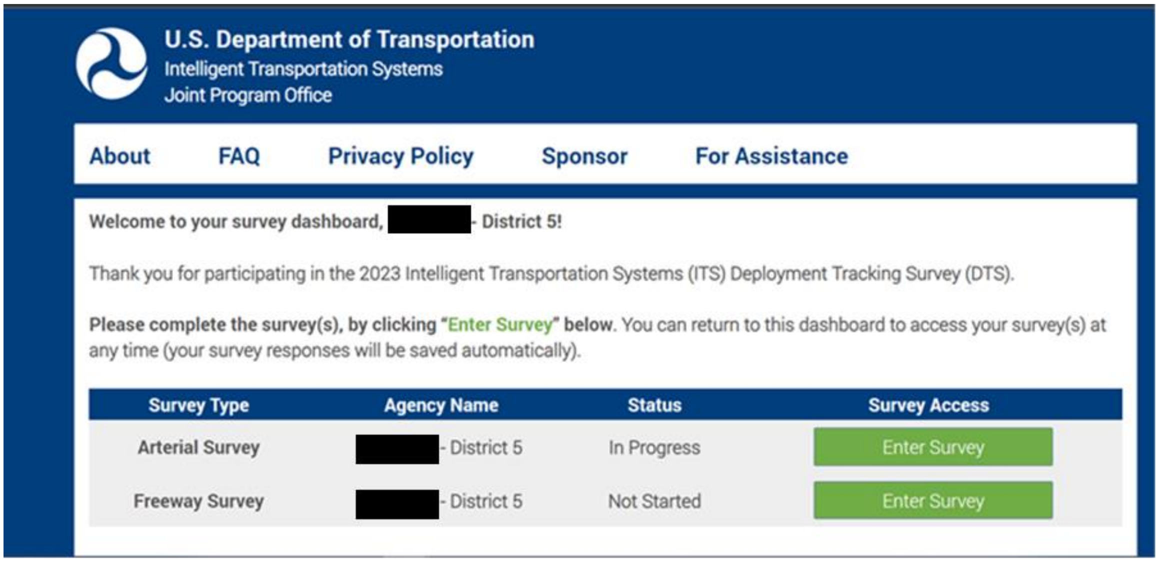


Figure 1. Example Personalized Survey Dashboard

Survey Administration

To test the functionality of the survey process, including the online survey instruments and dashboard, the survey invitation was sent to a small subset of freeway, arterial, and transit agencies (i.e., soft launch) on October 3, 2023, prior to the full launch of the ITS Deployment Tracking Survey. The full launch occurred on October 5, 2023. In total, the Arterial Management Survey was sent to 355 State DOT districts managing arterials and 836 local arterial management agencies. While the survey was in the field, it was further determined three local arterial management agencies were ineligible because they did not manage arterials. At the conclusion of survey administration, the final eligible sample included 355 State DOT districts managing arterials and 896 local arterial management agencies.

Multiple reminder efforts were undertaken to encourage survey response. Two rounds of reminder emails were sent in October 2023. Following these reminders, those who had not yet completed their assigned survey(s) were contacted by phone up to three more times in November and December of 2023. Telephone reminders also included a voicemail left for contacts who could not be reached by phone. Telephone reminders were also followed by an email to contacts. Additional telephone calls with email reminders were sent in mid-December targeting under-represented geographic areas. In early January 2024, emails were also sent to respondents whose surveys were "in progress," encouraging respondents to complete their survey.

The survey was closed on January 19, 2024. Of the eligible arterial management agencies, 276 State DOT districts managing arterials completed the survey for a **response rate of 78 percent**, and 423 local agencies completed the survey for a **response rate of 47 percent** as shown in Table 2.[21]

Table 2. Survey Response by Arterial Management Survey Population

Survey	Eligible Sample	Number of Completed Surveys	Response Rate
State DOT districts managing arterials	355	276	78%
Local Agencies	896	423	47%

Data Cleaning and Weighting

The survey data went through an extensive review and cleaning process, and open-ended responses were reviewed and coded into existing response categories as appropriate. The survey team consulted with USDOT SMEs to ensure that write-in responses were accurately recoded if appropriate.

The Arterial Management Survey administered to State DOT districts managing arterials ("Arterial State DOT Survey") did not require any data weighting; design weights were not applicable because the survey sample was a census, and non-response weighting was not needed due to the high response rate (i.e., no significant non-response bias).

The Arterial Management Survey administered to local arterial management agencies ("Arterial Local Survey") did require data weighting, and this is described in detail in Chapter 4: Data Weighting.

[21] To address the issue of the relatively lower response rate, data from the Arterial Local Survey are weighted to adjust for potential nonresponse bias (see: the Arterial Local Survey Survey Methodology).

Chapter 3. Arterial Management Survey Findings: State Department of Transportation Districts

This chapter summarizes the methodology and the findings of the 2023 Arterial State DOT Survey, which was distributed to all State DOT districts that manage arterial roadways.

Survey Methodology

The 2023 ITS Deployment Tracking Survey included a census of all State DOT districts managing arterials in order to obtain a more complete, nationwide picture of State DOT districts' ITS deployment on arterial roads. Overall, this population is comprised of 355 eligible State DOT districts managing arterials of which 276 completed the Arterial Management Survey for a 78 percent response rate. Please see Chapter 2 for detailed information about contact enumeration, questionnaire development, and data collection and processing.

Data Weighting

The Arterial State DOT Survey did not require any data weighting; design weights were not applicable because the survey sample was a census, and non-response weighting was not needed due to high response rates (i.e., no significant non-response bias).

Overview of Respondents

The responding agencies comprise State DOT districts that manage arterial roadways. Since State DOT districts cut across statistical areas (i.e., typically include metropolitan, micropolitan, and rural areas), it is not possible to categorize State DOT districts by statistical areas. However, the survey team could separate out the State DOT districts managing arterials into two distinct groups:

- State DOT districts managing arterials with at least one large urban area (defined as places[22] with populations greater than 100,000 or counties with populations greater than 950,000)
- State DOT districts managing arterials without a large urban area.

[22] For the purposes of reporting, "place" is used to describe all incorporated areas, such as cities, towns, villages, townships, and boroughs.

Forty-three (43) percent of responding State DOT districts managing arterials have at least one large urban area, while the remaining 57 percent do not, as shown in Table 3.

Table 3. Breakdown of Respondent Groups

Group	Percent	Number of Respondents
State DOT districts with a large urban area	43%	120
State DOT districts without a large urban area	57%	156

Source: USDOT

Reporting Notes

This chapter is organized by ITS technologies and topics. In each section, findings are presented for all 2023 Arterial State DOT Survey respondents (i.e., a total of 276 respondents), where applicable. In some cases, percentages presented are based on a subset of respondents who received the question due to skip logic[23] in the survey. The 2023 survey question number and number of respondents for each question are referenced at the bottom of each figure (e.g., n=276). In some cases, respondents chose not to respond to a question. These non-responses are referred to as “missing” responses and are identified either in the figure or at the bottom of the figure.

Subgroup findings are also presented where applicable. These analyses highlight significant differences across **population groups** (i.e., State DOT districts managing arterials with at least one large urban area compared to State DOT districts managing arterials without any large urban area).

In comparing differences across subgroups, significance testing was performed at a significance level of 0.05, with a 95 percent confidence interval.

ITS Technologies at Signalized Intersections

ITS technologies at signalized intersections include:

- ITS detection technologies at intersections
- Closed-circuit television (CCTV) at intersections
- Adaptive Signal Control Technology (ASCT)
- Signal coordination
- Preemption and priority technologies at intersections

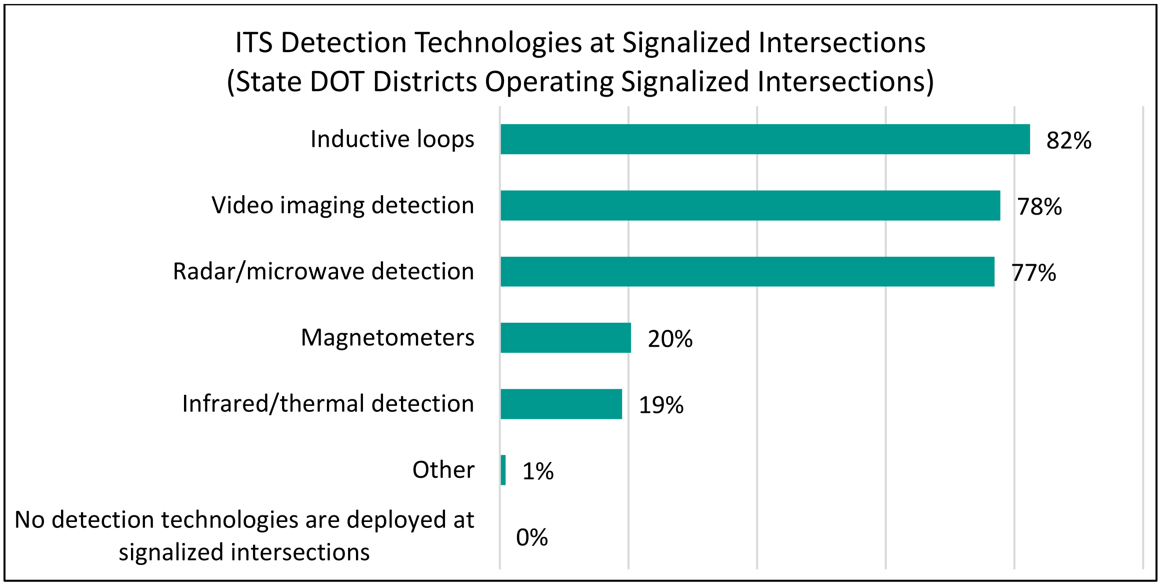
A large majority of surveyed State DOT districts managing arterials operate signalized intersections (80 percent). The following subsections present ITS technology deployment across the subset of 221 responding State DOT districts managing arterials operating signalized intersections.

[23] Skip logic is survey programming that automatically skips respondents past one or more questions based on their response to a previous question. For example, if an agency does not manage signalized intersections, they would skip out of the series of questions that ask about ITS at signalized intersections.

ITS Detection Technologies at Intersections Among State DOT Districts Operating Signalized Intersections

Of the 221 State DOT districts operating signalized intersections, 98 percent deploy at least one ITS detection technology at signalized intersections. State DOT districts deploying detection technologies at intersections use an average of 2.8 different ITS detection technologies.

As shown in Figure 2, a large majority of State DOT districts operating signalized intersections deploy *inductive loops* (82 percent), while *video imaging detection* (78 percent) and *radar/microwave detection* (77 percent) are each deployed by about three fourths of responding districts. *Magnetometers* (20 percent) and *infrared/thermal detection* (19 percent), a new response category in 2023, are each deployed by about one fifth of responding districts. No State DOT districts operating signalized intersections reported *no detection technologies are deployed at signalized intersections.*



2023 Q3; (n=221; 2% missing) *Source: USDOT*

Figure 2. ITS Detection Technologies at Signalized Intersections (State DOT Districts Operating Signalized Intersections)

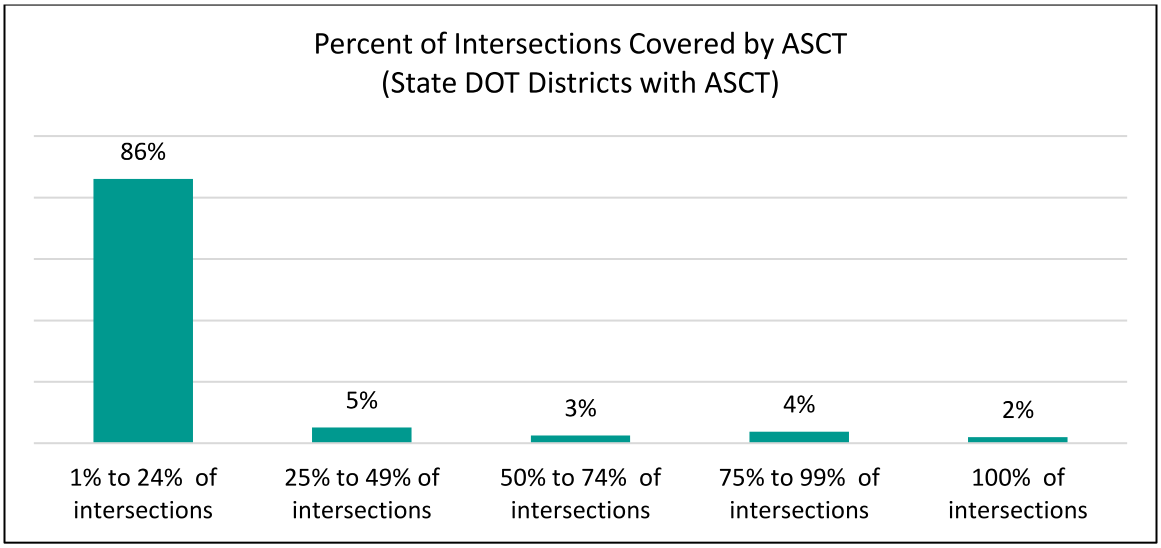
CCTV at Intersections Among State DOT Districts Operating Signalized Intersections

Nearly three fourths of the 221 State DOT districts operating signalized intersections equip signalized intersections with *CCTV* (70 percent) for the purpose of monitoring traffic flow.

Adaptive Signal Control Technology at Intersections Among State DOT Districts Operating Signalized Intersections

Of the 221 State DOT districts operating signalized intersections, over one third use *ASCT* (36 percent) as an operational strategy to improve coordinated signal timing.

Figure 3 shows a large majority of the 79 State DOT districts deploying ASCT do so on *1% to 24% of intersections* (86 percent). In contrast, 5 percent or fewer State DOT districts deploying ASCT do so on each of the subsequent response categories: *25% to 49% of intersections* (5 percent), *50% to 74% of intersections* (3 percent), *75% to 99% of intersections* (4 percent), and *100% of intersections* (2 percent).



2023 Q6; (n=79; 0% missing) *Source: USDOT*

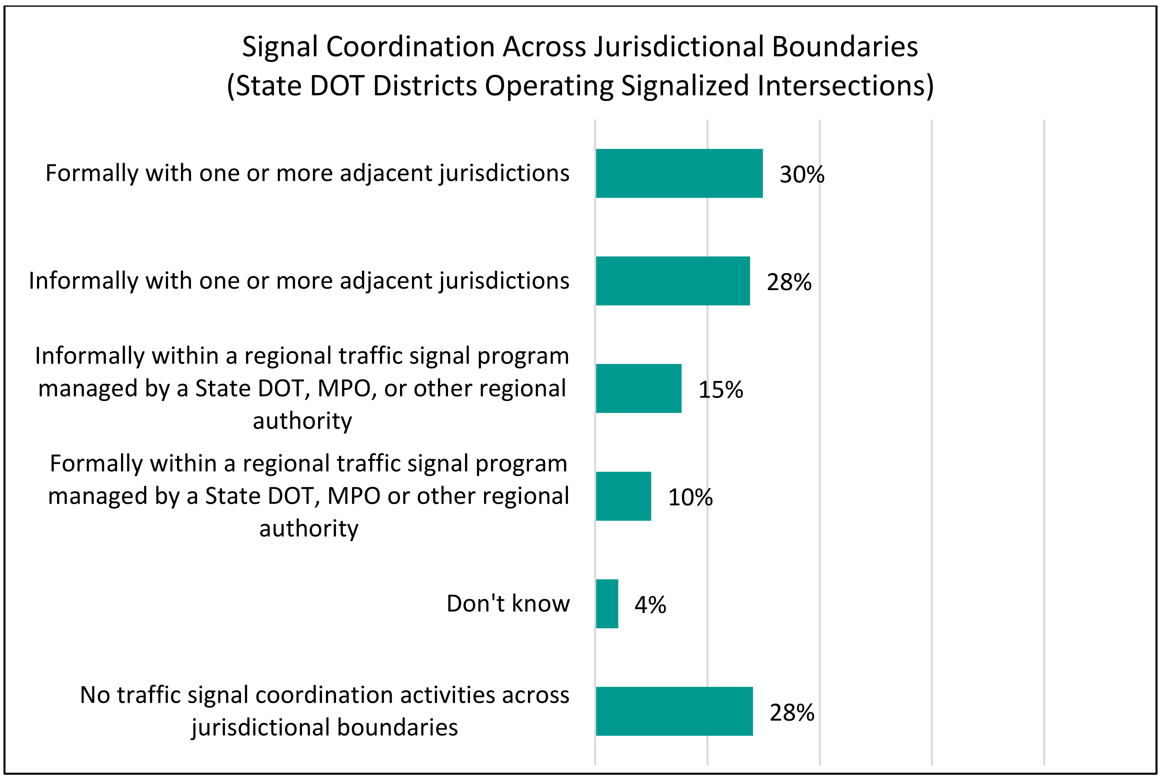
Figure 3. Percent of Intersections Covered by ASCT (State DOT Districts with ASCT)

Signal Coordination Among State DOT Districts Operating Signalized Intersections

Of the 221 State DOT districts operating signalized intersections, two thirds participate in signal coordination across jurisdictional boundaries (66 percent).

As shown in Figure 4, about one third of State DOT districts operating signalized intersections participate in signal coordination *formally with one or more adjacent jurisdictions*[24] (30 percent), while about one fourth participate *informally with one or more adjacent jurisdictions* (28 percent).

Fewer State DOT districts operating signalized intersections participate in signal coordination *informally within a regional traffic program managed by a State DOT, Metropolitan Planning Organization (MPO), or other regional authority* (15 percent), or *formally within a regional traffic program managed by a State DOT, MPO or other regional authority* (10 percent). About one fourth of State DOT districts operating signalized intersections report they *do not participate in traffic signal coordination activities across jurisdictional boundaries* (28 percent).



2023 Q7; (n=221; 1% missing) *Source: USDOT*

Figure 4. Signal Coordination Across Jurisdictional Boundaries (State DOT Districts Operating Signalized Intersections)

[24] The survey instrument provided examples of formal agreements, including Memorandums of Understanding and written agreements.

As shown in Table 4, State DOT districts operating signalized intersections with a large urban area are significantly more likely to participate in signal coordination *formally within a regional traffic signal program managed by a State DOT, MPO or other regional authority* compared to State DOT districts without a large urban area (15 percent compared to 6 percent).

By contrast, a greater percentage of State DOT districts operating signalized intersections without a large urban area reported they *do not participate in traffic signal coordination activities across jurisdictional boundaries* compared to State DOT districts with a large urban area (39 percent compared to 14 percent).

Table 4. Signal Coordination Across Jurisdictional Boundaries (Districts with Signal Coordination): Significant Differences Between State DOT District Population Groups

Response	State DOT Districts with a Large Urban Area (n=99)	State DOT Districts without a Large Urban Area (n=122)
Formally within a regional traffic signal program managed by a State DOT, MPO or other regional authority	15%	6%
Does not participate in traffic signal coordination activities across jurisdictional boundaries	14%	39%

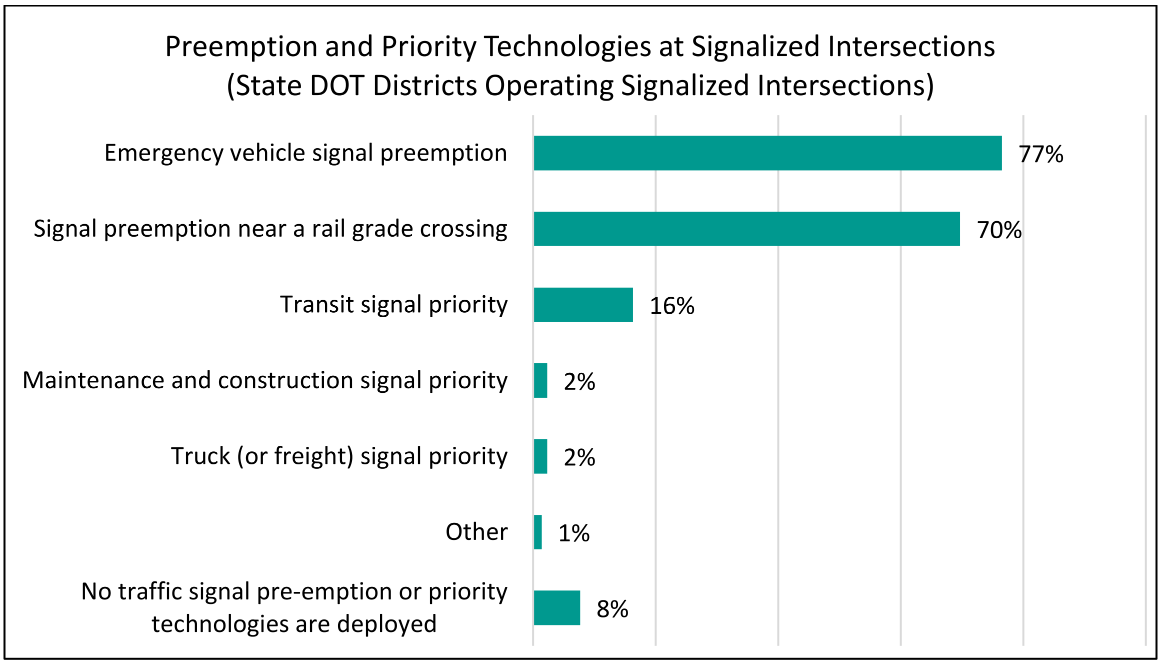
Source: USDOT

Preemption and Priority Technologies at Intersections Among State DOT Districts Operating Signalized Intersections

Of the 221 State DOT districts operating signalized intersections, 91 percent deploy at least one preemption or priority technology at signalized intersections. State DOT districts deploying these technologies at intersections reported deploying an average of 1.9 different technologies.

Figure 5 shows that about three fourths of State DOT districts operating signalized intersections deploy *emergency vehicle signal preemption* (77 percent), 70 percent deploy s*ignal preemption near a rail grade crossing*, and 16 percent deploy *transit signal priority* at intersections.

A substantially lower percentage of State DOT districts operating signalized intersections deploys *maintenance and construction signal priority* (2 percent), a new response category in 2023, and *truck (or freight) signal priority* (2 percent). Eight (8) percent of State DOT districts operating signalized intersections reported *no traffic signal preemption or priority technologies are deployed.*



2023 Q8; (n=221; 1% missing) *Source: USDOT*

Figure 5. Preemption and Priority Technologies at Signalized Intersections (State DOT Districts Operating Signalized Intersections)

Among State DOT districts operating signalized intersections, there is a significant difference in the deployment of *transit signal priority* at intersections between population groups. About one fourth of State DOT districts operating signalized intersections with a large urban area (27 percent) deploy *transit signal priority* compared to 7 percent of State DOT districts without a large urban area.

Safety-Related ITS Technologies

Safety-related ITS technologies include:

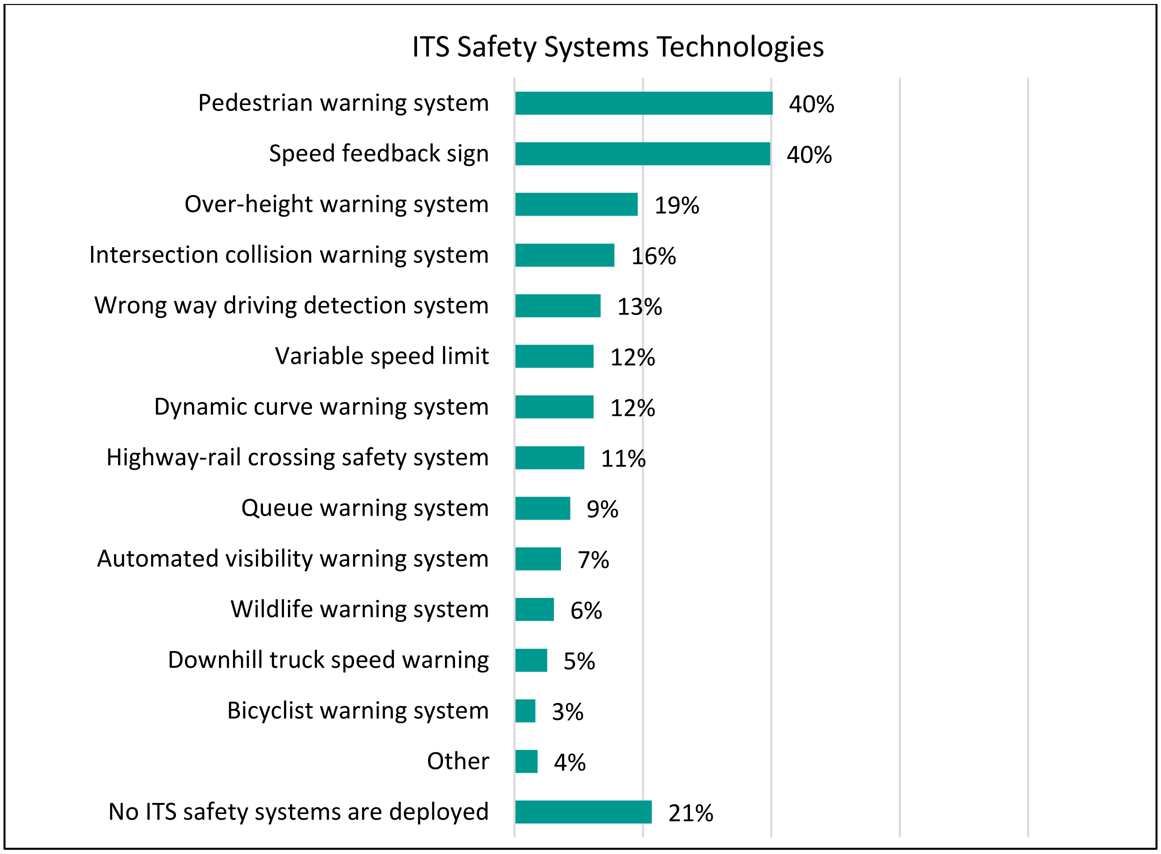
- ITS safety systems technologies
- Work zone ITS technologies
- ITS for road weather management
- Automated enforcement technologies
- Incident detection and verification methods

ITS Safety Systems Technologies

Among all responding State DOT districts managing arterials, 78 percent deploy at least one ITS safety systems technology on arterials. State DOT districts managing arterials deploying ITS safety systems deploy an average of 2.5 technologies.

Figure 6 shows *pedestrian warning systems* (40 percent) and *speed feedback signs* (40 percent) have the highest deployment levels across all surveyed ITS safety systems technologies among State DOT districts managing arterials. *Over-height warning systems* (19 percent), *intersection collision warning systems* (16 percent), *wrong way detection systems* (13 percent), *variable speed limits* (12 percent), *dynamic curve warning systems* (12 percent), and *highway-rail crossing safety systems* (11 percent) are each deployed by fewer than one fifth of State DOT districts managing arterials.

Fewer than 10 percent of State DOT districts managing arterials deploy *queue warning systems*, *automated visibility warning systems*, *wildlife warning systems*, *downhill truck speed warnings*, and *bicyclist warning systems*. About one fifth of responding State DOT districts managing arterials reported *no ITS safety systems are deployed* (21 percent).



2023 Q17; (n=276; 1% missing) *Source: USDOT*

Figure 6. ITS Safety Systems Technologies

Table 5 shows that State DOT districts managing arterials with a large urban area compared to State DOT districts without a large urban area are significantly more likely to deploy *wrong way driving detection systems* (20 percent compared to 8 percent), while significantly fewer State DOT districts with a large urban area deploy *intersection collision warning systems* compared to State DOT districts without a large urban area (8 percent compared to 21 percent).

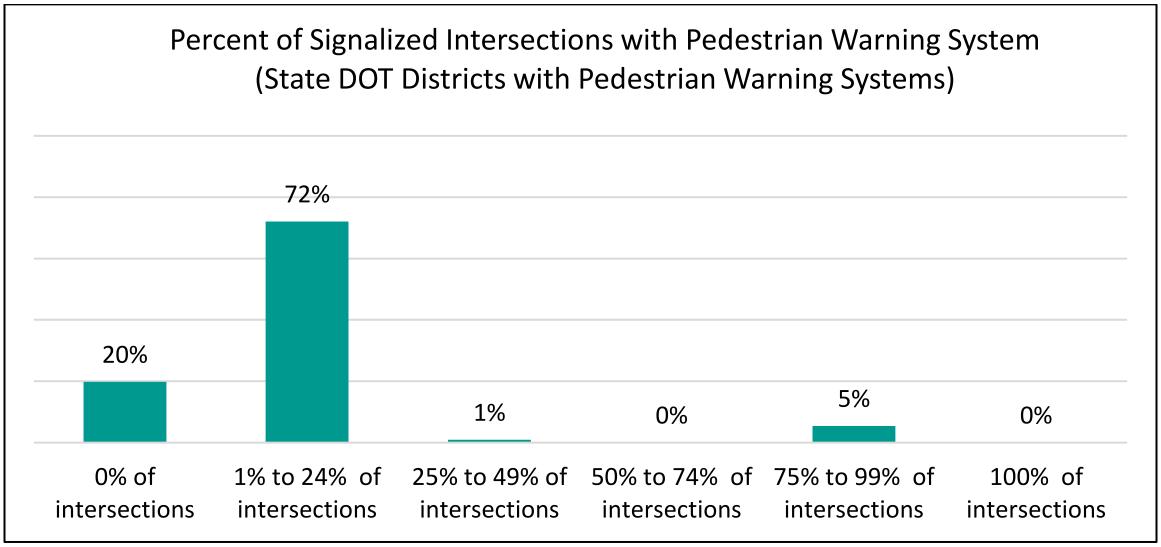
Table 5. ITS Safety Systems Technologies: Significant Differences Between State DOT District Population Groups

Technology	State DOT Districts with a Large Urban Area (n=120)	State DOT Districts without a Large Urban Area (n=156)
Wrong way driving detection	20%	8%
Intersection collision warning system	8%	21%

Source: USDOT

The 111 State DOT districts managing arterials that deploy ITS pedestrian warning systems were asked what percentage of their signalized intersections are equipped with ITS pedestrian warning systems (e.g. pedestrian hybrid beacon, passive pedestrian sensors).

Figure 7 shows that 20 percent of these State DOT districts equip *0% of intersections*.[25] Nearly three fourths of State DOT districts reported that *1% to 24% of intersections* (72 percent) are equipped, and 5 percent or fewer responded to each category indicating deployment greater than 25% of intersections.



2023 Q18; (n=111; 2% missing) *Source: USDOT*

Figure 7. Percent of Signalized Intersections with a Pedestrian Warning System (State DOT Districts with Pedestrian Warning Systems)

Work Zone ITS Technologies

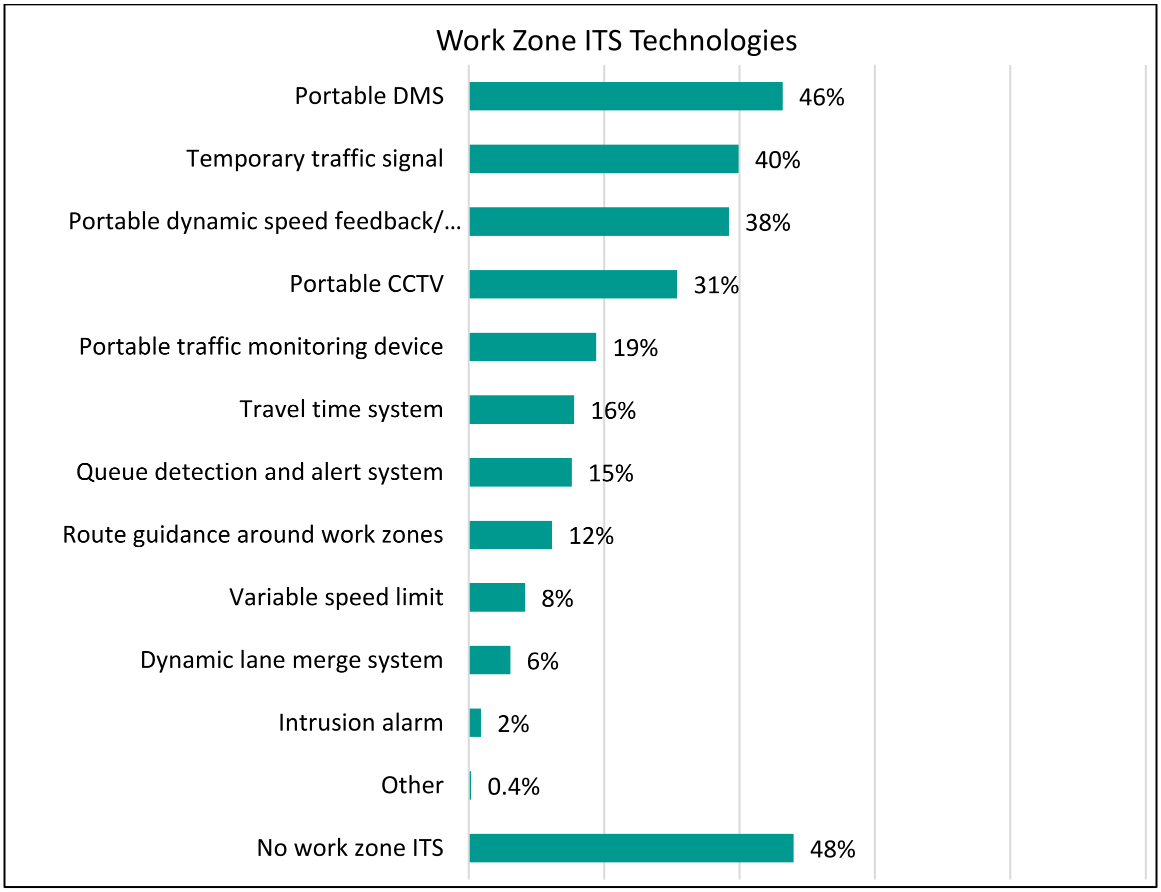
Among all responding State DOT districts managing arterials, 51 percent deploy at least one work zone ITS technology, and nearly half reported they deploy *no work zone ITS* (48 percent).

In a follow-up question, respondents were asked to report on the specific work zone ITS technologies they use. State DOT districts managing arterials who reported using any work zone ITS deploy an average of 4.6 work zone ITS technologies. There were two new response categories in 2023—*portable dynamic message sign (DMS)* and *portable dynamic speed feedback/speed radar trailers*—which had been common write-in responses to the *Other* response option in the 2020 survey.

[25] Note that pedestrian warning systems can be deployed mid-block and are therefore not always placed at signalized intersections.

Figure 8 shows that these technologies are among the most deployed work zone ITS technologies in 2023. Nearly one half of State DOT districts managing arterials deploy *portable DMS* (46 percent) at work zones while 40 percent deploy *temporary traffic signals*. *Portable dynamic speed feedback/speed radar trailers* (38 percent) and *portable CCTV* (31 percent) are each deployed by about one third.

Portable traffic monitoring devices (19 percent), *travel time systems* (16 percent)*, queue detection and alert systems* (15 percent), and *route guidance around work zones* (12 percent) are each deployed by less than one fifth of State DOT districts managing arterials. *Variable speed limits*, *dynamic lane merge systems*, and *intrusion alarms* are each deployed by less than 10 percent of respondents.



2023 Q23; (n=276; 1% missing) *Source: USDOT*

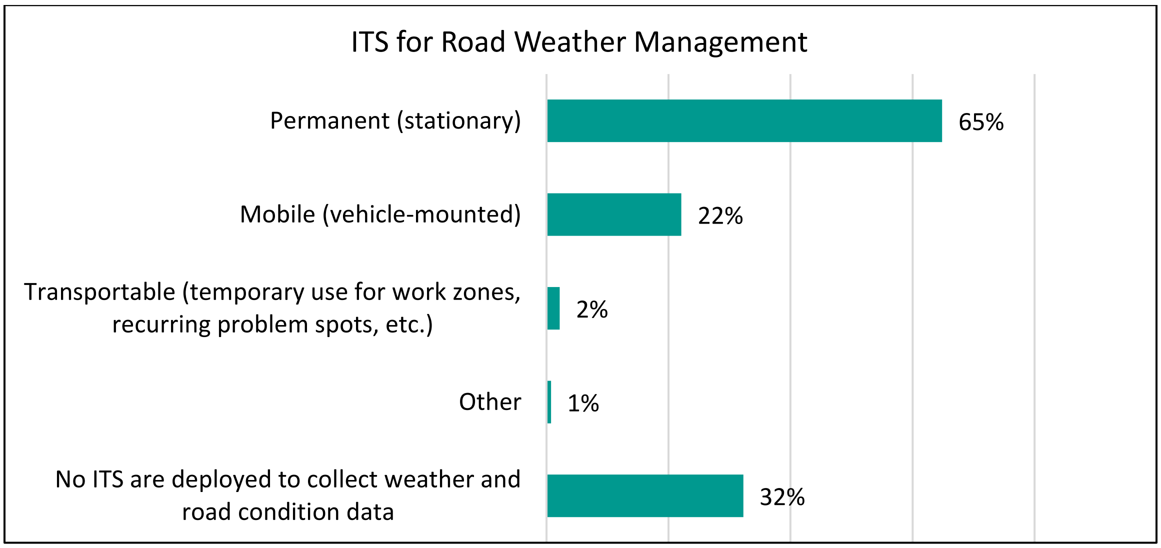
Figure 8. Work Zone ITS Technologies

About one fifth of State DOT districts managing arterials with a large urban area (21 percent) deploy *travel time systems* which is significantly higher compared to 12 percent of State DOT districts without a large urban area.

ITS for Road Weather Management

The survey included a question on the different types (permanent, mobile, or transportable) of Road Weather Information Systems (RWIS)/Environmental Sensor Stations (ESS) deployed by arterial management agencies. Among all responding State DOT districts managing arterials, 67 percent use one or more of the surveyed types of RWIS/ESS.

Figure 9 shows about two thirds of responding State DOT districts managing arterials use *permanent (stationary)* systems (65 percent), and 22 percent use *mobile (vehicle mounted)* systems to collect weather and road conditions data on arterials. Use of *transportable (temporary use)* systems was reported by only 2 percent of State DOT districts managing arterials. About one third of State DOT districts managing arterials reported *no ITS are deployed to collect weather and road condition data* (32 percent).



2023 Q19; (n=276; 1% missing) *Source: USDOT*

Figure 9. ITS for Road Weather Management

As shown in Table 6, State DOT districts managing arterials without a large urban area are significantly more likely than State DOT districts with a large urban area to use *permanent (stationary)* systems (73 percent compared to 54 percent) and *mobile (vehicle mounted)* systems (28 percent compared to 15 percent).

State DOT districts managing arterials with a large urban area are significantly more likely to report *no ITS are deployed to collect weather and road condition data* compared to State DOT districts without a large urban area (41 percent compared to 26 percent).

Table 6. ITS for Road Weather Management: Significant Differences Between District Population Groups

Technology	State DOT Districts with a Large Urban Area (n=120)	State DOT Districts without a Large Urban Area (n=156)
Permanent (stationary) systems	54%	73%
Mobile (vehicle mounted) systems	15%	28%
No ITS are deployed to collect weather and road condition data	41%	26%

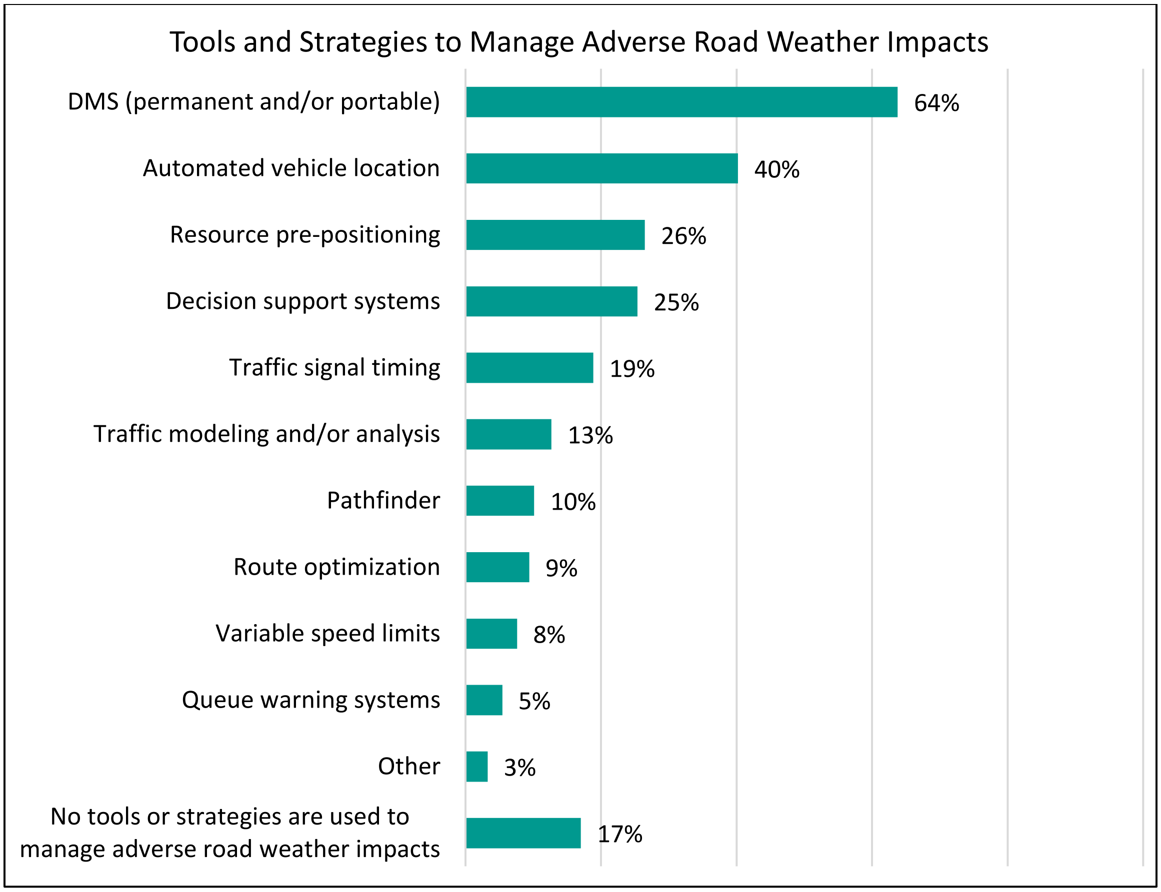
Source: USDOT

For the first time in 2023, the ITS Deployment Tracking Survey included a question asking all surveyed State DOT districts managing arterials which tools and strategies they use to manage adverse road weather impacts. A large majority of State DOT districts managing arterials (82 percent) use at least one tool or strategy to manage adverse road weather impacts, and among the State DOT districts using tools or strategies, they reported using an average of 2.7 tools or strategies (out of 11 response categories).

Figure 10 shows that almost two thirds of responding State DOT districts managing arterials use *DMS (permanent and/or portable)* (64 percent) to manage adverse road weather impacts. Less than half reported using *automated vehicle location* (40 percent), while *resource pre-positioning* (26 percent) and *decision support systems* (25 percent) are each used by about one fourth of responding State DOT districts managing arterials.

Traffic signal timing (19 percent) and *traffic modeling and/or analysis* (13 percent) are each used by less than one fifth of responding State DOT districts managing arterials. *Pathfinder*[26], *route optimization*, *variable speed limits*, and *queue warning systems* are each reported by fewer than 10 percent of State DOT districts managing arterials. Nearly one fifth reported *no tools or strategies are used to manage adverse road weather impacts* (17 percent).

[26] "Pathfinder" is a collaborative strategy for proactive transportation system management ahead of and during adverse weather events and encourages State DOTs, National Weather Service, and weather service contractors to share and translate weather forecasts and road conditions into consistent transportation impact messages for the public. For more information, see: https://ops.fhwa.dot.gov/publications/fhwahop18034/index.htm



2023 Q20; (n=276; 1% missing) *Source: USDOT*

Figure 10. Tools and Strategies to Manage Adverse Road Weather Impacts

Table 7 shows that State DOT districts managing arterials without large urban area are significantly more likely than State DOT districts with a large urban area to use *automated vehicle location* (47 percent compared to 32 percent), as well as *DMS (permanent and/or portable)* (69 percent compared to 57 percent) to manage adverse road weather impacts.

Table 7. Tools and Strategies to Manage Adverse Road Weather Impacts: Significant Differences Between State DOT District Population Groups

Technology	State DOT Districts with a Large Urban Area (n=120)	State DOT Districts without a Large Urban Area (n=156)
Automated Vehicle Location	32%	47%
DMS (permanent and/or portable)	57%	69%

Source: USDOT

Automated Enforcement Technologies

In 2023, 9 percent of all surveyed State DOT districts managing arterials (24 State DOT districts) deploy at least one automated enforcement technology on arterials. Due to the small sample size of State DOT districts deploying automated enforcement, percentages are not reported in this section.

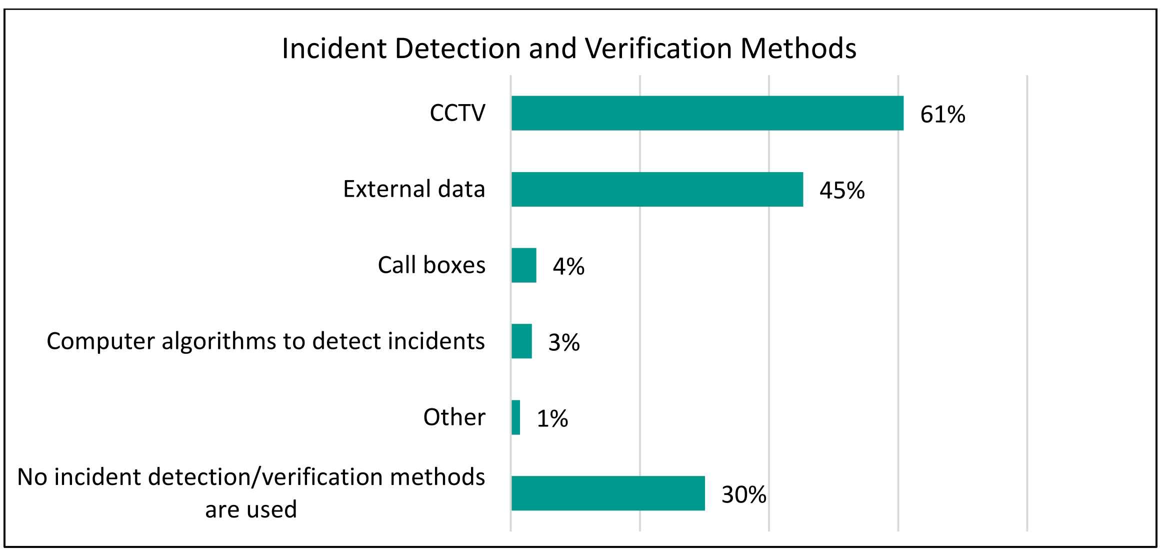
Among the 24 State DOT districts deploying automated enforcement technologies on arterials, 18 State DOT districts use *cameras*, 16 State DOT districts use *radar*, 7 State DOT districts use *license plate recognition*, and 2 State DOT districts use *toll tag readers*.

Of the 24 State DOT districts deploying automated enforcement technologies on arterials, 14 State DOT districts use automated enforcement technologies in *work zones*, 9 State DOT districts for *speeding*, 8 State DOT districts for *red light running*, 6 State DOT districts in *school zones*, and 3 State DOT districts at *railroad crossings*. None of these 24 State DOT districts with automated enforcement technologies reported using for *bus-use only*.

Incident Detection and Verification

Over two thirds of the responding State DOT districts managing arterials use at least one incident detection or verification method on arterials (69 percent).

Figure 11 shows that a majority of State DOT districts managing arterials use *CCTV* (61 percent), and 45 percent use *external data (e.g., data provided by crowdsourcing, commercial providers, or citizen-reported)* for incident detection or verification on arterials. Substantially fewer use *call boxes* (4 percent) and *computer algorithms to detect incidents* (3 percent). About one third of State DOT districts managing arterials reported *no incident detection/verification methods are used* (30 percent).



2023 Q21; (n=276; 1% missing) *Source: USDOT*

Figure 11. Incident Detection and Verification Methods

Real-Time Data Collection

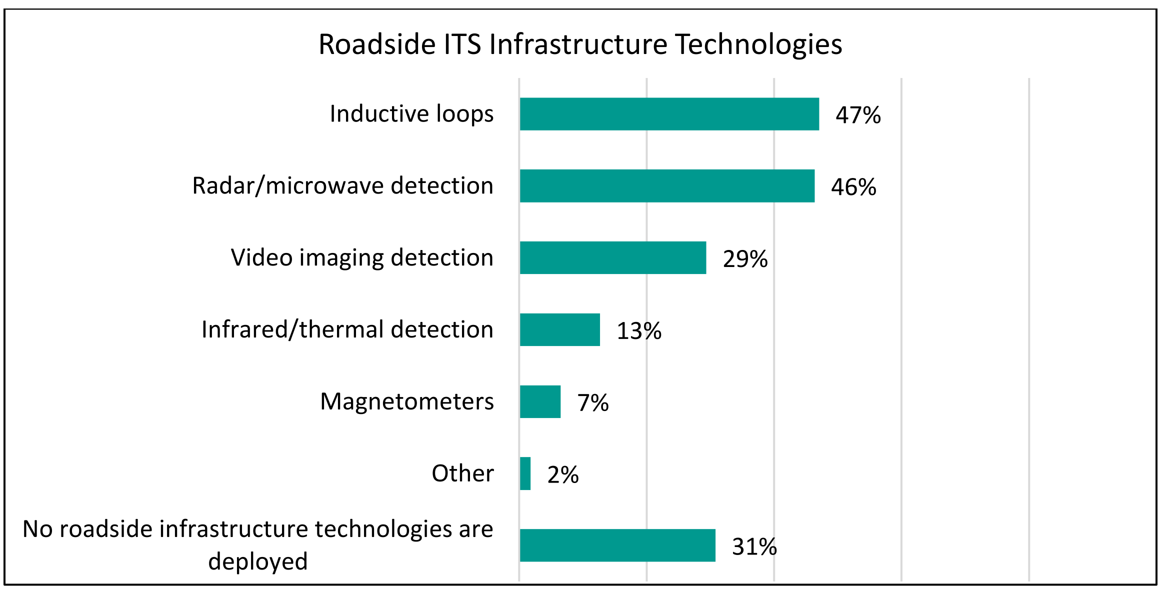
Real-time data collection includes:

- Roadside ITS infrastructure technologies
- Vehicle probe readers
- External data sources

Roadside ITS Infrastructure Technologies

About two thirds of all responding State DOT districts managing arterials deploy at least one roadside ITS infrastructure technology (65 percent). Among these deployers, State DOT districts deploy an average of 2.2 different roadside ITS technologies on arterials.

As shown in Figure 12, *inductive loops* (47 percent) and *radar/microwave detection* (46 percent) are each deployed by nearly half of State DOT districts managing arterials, while 29 percent deploy *video imaging detection technologies*. Fewer State DOT districts managing arterials deploy *infrared/thermal detection technologies* (13 percent), a new response category in 2023, and *magnetometers* (7 percent). About one third of responding State DOT districts managing arterials reported *no roadside infrastructure technologies are deployed* (31 percent).



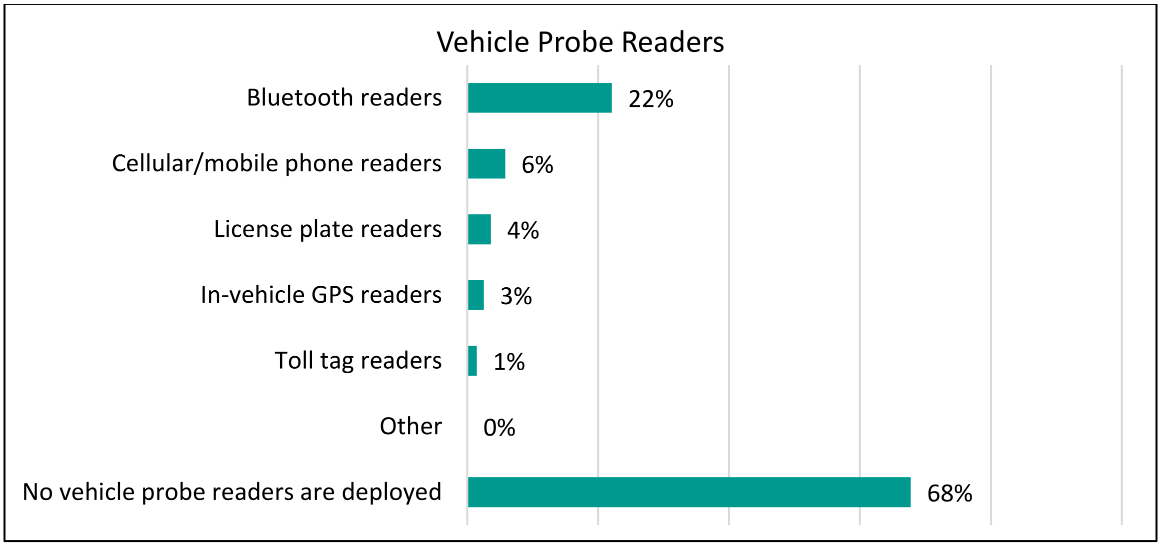
2023 Q9; (n=276; 5% missing) *Source: USDOT*

Figure 12. Roadside ITS Infrastructure Technologies

Vehicle Probe Readers

Vehicle probe readers are deployed by 28 percent of all responding State DOT districts managing arterials, and these deployers use an average of 1.3 different types of vehicle probe readers.

As shown in Figure 13, *Bluetooth readers* (22 percent) were the most reported type of vehicle probe readers. Fewer State DOT districts managing arterials deploy *cellular/mobile phone readers* (6 percent), *license plate readers* (4 percent), *in-vehicle GPS* readers (3 percent), and *toll tag readers* (1 percent). About two thirds of State DOT districts managing arterials reported *no vehicle probe readers are deployed* (68 percent).



2023 Q10; (n=276; 4% missing) *Source: USDOT*

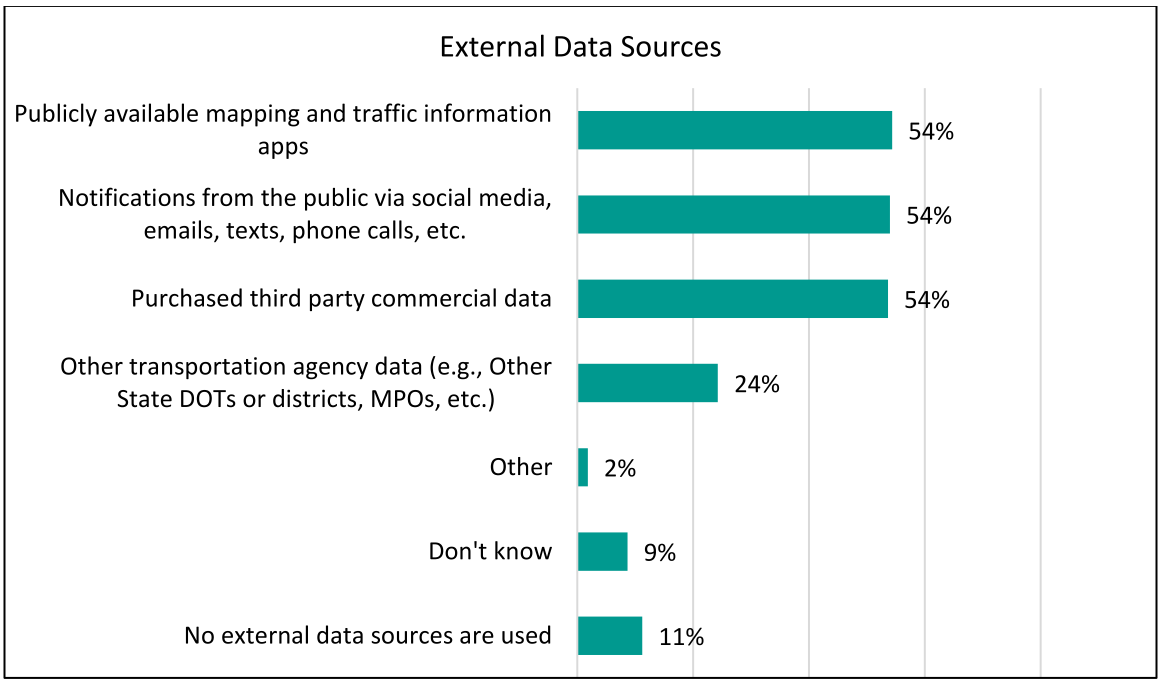
Figure 13. Vehicle Probe Readers

State DOT districts managing arterials with a large urban area (28 percent) are significantly more likely to deploy *Bluetooth* vehicle probe readers compared to State DOT districts without a large urban area (17 percent).

External Data Sources

A large majority of all responding State DOT districts managing arterials use at least one source of external data (80 percent) for arterial management. State DOT districts managing arterials using external data use an average of 2.3 different sources.

As shown in Figure 14, *publicly available mapping and traffic information apps; notifications from the public via social media, emails, texts, phone calls, etc.*; and *purchased third-party commercial data* are each deployed by 54 percent of responding State DOT districts managing arterials. About one fourth reported using *other transportation agency data (e.g., other State DOTs or districts, MPOs, etc.)* (24 percent), a new response category in 2023. Eleven (11) percent of State DOT districts reported *no external data sources are used.*



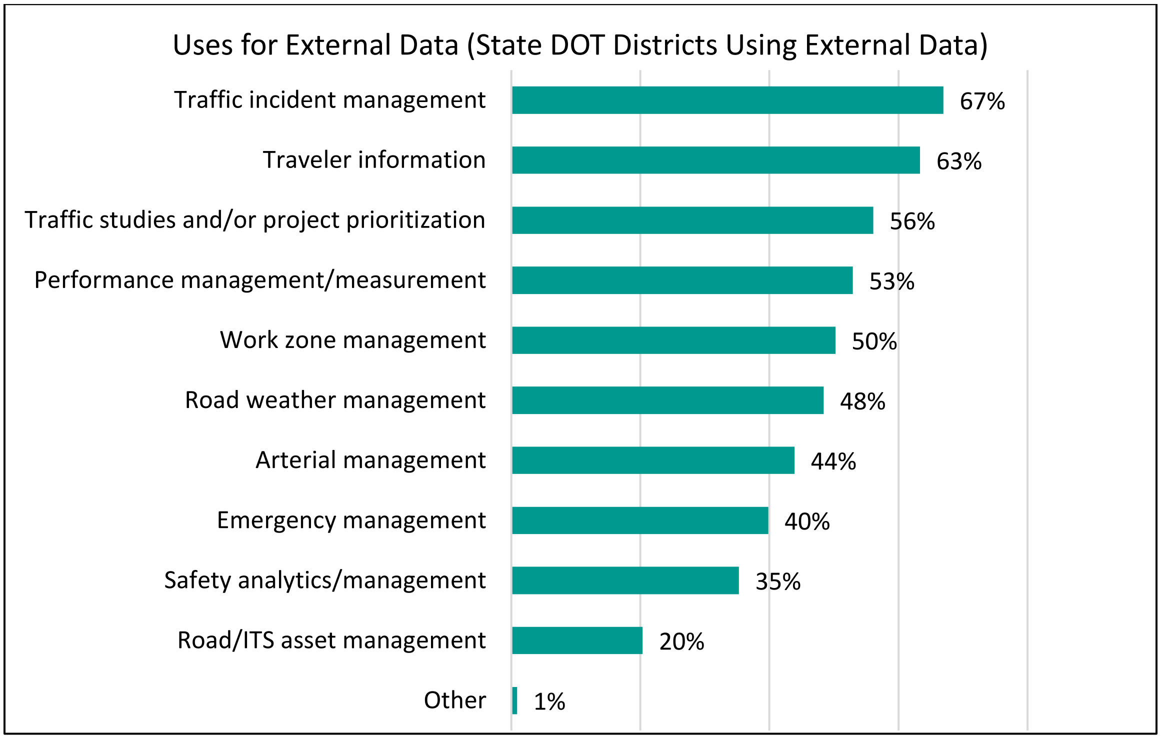
2023 Q11; (n=276; 0% missing) *Source: USDOT*

Figure 14. External Data Sources

The 2023 ITS Deployment Tracking Survey included a new question about how external data are being used, which was asked of State DOT districts that reported using external data sources for arterial management. The 221 State DOT districts using external data for arterial management reported an average of 4.9 different uses for external data.

As shown in Figure 15, about two thirds of the 221 State DOT districts using external data for arterial management use it for *traffic incident management* (67 percent) and *traveler information* (63 percent), while 56 percent use external data for *traffic studies and/or project prioritization*.

Performance management/measurement (53 percent) and *work zone management* (50 percent) are each uses for about one half of State DOT districts using external data for arterial management. *Road weather management* (48 percent), *arterial management* (44 percent), and *emergency management* (40 percent) are each uses for less than one half of State DOT districts, while fewer use it for *safety analytics/management* (35 percent) or *road/ITS management* (20 percent).



2023 Q12; (n=221; 2% missing) *Source: USDOT*

Figure 15. Uses for External Data (State DOT Districts Using External Data)

Table 8 shows that among the 221 State DOT districts using external data for arterial management, State DOT districts with a large urban area are significantly more likely to use external data for *arterial management* than State DOT districts without a large urban area (55 percent compared to 35 percent). By contrast, State DOT districts using external data for arterial management without a large urban area are significantly more likely to use external data for *road weather management* than State DOT districts with a large urban area (59 percent compared to 35 percent).

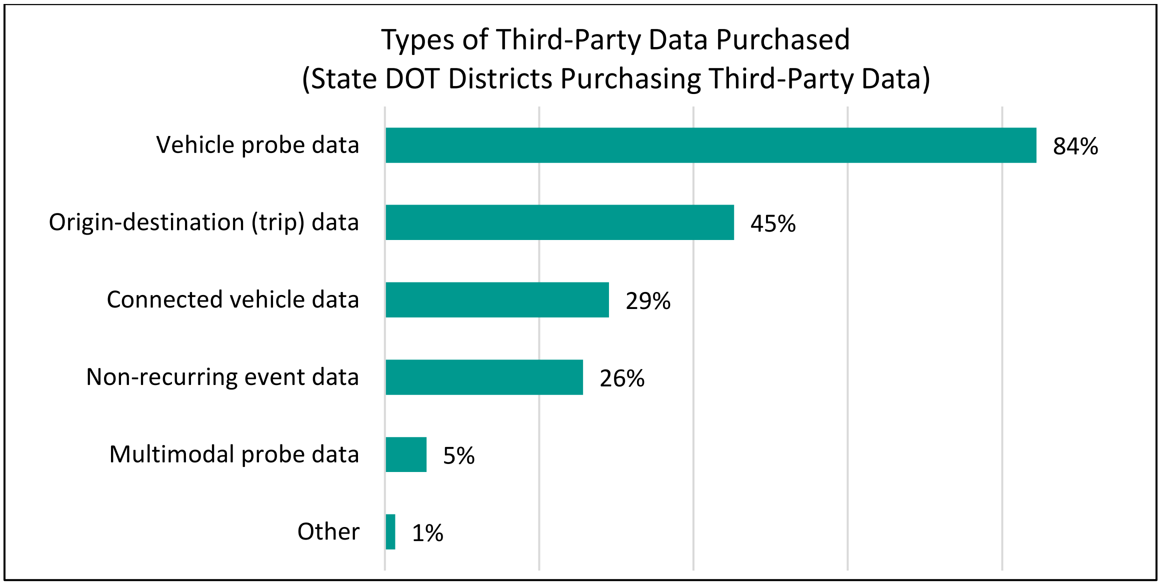
Table 8. Uses for External Data (State DOT Districts Using External Data): Significant Differences Between State DOT District Population Groups

Use	State DOT Districts with a Large Urban Area (n=99)	State DOT Districts without a Large Urban Area (n=122)
Arterial management	55%	35%
Road weather management	35%	59%

Source: USDOT

For the first time in 2023, State DOT districts managing arterials that reported purchasing third-party commercial *data* were also asked what types of arterial data they purchase. These State DOT districts purchase an average of 2.0 types of third-party commercial data.

As shown in Figure 16, a majority of the 148 State DOT districts managing arterials that purchase third-party data reported purchasing *vehicle probe data* (84 percent), while a lower percentage of these districts purchase *origin-destination (trip) data* (45 percent), *connected vehicle data* (29 percent), *non-recurring event data* (26 percent), or *multimodal probe data* (5 percent).



2023 Q13; (n=148; 5% missing) *Source: USDOT*

Figure 16. Types of Third-Party Data Purchased (State DOT Districts Purchasing Third-Party Data)

Among the 148 State DOT districts managing arterials that reported purchasing third-party data, significantly more State DOT districts without large urban area (55 percent) purchase *origin-destination (trip) data* compared to State DOT districts with a large urban area (35 percent).

Telecommunications Technologies to Enable ITS

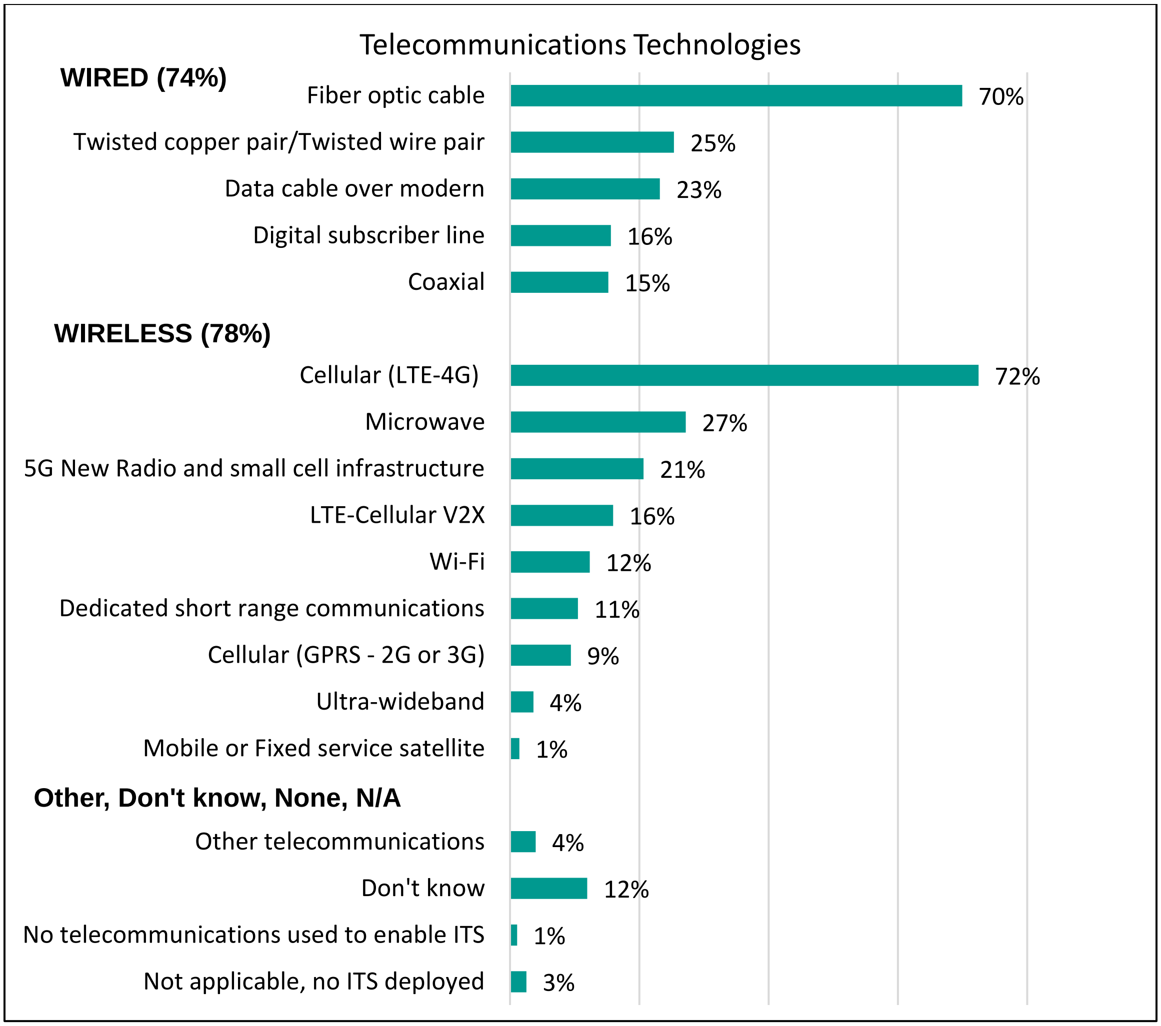
Telecommunications technologies enable communications between ITS devices, roadside devices, and/or a central processing location, typically for data collection and dissemination.

Among all responding State DOT districts managing arterials, 84 percent use at least one telecommunications technology (either wired or wireless) to enable ITS on arterials. Twelve (12) percent of State DOT districts responded *don't know,* 1 percent reported *no telecommunications used to enable ITS on arterials,* and 3 percent reported *no ITS infrastructure or devices are deployed*.

As shown in Figure 17, at least one wired telecommunications technology is deployed by about three fourths of State DOT districts managing arterials (74 percent), while 78 percent deploy at least one wireless telecommunications technology to enable ITS. State DOT districts managing arterials deploying any telecommunications technologies indicate using an average of 3.9 different wired and/or wireless telecommunications technologies to enable ITS.

Of the wired telecommunications technologies, *fiber-optic cable* (70 percent) is the most used type of telecommunications technology by State DOT districts managing arterials. Other wired technologies are used by fewer State DOT districts managing arterials, including *twisted copper pair/twisted wired pair* (25 percent), *data cable over modem* (23 percent), *digital subscriber line* (16 percent), and *coaxial* (15 percent).

Of the wireless telecommunications technologies, *cellular (LTE-4G)* (72 percent) is deployed by a large majority of State DOT districts managing arterials. About one fourth reported using *microwave* (27 percent), while about one fifth reported using *5G New Radio and small cell infrastructure* (21 percent). Fewer State DOT districts managing arterials use *LTE-Cellular V2X* (16 percent), *Wi-Fi* (12 percent), and *dedicated short range communications* (11 percent). *Cellular (GPRS -2G or 3G)*, *ultra-wideband*, and *mobile or fixed service satellite* are each used by fewer than 10 percent of State DOT districts managing arterials.



2023 Q42; (n=276; 1% missing) *Source: USDOT*

Figure 17. Telecommunications Technologies

Table 9 shows that State DOT districts managing arterials with a large urban area are significantly more likely to use *fiber-optic cable* compared to State DOT districts without a large urban area (79 percent compared to 63 percent). Significantly fewer State DOT districts with a large urban area compared to State DOT districts without a large urban area use *microwave* (20 percent compared to 33 percent).

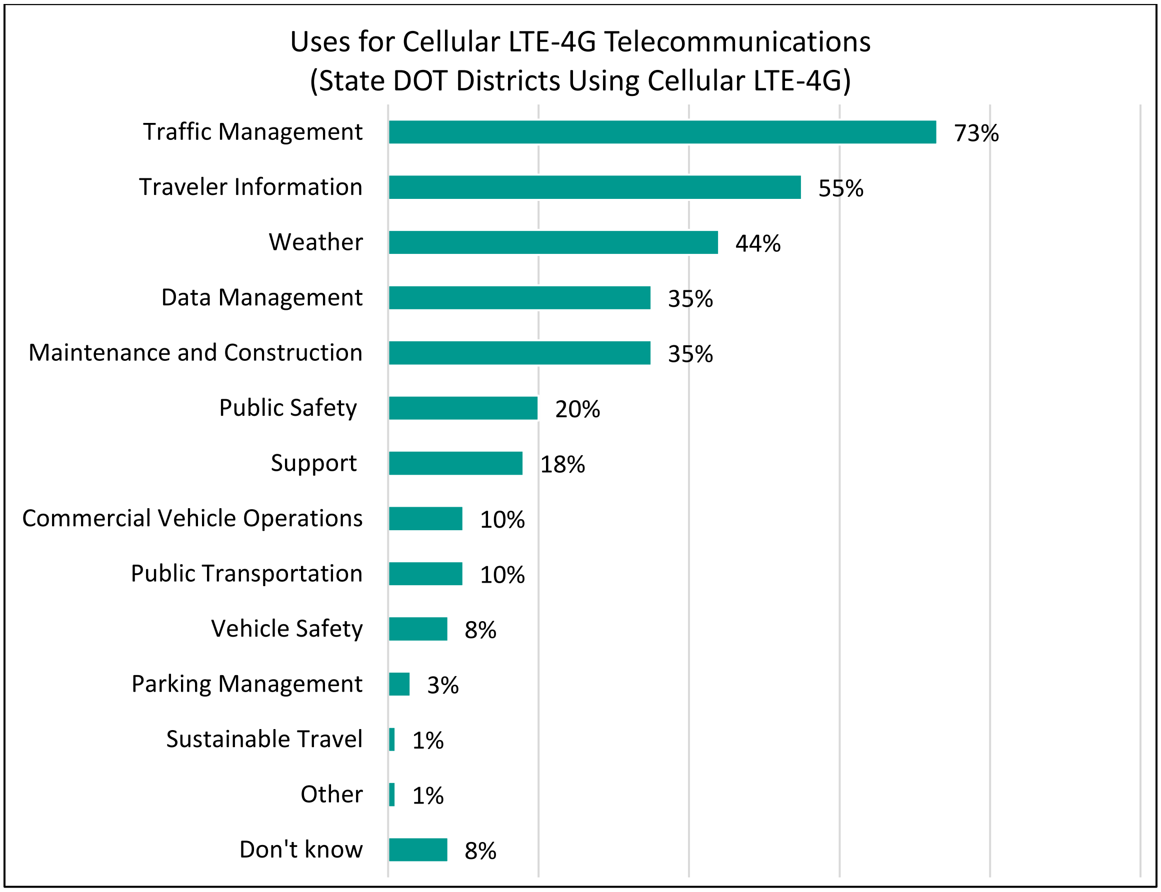
Table 9. Telecommunications Technologies: Significant Differences Between State DOT District Population Groups

Technology	State DOT Districts with a Large Urban Area (n=120)	State DOT Districts without a Large Urban Area (n=156)
Fiber-optic cable	79%	63%
Microwave	20%	33%

Source: USDOT

For the first time in 2023, survey respondents were asked how they use telecommunications technologies to enable ITS.[27]

As shown in Figure 19, about three fourths of the 200 State DOT districts that reported using cellular (LTE-4G) use this technology for *traffic management* (73 percent), a majority use it for *traveler information* (55 percent), and 44 percent for *weather*. *Data management* and *maintenance and construction* were each reported uses by 35 percent of State DOT districts using cellular (LTE-4G). All other uses of cellular (LTE-4G) were reported by fewer than 20 percent of State DOT districts.



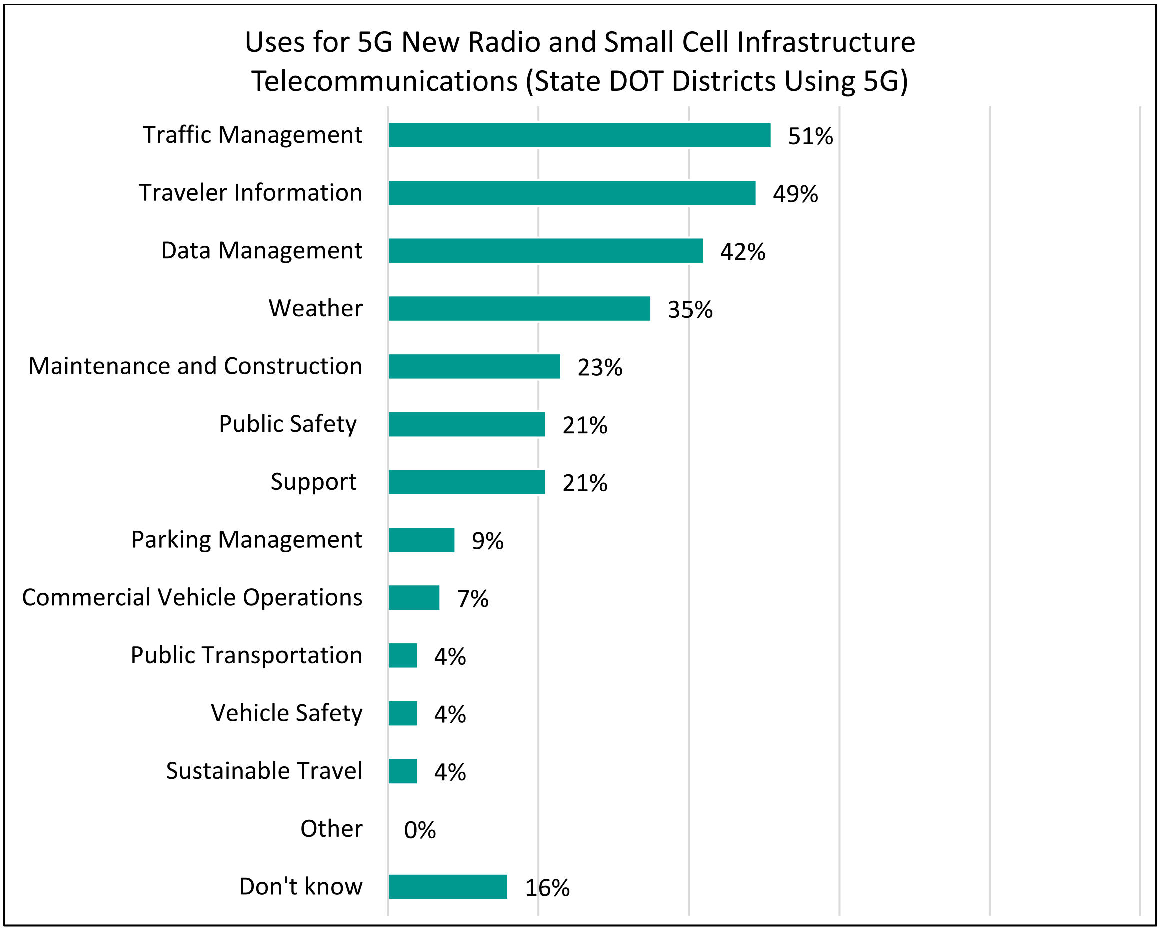
2023 Q43; (n=200; 7% missing) *Source: USDOT*

Figure 18. Uses for Cellular LTE-4G Telecommunications (State DOT Districts Using Cellular LTE-4G)

State DOT districts managing arterials without a large urban area are significantly more likely than State DOT districts with a large urban area to use cellular (LTE-4G) for *weather* (60 percent compared to 25 percent).

[27] This follow-up question applied to a subset of telecommunications technologies. Excluded technologies were coaxial, fiber-optic cable, mobile or fixed service satellite, ultra-wideband, or microwave.

Figure 19 shows about half of the 57 State DOT districts that reported using 5G New Radio and small cell infrastructure use this technology for *traffic management* (51 percent) and *traveler information* (49 percent), while 42 percent use it for *data management,* and over a third use it for *weather* (35 percent). All other uses of 5G New Radio and small cell infrastructure were reported by less than one fourth of State DOT districts.



2023 Q43; (n=57; 25% missing) *Source: USDOT*

Figure 19. Uses for 5G New Radio and Small Cell Infrastructure Telecommunications (State DOT Districts Using 5G)

Connected Vehicles

The 2023 questionnaire included a number of questions on the deployment of connected vehicle (CV) technologies. Due to the complex skip logic in this section of the survey, a summary of the questions is presented here.

All 276 State DOT districts managing arterials were asked first about whether they are currently developing, testing, or deploying CV technologies. Response options included *yes*; *no, but my agency is planning for CV*; *no plans for CV*; and *don't know*.

The subset of State DOT districts managing arterials that reported they are not currently developing, testing, or deploying CV but are planning for CV deployment in the future were asked two follow-up questions:

- Whether their plans for CV are documented *(yes, no, don't know)*
- When they plan to begin developing, testing, or deploying CV (*within the next 3 years, in 3 to 6 years*, or *in 7 or more years*)

The subset of State DOT districts managing arterials that reported they are currently developing, testing, or deploying CV technologies were asked two follow-up questions:

- Whether they are deploying RSUs on arterials *(yes, no, don't know)*
- Whether they are developing, testing or deploying CV applications on arterials *(yes, no, don't know)*

If a State DOT district reported deploying RSUs on arterials, it was asked two additional follow-up questions:

- How many RSUs are being tested or deployed on arterials
- Which standard data structures are being transmitted for the CV system by those RSUs

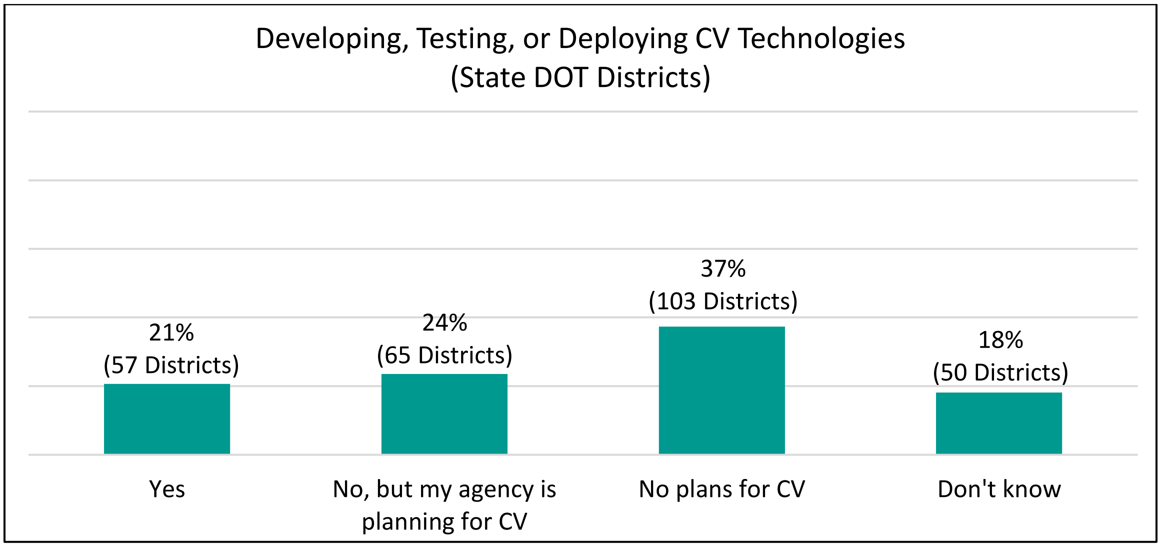
If a State DOT district reported it was developing, testing, or deploying CV applications for use on arterials, it was asked a single follow-up question:

- Which specific CV applications is the agency developing, testing or deploying on arterials

The findings for all these questions are presented in this section.

Developing, Testing, Or Deploying CV Technologies

Figure 20 shows that of all 276 responding State DOT districts managing arterials, 21 percent are *currently developing, testing, or deploying CV technologies*, while 24 percent are not currently developing, testing, or deploying but are *planning for CV*. About one third reported *no plans for CV* (37 percent). Eighteen (18) percent of State DOT districts managing arterials reported *don't know*.



2023 Q28; (n=276; 0.4% (1 district) missing) *Source: USDOT*

Figure 20. Developing, Testing, or Deploying CV Technologies (State DOT Districts)

Table 10 shows that State DOT districts managing arterials with a large urban area are significantly more likely to be *currently developing, testing, or deploying CV technologies* compared to State DOT districts without a large urban area (29 percent compared to 14 percent). By contrast, State DOT districts without a large urban area are significantly more likely than State DOT districts with a large urban area to have *no plans for CV* (47 percent compared to 25 percent).

Table 10. Developing, Testing, or Deploying CV Technologies: Significant Differences Between State DOT District Population Groups

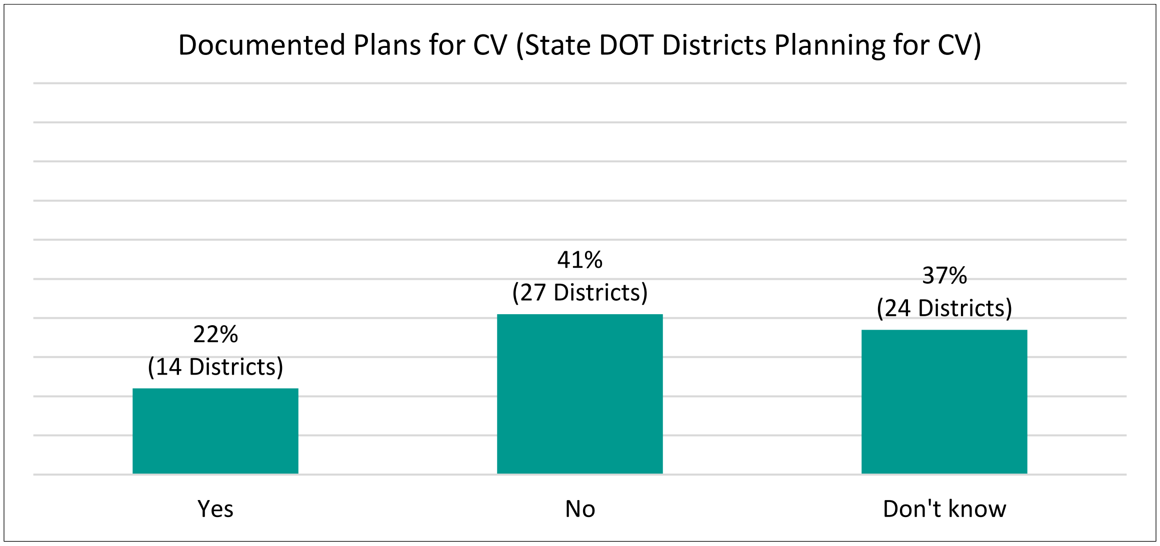
Response	State DOT Districts with a Large Urban Area (n=120)	State DOT Districts without a Large Urban Area (n=156)
Currently developing, testing, or deploying CV	29%	14%
No plans for CV	25%	47%

Source: USDOT

Planning For CV (But Not Currently Developing, Testing, or Deploying)

The 65 State DOT districts that are not currently developing, testing, or deploying CV but are planning for CV on arterials (referred to as "districts planning for CV" in this section, and as shown previously in Figure 20) were asked if those plans are documented.

Of these 65 State DOT districts planning for CV on arterials, 22 percent *have a documented plan*, 41 percent reported *no documented plans for CV*, and 37 percent reported *don't know* as shown in Figure 21.



2023 Q29; (n=65; 0% missing) *Source: USDOT*

Figure 21. Documented Plans for CV (State DOT Districts Planning for CV)

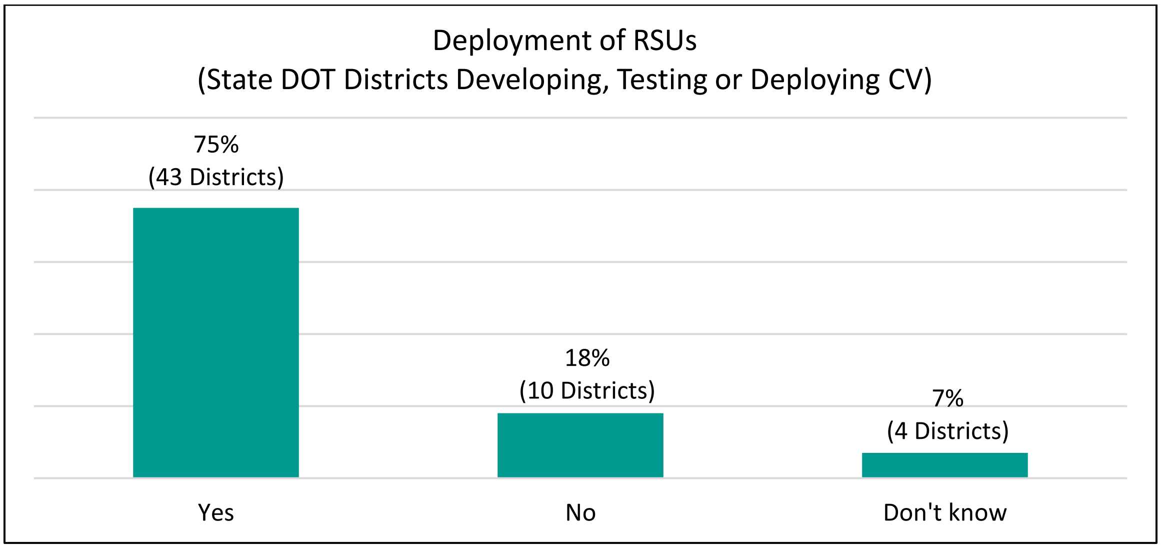
Additionally, among these 65 State DOT districts planning for CV, 25 percent expect to begin developing, testing, or deploying *within the next 3 years,* 39 percent *in 3 to 6 years*, 5 percent *in 7 or more years*, and 32 percent reported *don't know.*

The 57 State DOT districts managing arterials that reported they are currently developing, testing, or deploying CV were asked separate questions about their deployment of roadside units (RSUs) and deployment of CV applications. The findings are presented in the following two sections of the report.

Deployment of RSUs Among State DOT Districts Developing, Testing, or Deploying CV

The 57 State DOT districts managing arterials that are developing, testing, or deploying CV technologies (as shown previously in Figure 20) were asked if their agency deploys RSUs on arterials to support CV and/or AV testing/deploying.

Figure 22 shows three fourths *deploy RSUs* (75 percent), 18 percent *do not deploy RSUs*, and 7 percent reported *don't know*.



2023 Q31; (n=57; 0% missing) *Source: USDOT*

Figure 22. Deployment of RSUs (State DOT Districts Developing, Testing, or Deploying CV)

Since the number of responding State DOT districts deploying RSUs is small (43 State DOT districts), the findings for the RSU follow-up questions are presented by number of State DOT districts instead of percentages.

Of the 43 State DOT districts deploying RSUs on arterials:

- Ten (10) deploy *1 to 10 RSUs.*
- Eighteen (18) deploy *11 to 50 RSUs.*
- Eight (8) deploy *51 to 150 RSUs.*
- Seven (7) deploy *151 or more RSUs.*

In addition, the 43 State DOT districts deploying RSUs on arterials reported that their RSUs are transmitting the following standard data structures:

- *Signal phase and timing data* (32 State DOT districts)
- *Basic safety messages* (28 State DOT districts)

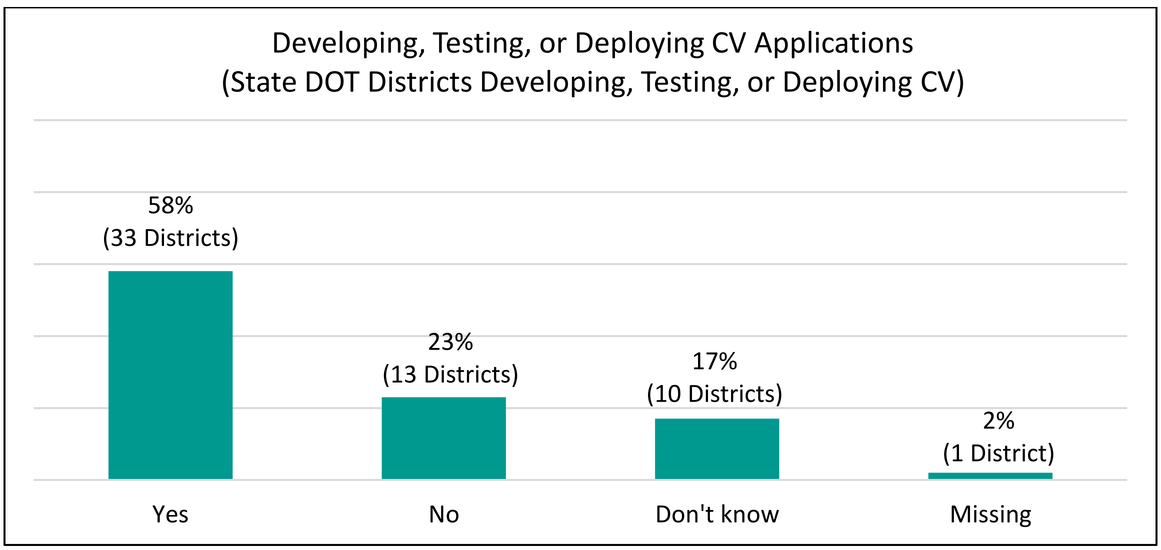
- *MAP data* (18 State DOT districts)
- *Traveler information messages* (17 State DOT districts)
- *Pedestrian safety message* (12 State DOT districts)
- *Signal status message* (12 State DOT districts)

Also, of the 43 State DOT districts deploying RSUs on arterials 10 or fewer reported transmitting each of the following: *signal request messages, roadside safety messages,* and *position corrected messages.* No State DOT districts reported transmitting *sensor data sharing messages* or *other* standard data structures. Eight (8) State DOT districts responded *don't know*.

Deployment of CV Applications Among State DOT Districts Developing, Testing, or Deploying CV Technologies

The 57 State DOT districts managing arterials that are developing, testing, or deploying CV technologies (as shown previously in Figure 20) were asked if their agency is developing, testing or deploying any CV applications for use on arterials.[28]

As shown in Figure 23, 58 percent of State DOT districts developing, testing, or deploying CV are *developing, testing, or deploying CV applications*, while 23 percent reported they are *not developing, testing, or deploying CV applications*, and 17 percent reported indicated *don't know*.



2023 Q34; (n=57) *Source: USDOT*

Figure 23. Developing, Testing or Deploying CV Applications
(State DOT Districts Developing, Testing, or Deploying CV)

[28] Respondents were asked, "Is your agency developing, testing, or deploying any connected vehicle applications for use on arterials, including in-vehicles (i.e., using an onboard unit (OBU), Human Machine Interface (HMI), or similar) or among pedestrians or cyclists (i.e., using a handheld device)? *This may include applications that your agency is testing either on its own fleet or in partnership with automakers/original equipment manufacturers."*

The 33 State DOT districts that are developing, testing, or deploying CV applications were asked to indicate the specific CV applications being developed, tested, or deployed. Since the number of State DOT districts developing, testing, or deploying CV applications on arterials is small, numbers are presented instead of percentages.

The 33 State DOT districts developing, testing, or deploying CV applications reported the following:

- *Emergency signal preemption* (21 State DOT districts)
- *Transit signal priority* (16 State DOT districts)
- *Pedestrian in signalized crosswalk warnings* (13 State DOT districts)
- *Red light violation warning*s (9 State DOT districts)
- *Reduced speed/work zone warning*s (7 State DOT districts)
- *Freight signal priority* (6 State DOT districts)

None of the 33 State DOT districts developing, testing, or deploying CV applications reported *dynamic eco routing* CV applications, and 5 or fewer reported deployment of the following surveyed applications:

- *Curve speed warnings*
- *Blind spot/lane change warnings*
- *Emergency electronic brake lights*
- *Forward collision warnings*
- *Intersections movement assist*
- *Vehicle turning right in front of bus warnings*
- *Connection protection, dynamic transit operations, and dynamic ridesharing*
- *Intelligent traffic signal systems*
- *Queue warnings*
- *Eco-approach and departure at signalized intersections*
- *Agency data applications*
- *Road weather warnings*
- *Other CV applications*[29]

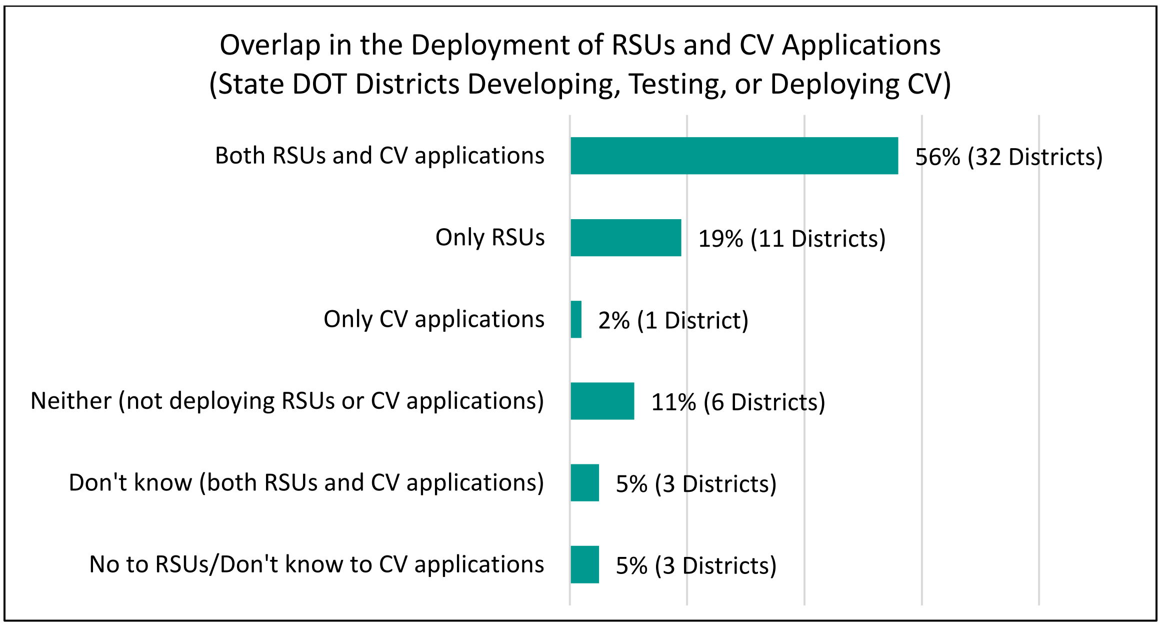
[29] Of the 5 State DOT districts that reported *other CV applications,* 3 State DOT districts wrote in “snowplow preemption,” one wrote in “work zone data exchange,” and another wrote in "maintenance vehicle signal priority.”

Overlap in the Deployment of RSUs and CV Applications Among State DOT Districts Developing, Testing, or Deploying CV Technologies

Additional analysis was performed to understand the extent to which State DOT districts managing arterials are deploying RSUs and/or CV applications, as shown in Figure 24.

Of the 57 State DOT districts developing, testing, or deploying CV on arterials (as shown previously in Figure 20), 56 percent reported deploying both RSUs and CV applications, about one fifth reported deploying only RSUs (19 percent), and 2 percent reported deploying only CV applications.

Eleven (11) percent of State DOT districts developing, testing, or deploying CV on arterials reported deploying neither RSUs nor CV applications, 5 percent reported *don't know* when asked about both RSUs and CV applications, and 5 percent *do not deploy RSUs* and reported *don't know* regarding CV applications.

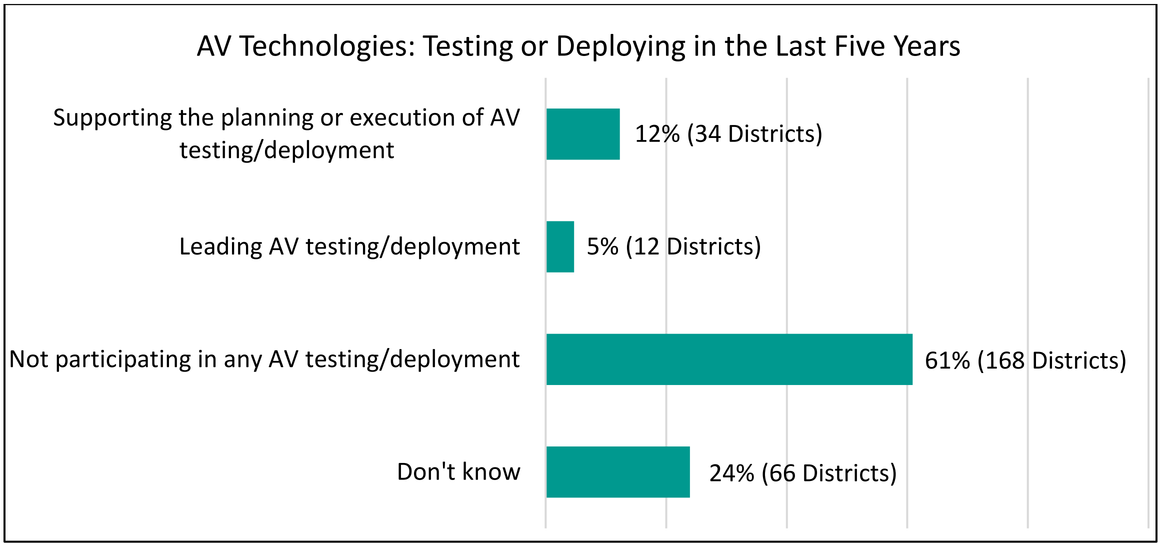


2023 Q31; Q34; (n=57; 2% missing) *Source: USDOT*

Figure 24. Overlap in the Deployment of RSUs and CV Applications
(State DOT Districts Developing, Testing, or Deploying CV)

Automated Vehicles

Figure 25 shows that of all 276 responding State DOT districts managing arterials, 5 percent are *leading or has led automated vehicle (AV) testing/deployment* in the last five years, while 12 percent are *supporting or has supported the planning or execution of an AV test/deployment* in the last five years.[30] A majority of State DOT districts managing arterials are *not participating in any AV testing/deployment* (61 percent), while nearly one fourth reported *don't know* (24 percent).



2023 Q36; (n=276, 0.4% (1 district) missing) *Source: USDOT*

Figure 25. AV Technologies: Testing or Deploying in the Last Five Years

Table 11 shows that a significantly higher percentage of State DOT districts managing arterials with a large urban area are *supporting or has supported the planning or execution of AV testing/deployment* compared to State DOT districts without a large urban area (19 percent compared to 7 percent).

By contrast, a significantly higher percentage of State DOT districts managing arterials without a large urban area reported *not participating in any AV testing/deployment* (69 percent) compared to State DOT districts with a large urban area (50 percent).

[30] Respondents were able to select both *leading* and *supporting,* if applicable. Therefore, the chart does not add to 100 percent. The net for these two responses is 15 percent (42 State DOT Districts either leading or supporting AV testing/deployment).

Table 11. AV Technologies: Testing or Deploying in the Last Five Years: Significant Differences Between State DOT District Population Groups

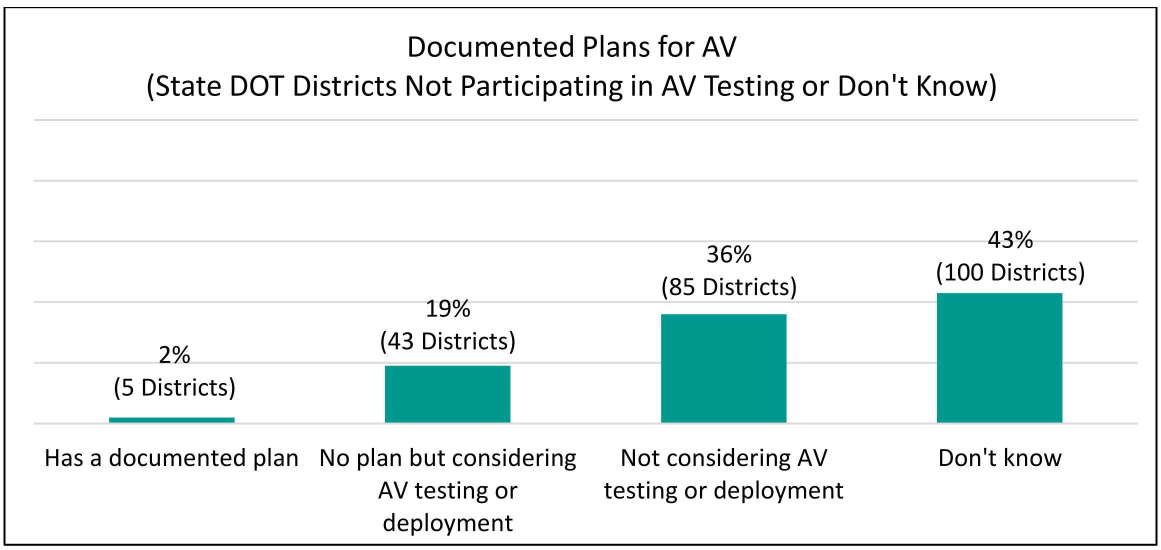
Response	State DOT Districts with a Large Urban Area (n=120)	State DOT Districts without a Large Urban Area (n=156)
Supporting the planning or execution of AV testing/deployment	19%	7%
Not participating in any AV testing/deployment	50%	69%

Source: USDOT

State DOT Districts Not Participating in AV Testing/Deployment

The 234 State DOT districts either not participating in AV testing/deployment on arterials or that reported don't know (as previously shown in Figure 25) were asked about their plans for AV.

Figure 26 shows that only 2 percent of these State DOT districts *have a documented plan to participate in AV tests or deployments,* and 19 percent report *no plan but considering AV testing or deployment.* Thirty-six (36) percent of these State DOT districts reported they are *not considering AV testing or deployments* on arterials, while 43 percent reported *don't know*.



2023 Q37; (n=234; 0.4% missing) *Source: USDOT*

Figure 26. Documented Plans for AV (State DOT Districts Not Participating in AV Testing or Don't Know)

Of the 234 State DOT districts that reported they are not participating in AV testing or deployment on arterials or don't know, significantly more State DOT districts without a large urban area (44 percent) reported they are *not considering AV testing or deployment* compared to State DOT districts with a large urban area (25 percent).

The 48 State DOT districts managing arterials that either have a documented plan for AV or have no plan but are considering AV testing or deployment were asked about their timeline for deploying. Of these 48 State DOT districts, 21 percent expect to begin deploying *within the next 3 years,* 31 percent *in 3 to 6 years*, and 4 percent *in 7 or more years*. Forty-four (44) percent of these districts reported *don't know.*

State DOT Districts Leading or Supporting AV Testing/Deployment

Since the number of responding State DOT districts leading or supporting AV testing or deployment is small, findings for the follow-up questions are presented by numbers instead of percentages.

The 42 State DOT districts leading or supporting AV testing or deployment are or were partnering with a range of entities, including:

- *Universities* (24 State DOT districts)
- *State agencies* (14 State DOT districts)
- *Automakers or Original Equipment Manufacturers* (10 State DOT districts)
- *MPOs* (8 State DOT districts)
- *Other local agencies* (8 State DOT districts)
- *Automated Driving Systems Developers* (7 State DOT districts)
- *Transit agencies* (6 State DOT districts)

Fewer than 5 State DOT districts reported partnering with *private sector consultants* and *Advanced Driver Assistance Systems developers*. No State DOT districts reported working with *transportation network companies*.

State DOT districts leading or supporting AV testing or deployment in the last five years were asked about the types of tests or deployments they execute. Of the 42 State DOT districts reporting AV activity, 14 State DOT districts test or deploy *automated passenger fixed route*.

Ten (10) or fewer State DOT districts reported each of the following:

- *Truck platooning*
- *Automated bus rapid transit*
- *Construction or maintenance operations*
- *Automated light duty passenger vehicles*
- *Automated personal delivery device*
- *Automated last mile delivery*

No State DOT districts reported testing or deploying *automated logistics yard operations*, *automated regional or long-haul trucking*, *automated maintenance and bus yard operations,* or *automated passenger on-demand*.

Traffic Management

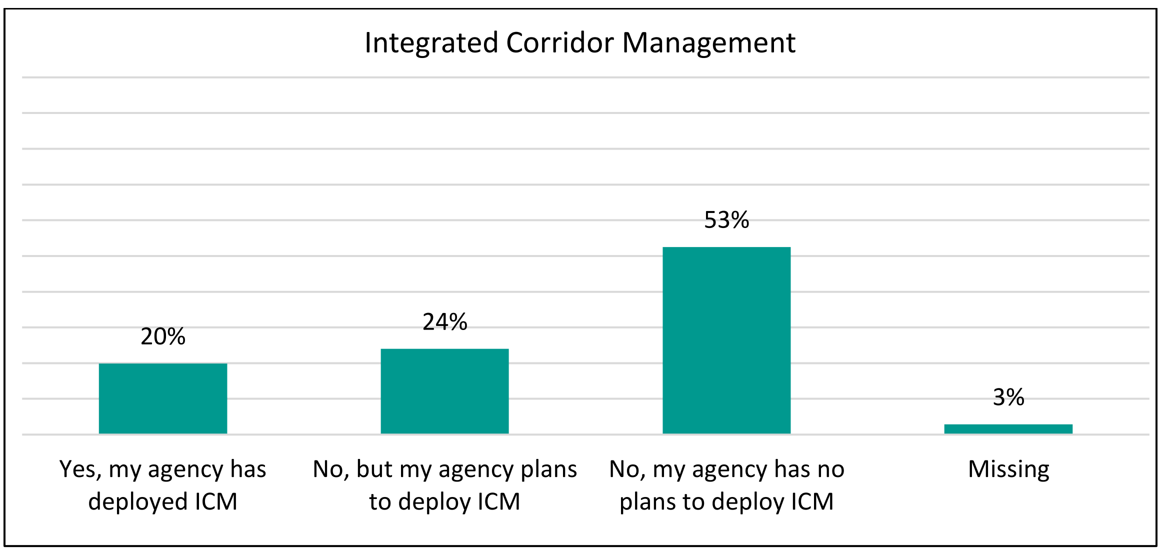
This section of the report presents findings on different traffic management technologies and strategies, including:

- Integrated corridor management (ICM)
- Transportation Systems Management and Operations (TSMO) Plan[31]
- Parking management

Integrated Corridor Management

ICM is an approach to managing 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 dissemination to maximize the capacity of all facilities and modes across the corridor. A corridor includes freeway, arterial, and public transit facilities with cross-facility connections.

Figure 27 shows that about one fifth of all responding State DOT districts managing arterials *deploy ICM* (20 percent), while about one fourth *plan to deploy ICM* (24 percent). About half of State DOT districts *have no plans to deploy ICM* (53 percent).



2023 Q57; (n=276) *Source: USDOT*

Figure 27. Integrated Corridor Management

[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, in which strategies are coordinated across multiple jurisdictions, agencies, and modes.

Table 12 shows that State DOT districts managing arterials with a large urban area were significantly more likely to report *plans to deploy ICM* compared to State DOT districts without a large urban area (33 percent compared to 18 percent). By contrast, State DOT districts without a large urban area were significantly more likely than State DOT districts with a large urban area to have *no plans to deploy ICM* (62 percent compared to 40 percent).

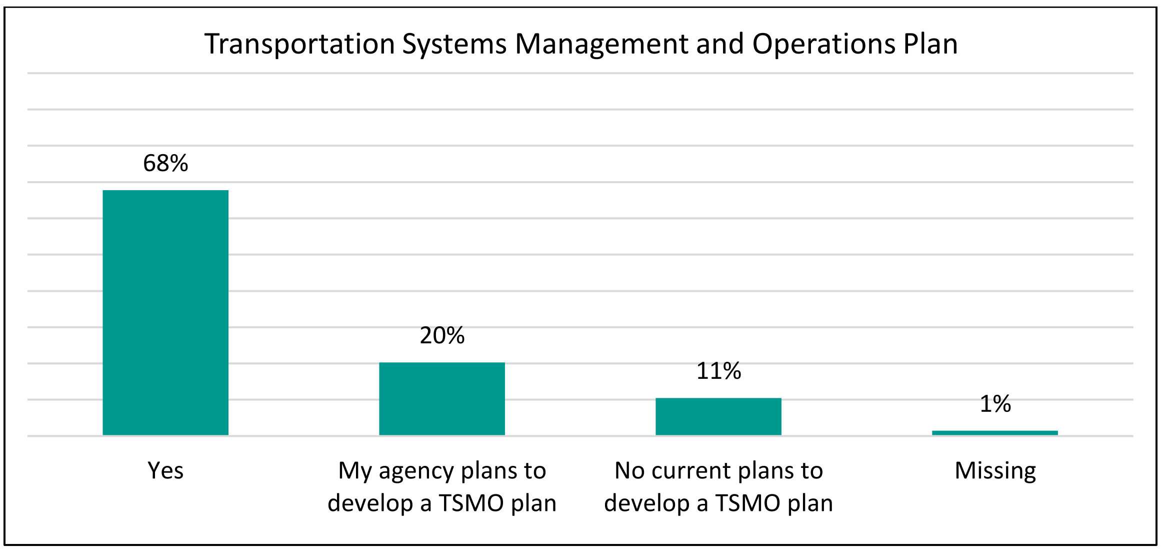
Table 12. Integrated Corridor Management: Significant Differences Between State DOT District Population Groups

Response	State DOT Districts with a Large Urban Area (n=120)	State DOT Districts without a Large Urban Area (n=156)
No, but my agency plans to deploy ICM	33%	18%
No, my agency has no plans to deploy ICM	40%	62%

Source: USDOT

Transportation Systems Management and Operations Plans

Figure 28 shows about two thirds of responding State DOT districts managing arterials *have a TSMO Plan* (68 percent), and 20 percent of State DOT districts *plan to develop a TSMO plan*. Eleven (11) percent have *no current plans to develop a TSMO plan*.

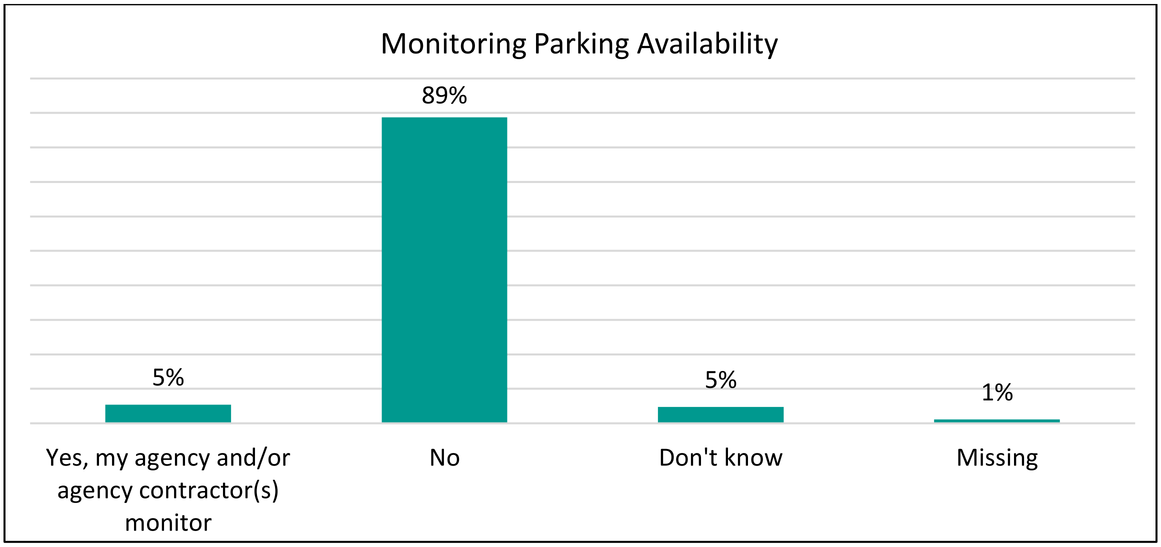


2023 Q47; (n=276) *Source: USDOT*

Figure 28. Transportation Systems Management and Operations Plan

Parking Management

As shown in Figure 29, 5 percent of all State DOT districts managing arterials responded that *their agency or contractor(s) monitors parking availability (including on-street spaces or off-streets lots or garages).* A large majority of State DOT districts responded that they *do not monitor* parking availability (89 percent), while 5 percent responded that they *don't know*.



2023 Q26; (n=276) *Source: USDOT*

Figure 29. Monitoring Parking Availability

Since the number of State DOT districts reporting that their agency or contractor(s) monitor the availability of parking is small, the findings for the parking management follow-up question is presented by number of State DOT districts instead of percentages.

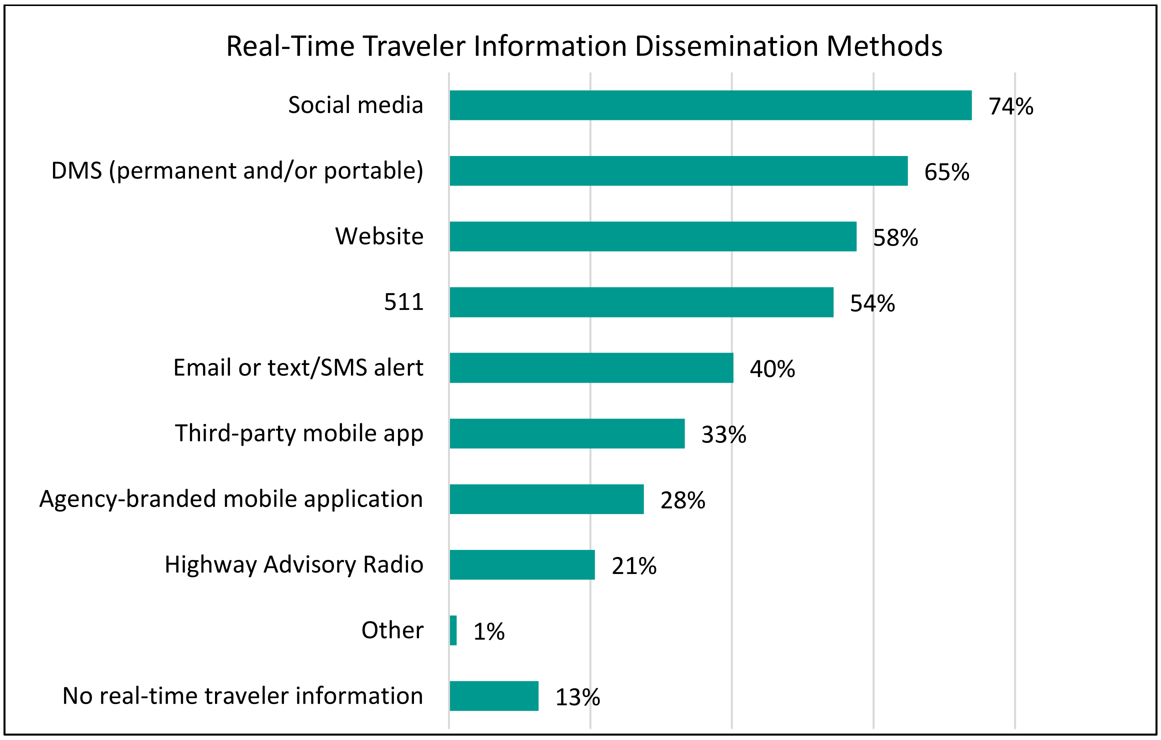
Of the 15 State DOT districts managing arterials that reported their agency or contractor(s) monitors the availability of parking, 11 State DOT districts *disseminate parking availability information to drivers.* The use of *a parking pricing strategy (e.g. peak period surcharges) to manage congestion*, and *the allowance of drivers to reserve a parking space at a destination facility on demand to ensure availability* are each reported by only 1 responding State DOT district.

Traveler Information

A large majority of responding State DOT districts managing arterials disseminate real-time traveler information about arterials (87 percent), and these State DOT districts are using an average of 4.3 different methods.

As shown in Figure 30, a large majority of State DOT districts managing arterials use *social media* (74 percent) to share real-time traveler information, while about two thirds use *DMS (permanent and/or portable)* (65 percent).

Websites (58 percent) and *511* (54 percent) are each used by a smaller majority of State DOT districts. Fewer State DOT districts use *email or text/SMS alert*s (40 percent), *third-party mobile apps* (33 percent), *agency-branded mobile applications* (28 percent), and *Highway Advisory Radio* (21 percent) to disseminate real-time traveler information about arterials. Thirteen (13) percent of State DOT districts reported *no real-time traveler information.*

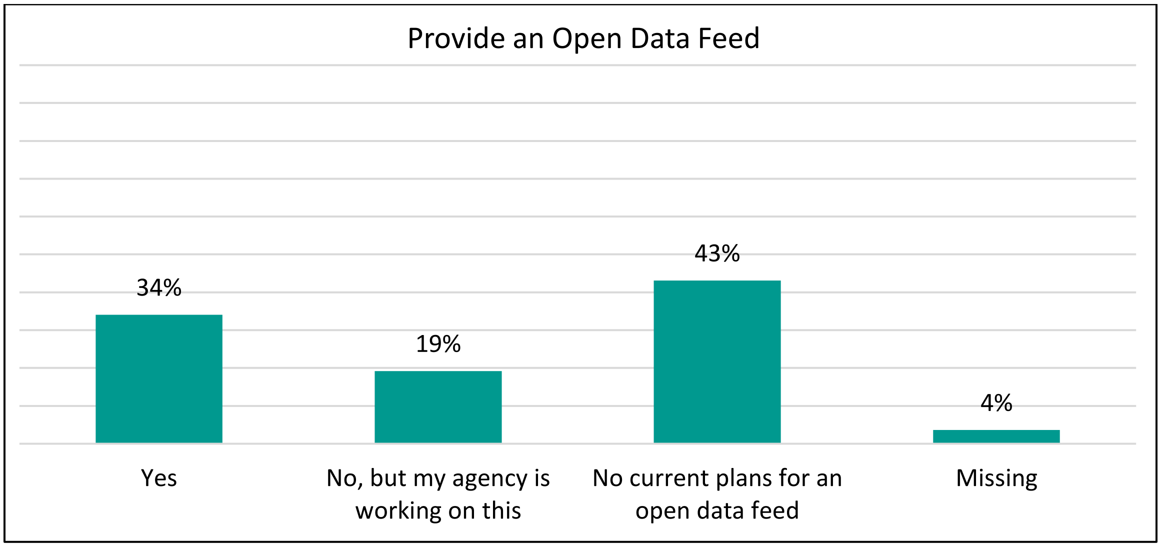


2023 Q24; (n=276; 0% missing) *Source: USDOT*

Figure 30. Real-Time Traveler Information Dissemination Methods

Open Data Feed

Figure 31 shows that 34 percent of all responding State DOT districts managing arterials *provide an open data feed* that shares real-time transportation-related data using data standards/specifications. Nearly one fifth of State DOT districts managing arterials reported *working on providing an open data feed* (19 percent), while 43 percent have *no current plans for an open data feed.*



2023 Q25; (n=276) *Source: USDOT*

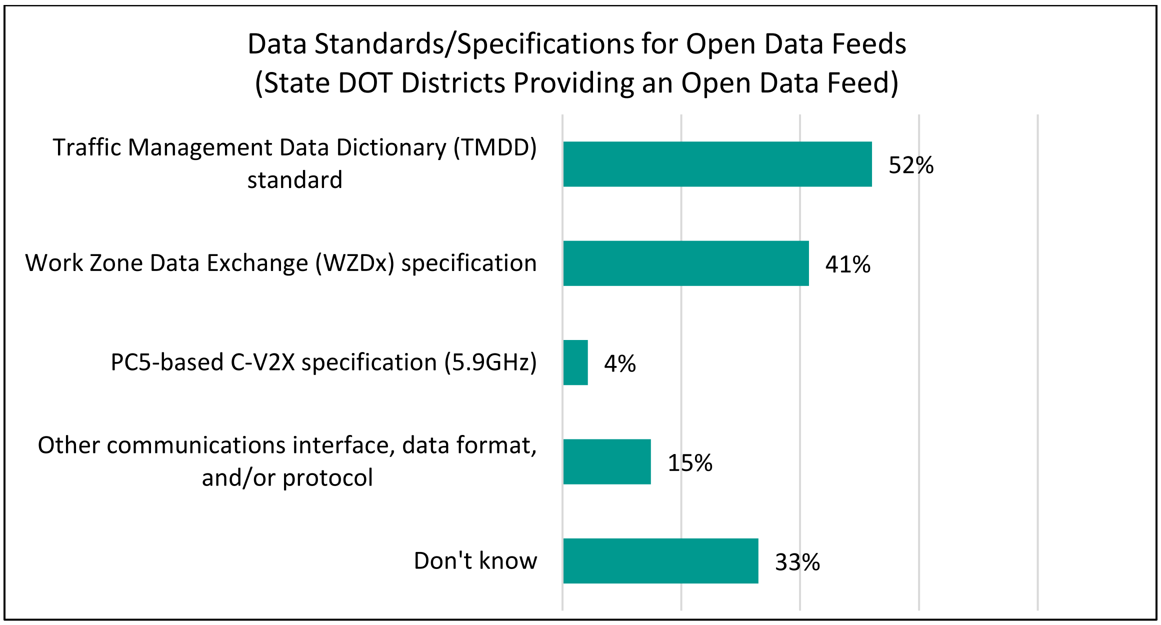
Figure 31. Provide an Open Data Feed

State DOT districts managing arterials without a large urban area (50 percent) were significantly more likely to report *no current plans for an open data feed* compared to State DOT districts with a large urban area (34 percent).

For the first time in 2023, State DOT districts managing arterials providing an open data feed were asked about the data standards/specifications used to share real-time transportation data in their open data feed.

As shown in Figure 32, of the 94 State DOT districts providing an open data feed, the *Traffic Management Data Dictionary (TMDD) standard* (52 percent) is used by about half, while 41 percent use the *Work Zone Data Exchange (WZDx) specification*. Only 4 percent of State DOT districts providing an open data feed use *PC5-based C-V2X specification (5.9GHz)*.

In addition, 15 percent of these State DOT districts reported *other communications interface, data format, and/or protocols* (14 districts), of which 9 districts wrote in “XML” or “XML feed.” One third of districts with an open data feed reported *don’t know* (33 percent).



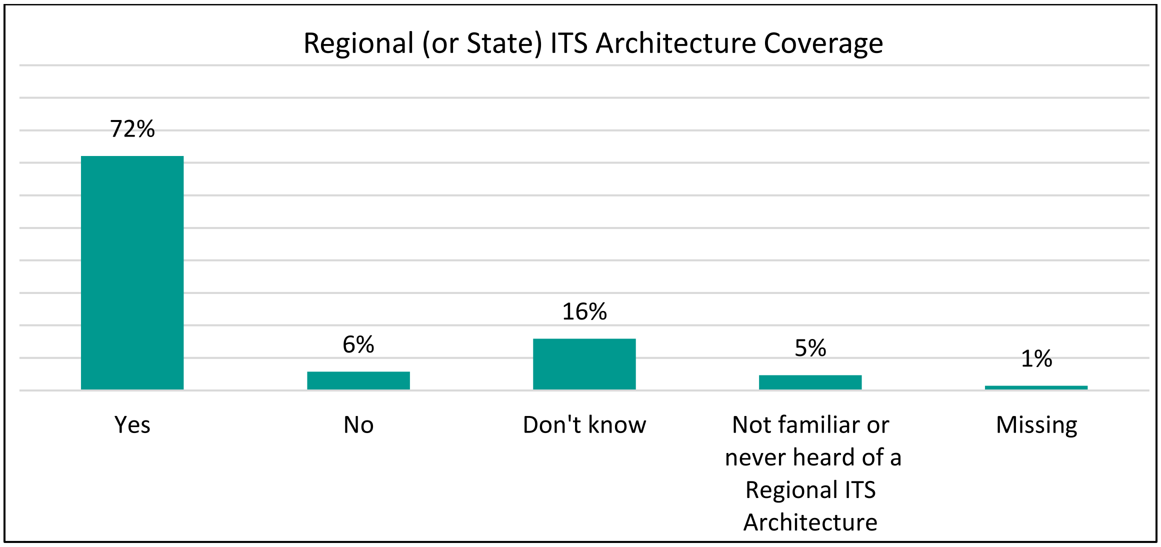
2023 Q25a; (n=94; 0% missing) *Source: USDOT*

Figure 32. Data Standards/Specifications for Open Data Feeds (State DOT Districts Providing an Open Data Feed)

Regional (or State) ITS Architecture

Surveyed State DOT districts managing arterials were asked if their agency/region is covered by a Regional (or State) ITS Architecture.[32]

Figure 33 shows about three fourths of State DOT districts managing arterials reported being *covered by a Regional (or State) ITS Architecture* (72 percent). Sixteen (16) percent of respondents reported they *don't know*. Fewer respondents reported their agency/region were *not covered* (6 percent) or that they were *not familiar with or never heard of a Regional ITS Architecture* (5 percent).



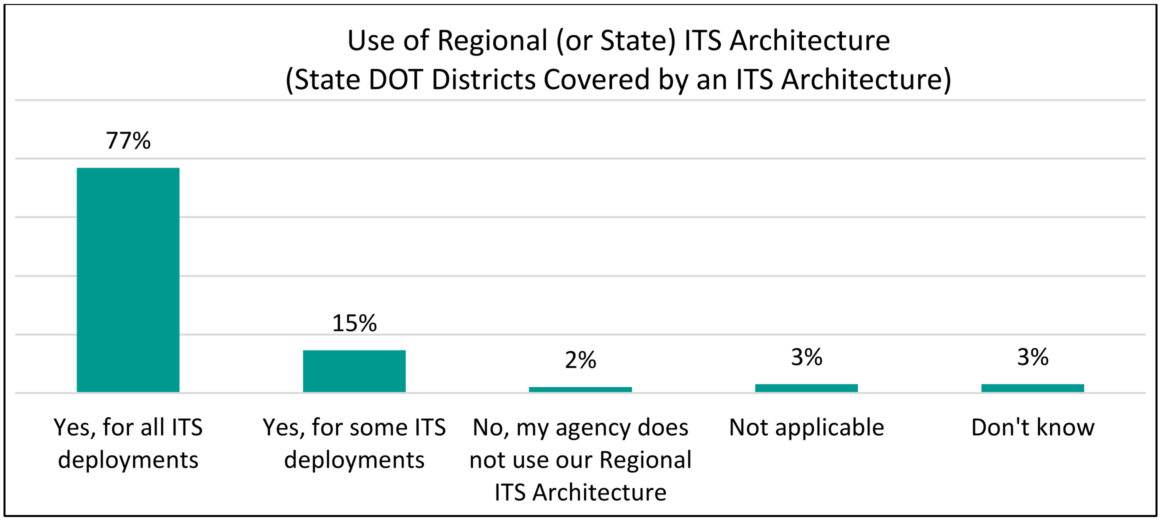
2023 Q54; (n=276) *Source: USDOT*

Figure 33. Regional (or State) ITS Architecture Coverage

State DOT districts managing arterials that reported being covered by a Regional (or State) ITS Architecture were asked whether they use their Regional (or State) ITS Architecture to support ITS deployments on arterials.

Figure 34 shows about three fourths of the 199 State DOT districts managing arterials covered by a Regional (or State) ITS Architecture use it *for all ITS deployments* (77 percent), and 15 percent use it *for some ITS deployments*. Two percent of covered State DOT districts reported *my agency does not use our Regional ITS Architecture*, and 3 percent reported *not applicable (i.e., my agency does not use federal funds for ITS deployment OR my agency has not deployed ITS).*

[32] A Regional (or State) ITS Architecture is defined as "A specific, tailored framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects in a particular region. It functionally defines what pieces of the system are linked to others and what information is exchanged between them." For more information, see https://ops.fhwa.dot.gov/plan4ops/regional_its.htm.

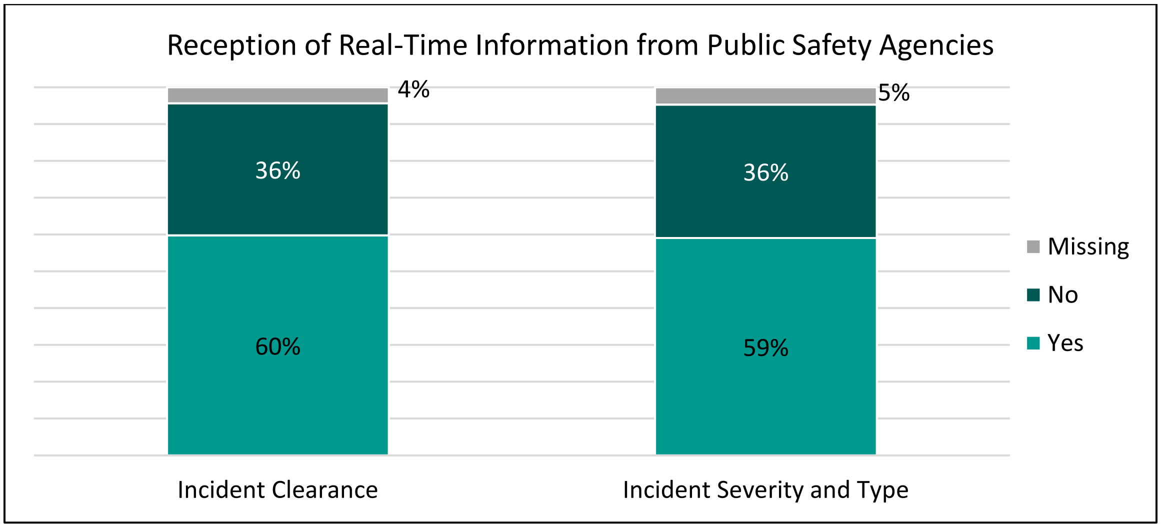


2023 Q55; (n=199; 0% missing) *Source: USDOT*

Figure 34. Use of Regional (or State) ITS Architecture (Sate DOT Districts Covered by ITS Architecture)

Agency Coordination

Figure 35 shows a majority of responding State DOT districts managing arterials receive real-time *incident clearance* (60 percent) and *incident severity and type* (59 percent) information from public safety agencies. However, over one third of State DOT districts managing arterials each report *not receiving incident clearance* information (36 percent) and *not receiving incident severity and type* information (36 percent).



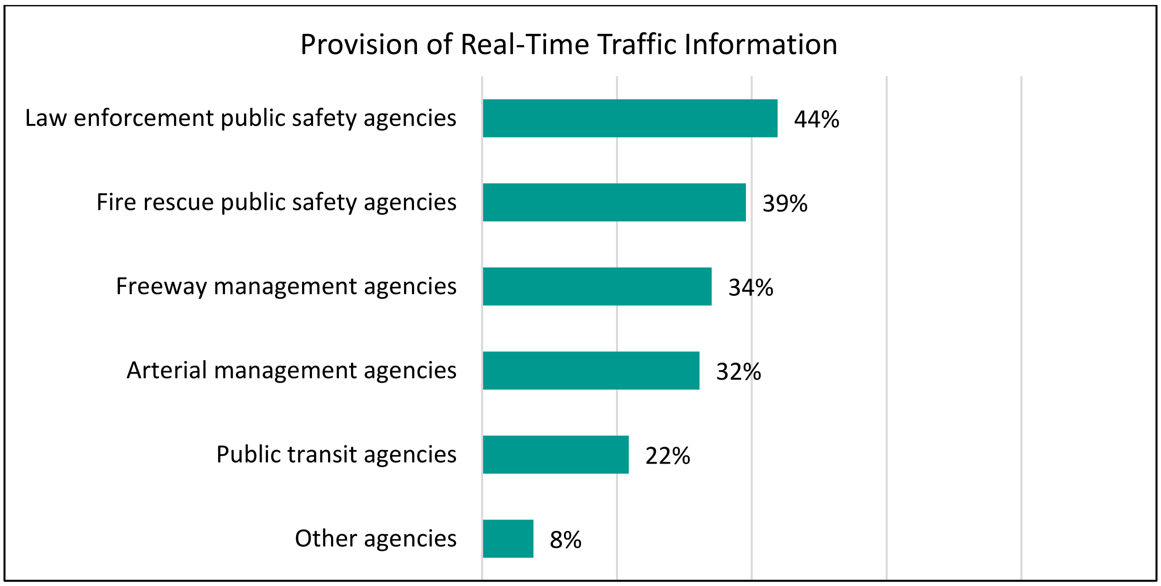
2023 Q58; (n=276) *Source: USDOT*

Figure 35. Reception of Real-Time Information from Public Safety Agencies

State DOT districts managing arterials also provide real-time traffic information (e.g., travel time, speed, and condition) to several different types of agencies.

Figure 36 shows 44 percent of State DOT districts managing arterials provide real-time traffic information to *law enforcement public safety agencies,* 39 percent to *fire rescue public safety agencies*, and about one third to *freeway management agencies* (34 percent) and *arterial management agencies* (32 percent).

Fewer State DOT districts reported providing real-time traffic information to *public transit agencies* (22 percent). Eight (8) percent of State DOT districts reported providing real-time traffic information to *other agencies* (21 districts), of which 6 State DOT districts managing arterials specified "Universities, MPOs" and 5 State DOT districts managing arterials specified "emergency medical services" in the open-ended responses.



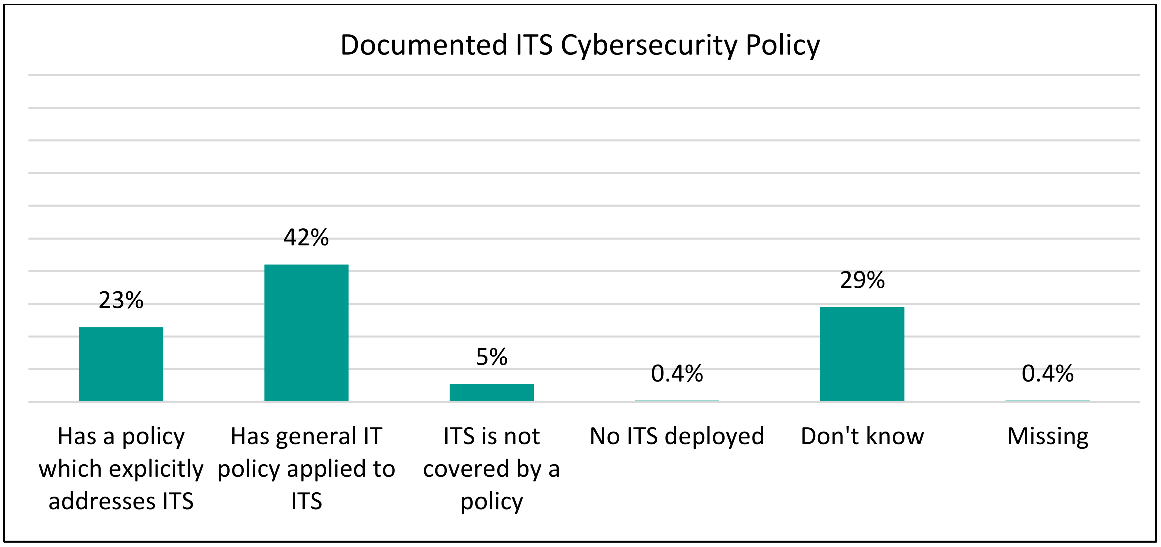
2023 Q59; (n=276) *Source: USDOT*

Figure 36. Provision of Real-Time Traffic Information

ITS Cybersecurity

Figure 37 shows that about one fourth of responding State DOT districts managing arterials *have a cybersecurity policy which explicitly addresses ITS* (23 percent), and 42 percent *have a general information technology (IT) cybersecurity policy which applies to ITS*.

Five (5) percent reported that *ITS is not covered by a cybersecurity policy,* and less than 1 percent reported they *have not deployed ITS technologies/equipment.* Over one fourth of State DOT districts managing arterials reported *don't know* (29 percent).

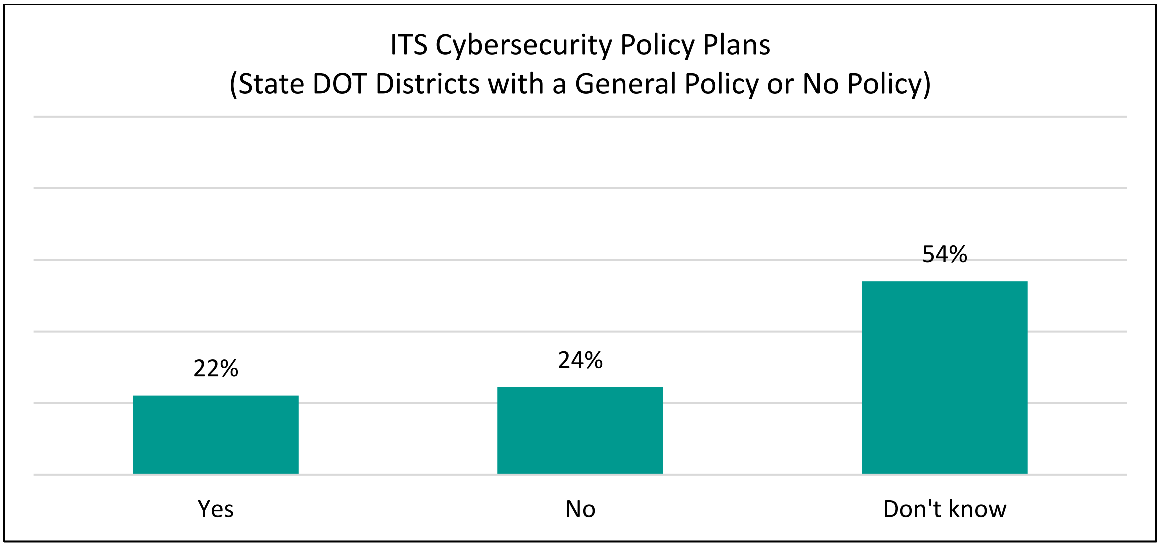


2023 Q48; (n=276) *Source: USDOT*

Figure 37. Documented ITS Cybersecurity Policy

For the 131 State DOT districts managing arterials that either have a general IT cybersecurity policy which applies to ITS or for which ITS is not covered by a cybersecurity policy.

Figure 38 shows that about one fifth *have plans to develop a cybersecurity policy that explicitly addresses ITS* (22 percent). About one fourth of districts reported *no plans to develop such a policy* (24 percent). Over half of respondents reported *don't know* (54 percent).



2023 Q49; (n=131; 0% missing) *Source: USDOT*

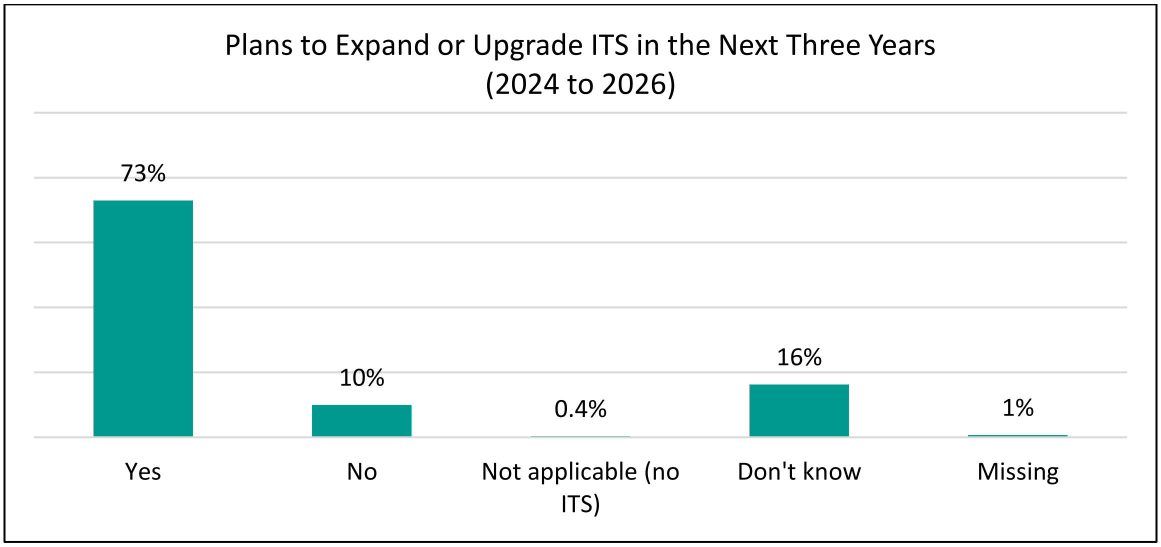
Figure 38. ITS Cybersecurity Policy Plans (State DOT Districts with a General Policy or No Policy)

Among State DOT districts managing arterials that have a general cybersecurity policy applied to ITS or that are not covered by a cybersecurity policy, State DOT districts with a large urban area were significantly more likely to *have plans to develop a cybersecurity policy that explicitly addresses ITS* compared to State DOT districts without a large urban area (37 percent compared to 13 percent).

Future Deployment Planning

All responding State DOT districts managing arterials were asked about their ITS deployment plans in the next three years (2024 through 2026).

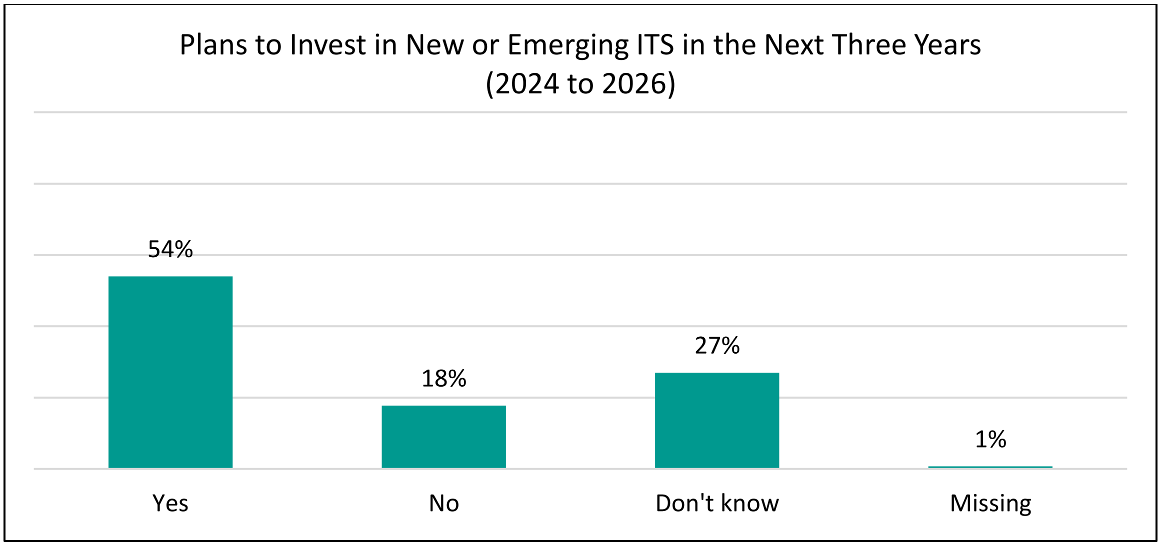
Figure 39 shows that about three fourths of State DOT districts managing arterials *plan to expand or upgrade their ITS* (73 percent) in the next three years. Only 10 percent reported *no plans to expand or upgrade their ITS*, while less than 1 percent reported *not applicable, my agency has not deployed ITS.* Sixteen (16) percent of State DOT districts managing arterials reported *don't know*.



2023 Q60; (n=276) *Source: USDOT*

Figure 39. Plans to Expand or Upgrade ITS in the Next Three Years (2024 to 2026)

Figure 40 shows over half of responding State DOT districts managing arterials reported *plans to invest in new or emerging ITS* (54 percent) in the next three years (2024 to 2026), while less than one fifth reported *no plans to invest in new or emerging ITS* (18 percent). Twenty-seven (27) percent of State DOT districts reported *don't know*.



2023 Q61; (n=276) *Source:* USDOT

Figure 40. Plans to Invest in New or Emerging ITS in the Next Three Years (2024 to 2026)

Significantly more State DOT districts managing arterials without a large urban area (22 percent) reported *no plans to invest in new or emerging ITS* on arterials in the next three years (2024 through 2026) compared to State DOT districts with a large urban area (13 percent).

Chapter 4. Arterial Management Survey Findings: Local Agencies

This chapter describes the survey methodology and the results of the 2023 Arterial Local Survey, which was distributed to local agencies that manage arterial roadways.

Survey Methodology

For the Arterial Local Survey, random stratified sampling was conducted. While it was possible to conduct a census of State DOT districts managing arterials (see Chapter 3), the large number of local jurisdictions (more than 10,000) did not allow for this same survey approach for the Arterial Local Survey. The survey team used 2020 Census data to identify places (e.g., cities, towns, townships) and counties across the country and to create a sampling frame. A minimum population threshold of 5,000 was set for both places and counties using 2020 Census populations. The sampling frame also excluded unincorporated places and counties which prior research indicated do not play a role in arterial management.

Prior to developing the local arterial management sampling frame, the survey team determined that the largest places (population of 600,000 or higher) and counties (population of 950,000 or higher) should be drawn with certainty (i.e., automatically included), referred to as the “certainties” in this report. This decision to select certainties ensured that the largest metropolitan areas were included in the sample, as they are most likely to be deploying a range of ITS, and it allows the survey to preserve some continuity with the historical ITS Deployment Tracking Survey data. The certainties, which included 28 places and 35 counties, were removed from the sampling frame prior to sample selection because they were already selected to be in the sample with a probability of one.

The sampling frame was then stratified by metropolitan, micropolitan, and rural census designations, and each of these groups were sub-stratified by county population size. Places within each county strata were sub-stratified by local population size. This process created 19 strata within the sampling frame as shown in Table 13.

Table 13. Stratification of Areas

Strata	Number of Non-Certainty Areas	Percent of Total
All Metropolitan Areas	**6,600**	
County, 5K to <20K	129	1.4%
Place, 5K to <20K	31	0.3%
County, 20K to <50K	160	1.7%
Place, 5K to <50K	198	2.1%
County (50K+)	570	6.1%
Place (5K to <20K)	3,225	34.6%
Place (20K to <50K)	1,360	14.6%
Place, 50K+	927	9.9%
All Micropolitan Areas	**1,490**	
County, 5K to <20K	73	0.8%
Place, 5K to <20K	31	0.3%
County, 20K to <50K	304	3.3%
Place (5K to <50K)	469	5.0%
County (50K+)	152	1.6%
Place (5K to <20K)	374	4.0%
Place (20K+)	87	0.9%
All Rural Areas	**1,239**	
County, 5K to <20K	621	6.7%
Place, 5K to <20K	179	1.9%
County, 20K to 50K+	208	2.2%
Place, 5K to <20K	231	2.5%
Total	**9,329**	**100%**

Using a target of 400 non-certainty survey completes, stratified sampling with proportional allocation was used to estimate the initial number of non-certainty completes required for each stratum to reach the target response rate for representation. This target was set so that there would be sufficient sample in key subgroups to obtain estimates that represent the population with a 95 percent confidence level and an expected margin of error of +/-0.10.

Certain subgroups did not meet the precision requirement. The survey team determined that more micropolitan and rural area completes were desired than what were proportionally allocated. Additionally, more non-certainty sample was desired in the stratum representing large metropolitan counties and places, which could be compared to the historical ITS Deployment Tracking Survey. The adjustments produced an updated sampling frame referred to as the adjusted, expected non-certainty completes.

Differential response rates for each stratum, based on the 2020 ITS Deployment Tracking Survey and the 2022 Pilot Survey, were applied to the distribution of adjusted, expected non-certainty completes, producing the (rounded) total non-certainty areas to be sampled (n=967).

Overall, the survey achieved a 47 percent response rate with 423 completed surveys. Please see Chapter 2 for detailed information about contact enumeration, questionnaire development, and data collection and processing.

Data Weighting

The purpose of design weights is to account for the sample design used when selecting a sample. Design weights are calculated as the inverse of the probability of selection for each sampled unit. In most cases, a sample weighted using the design weights will match the characteristics of the population from which the sample was selected. Local agencies were selected for the sample using a stratified, proportional selection within strata sample design. Strata were formed by the combination of metropolitan, micropolitan, or rural areas by their Census definition and the population size of the place and county. Agencies from places with a population of 600,000 or more and agencies in counties with a population of 950,000 or more were selected with certainty for the survey. These agencies were assigned weights of 1 and removed from further calculations.

For the remaining local agencies, the survey team calculated their selection probabilities by dividing the number sampled within each stratum by the total number of agencies within each stratum from the sample frame. Both the numerators and denominators were adjusted to remove the local agencies selected with certainty.

After calculating the design weights, the survey team then examined nonresponse patterns. This involved statistical testing for differences between respondents and eligible nonrespondents on a set of characteristics known for both groups. Places and counties identified as ineligible were excluded from these analyses. In general, non-response was highest among small places, particularly in micropolitan and rural areas.

Weights were adjusted, as needed, to account for nonresponse within the sampling strata. This involved calculating adjustment factors in each of the strata cells, defined as the sum of the weights for the full eligible sample divided by the sum of the weights for the respondents. In a final step, the weights were scaled to sum to the number of responding agencies for the Arterial Local Survey.

Overview of Respondents

The responding agencies comprise places and counties that manage arterial roadways, which are uniformly referred to as either **local arterial management agencies** or **local agencies** throughout this report. Local agencies can be categorized into the following statistical areas:

- **Large metropolitan areas** include counties with a population over 50,000 and places with a population over 50,000 within counties with a population over 50,000, and which the 2020 Census designates as within a metropolitan area.

- **Small metropolitan areas** include all other counties and places within metropolitan areas as designated by the 2020 Census and that are not large metropolitan areas.

- **Micropolitan areas** include counties and places within micropolitan areas designated by the 2020 Census.

- **Rural areas** include all other counties and places not designated as within metropolitan or micropolitan areas.

The weighted percentages and weighted number (WN) and unweighted number (UWN) of local agency respondents by statistical area are shown in Table 14. Agencies in small metropolitan, micropolitan, and rural areas are reported together in most subgroup analysis and referred to as "smaller urban and rural" areas or agencies. These three groups reported similar levels of deployment unless otherwise noted.

Table 14. Respondents by Statistical Area

Statistical Area	Percent	WN	UWN
Large metropolitan areas	18%	74	108
Small metropolitan areas	55%	233	149
Micropolitan areas	15%	65	86
Rural areas	12%	52	80

Source: USDOT

Reporting Notes

This chapter is organized by ITS technologies and topics. In each section, findings are presented for all 2023 Arterial Local Survey respondents (i.e., a total of 423 respondents), where applicable. All findings are weighted based on the sampling rate for each individual stratum and nonresponse bias. In some cases, percentages presented are based on a subset of respondents who received the question due to skip logic[33] in the survey. The 2023 survey question number and number of respondents for each question are referenced at the bottom of each figure. In cases of a reduced base, both weighted (WN) and unweighted (UWN) numbers of respondents are shown (i.e., WN=#, UWN=#), while the percentages shown within charts are all based on weighted data.

In some cases, respondents chose not to respond to a question. These non-responses are referred to as "missing" responses and are identified either in the figure or at the bottom of the figure.

Subgroup findings are also presented where applicable. These analyses highlight significant differences by:

- **Agency type:** compares the responses of the 100 counties to the responses of the 323 places.
- **Statistical area:** compares the responses of agencies in large metropolitan areas to the responses of agencies in smaller urban and rural areas (including small metropolitan, micropolitan, and rural areas).

In comparing differences across subgroups, significance testing was performed at a significance level of 0.05, with a 95 percent confidence interval.

[33] Skip logic is survey programming that automatically skips respondents past one or more questions based on their response to a previous question. For example, if an agency does not manage signalized intersections, they would skip out of the series of questions that ask about ITS at signalized intersections.

ITS Technologies at Signalized Intersections

ITS technologies at signalized intersections include:

- ITS detection technologies at intersections
- CCTV at intersections
- ASCT
- Signal coordination
- Preemption and priority technologies at intersections

About half of surveyed local arterial management agencies operate signalized intersections (51 percent). Place agencies (i.e., cities, towns, villages, townships, and boroughs) were significantly more likely to report operating signalized intersections compared to county agencies (58 percent compared to 30 percent).

As shown in Table 15, a large majority of local arterial management agencies in large metropolitan areas (82 percent) operate signalized intersections, which is significantly higher than every other statistical area. Among local arterial management agencies in smaller urban and rural areas, there are also significant differences. While the percentage of local agencies in small metropolitan areas (51 percent) and micropolitan areas (42 percent) operating signalized intersections is similar, both percentages are significantly higher than the percentage of agencies in rural areas operating signalized intersections (20 percent).

Table 15. Local Agency Operation of Signalized Intersections by Statistical Area

Large Metropolitan (WN=74; UWN=108)	Small Metropolitan (WN=233; UWN=149)	Micropolitan (WN=65; UWN=86)	Rural (WN=52; UWN=80)
82% (*^†)	51% (†)	42% (†)	20%

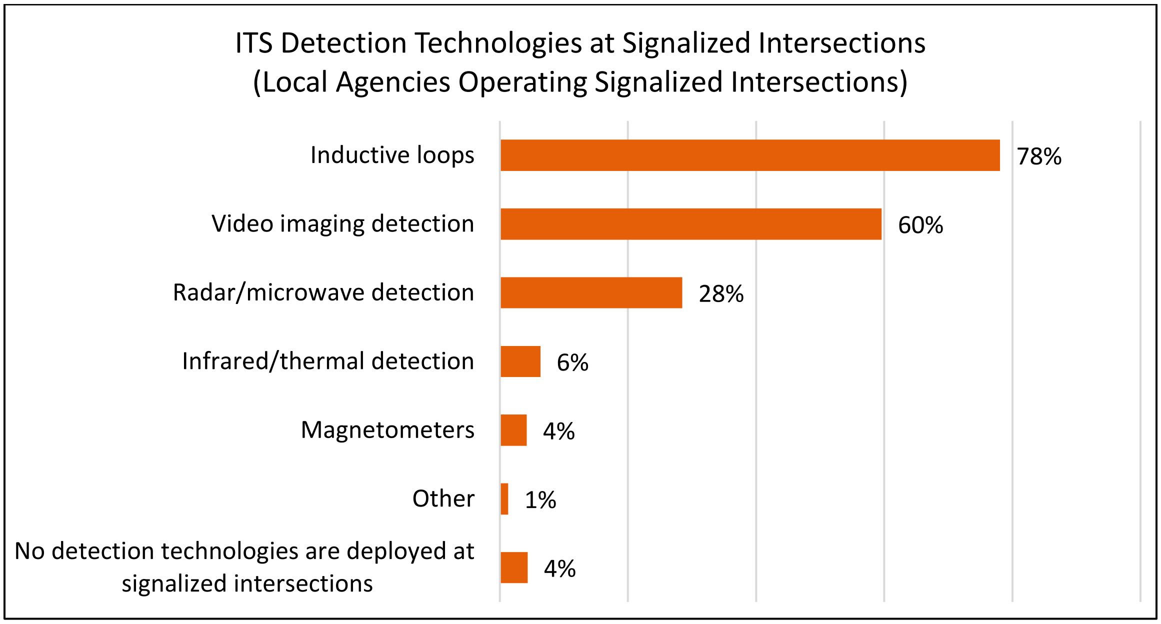
** statistically significant difference compared to small metropolitan areas;* *Source: USDOT*
^ statistically significant difference compared to micropolitan areas;
† statistically significant difference compared to rural areas

The following subsections present ITS technology deployment across the subset of 221 responding local arterial management agencies operating signalized intersections.

ITS Detection at Signalized Intersections Among Local Agencies Operating Signalized Intersections

Of the 221 local arterial management agencies that reported operating signalized intersections, 94 percent deploy at least one ITS detection technology at signalized intersections. Local arterial management agencies deploying detection technologies at intersections reported using an average of 1.9 different technologies.

Figure 41 shows over three fourths of arterial local management agencies operating signalized intersections deploy *inductive loops* (78 percent), and a smaller majority deploy *video imaging detection* (60 percent). Less than one third deploy *radar/microwave detection* (29 percent), while *infrared/thermal detection*, a new response category in 2023, and *magnetometers* are each deployed by about 5 percent. Four (4) percent of local agencies operating signalized intersections reported *no detection technologies are deployed at signalized intersections.*



2023 Q3; (WN=217, UWN=221; 2% missing) *Source: USDOT*

Figure 41. ITS Detection Technologies at Signalized Intersections (Local Agencies Operating Signalized Intersections)

Table 16 shows that local arterial management agencies in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to deploy almost all surveyed ITS detection technologies at signalized intersections, including *inductive loops* (89 percent compared to 74 percent), *video imaging detection* (84 percent compared to 50 percent), *radar/microwave detection* (56 percent compared to 18 percent), and *infrared/thermal detection* (15 percent compared to 3 percent).

Table 16. ITS Detection Technologies at Signalized Intersections (Local Agencies Operating Signalized Intersections): Significant Differences Between Statistical Areas

Technology	Large Metropolitan (WN=61; UWN=95)	Smaller Urban and Rural (WN=155; UWN=126)
Inductive loops	89%	74%
Video imaging detection	84%	50%
Radar/microwave detection	56%	18%
Infrared/thermal detection	15%	3%

Source: USDOT

CCTV at Intersections Among Local Agencies Operating Signalized Intersections

One fourth of the 221 local arterial management agencies that reported operating signalized intersections equip signalized intersections with *CCTV* (25 percent) for the purpose of monitoring traffic flow.

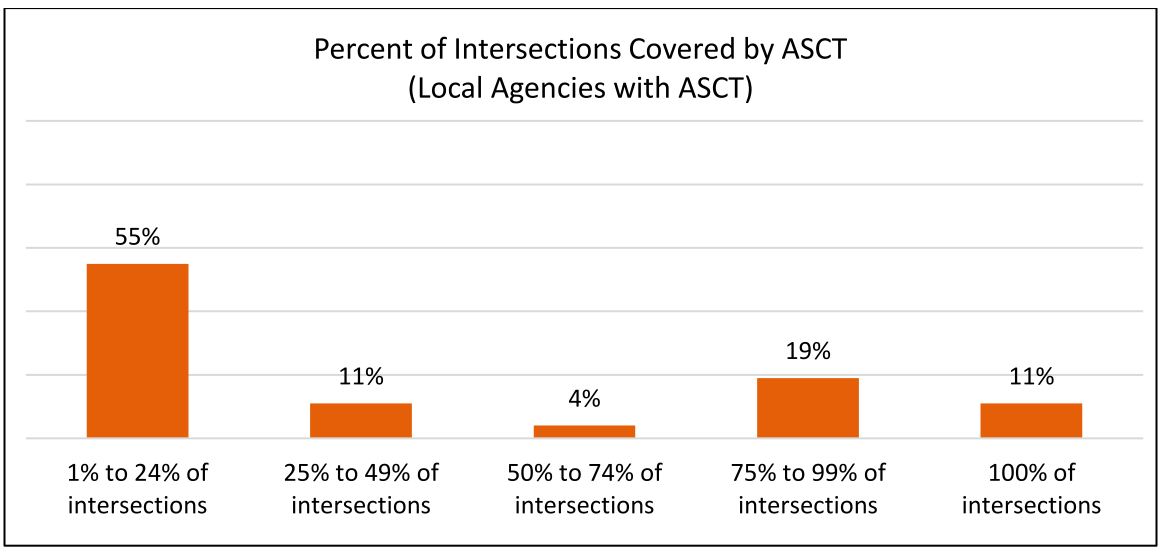
There is a significant difference between statistical areas: a majority of local arterial management agencies in large metropolitan areas (56 percent) deploy *CCTV* compared to 13 percent of local agencies in smaller urban and rural areas.

Adaptive Signal Control Technology at Intersections Among Local Agencies Operating Signalized Intersections

Of the 221 local arterial management agencies operating signalized intersections, about one fifth use *ASCT* (21 percent) as an operational strategy to improve coordinated signal timing.

There is a significant difference in the deployment of ASCT between statistical areas. A significantly higher percentage of local arterial management agencies in large metropolitan areas (33 percent) deploy *ASCT* compared to agencies in smaller urban and rural areas (17 percent).

Figure 42 shows that a majority of the 46 local arterial management agencies deploying ASCT do so on *1% to 24% of intersections* (55 percent). At the top end of deployment, almost one third deploy ASCT on either *75% to 99% intersections* (19 percent) or *100% of intersections* (11 percent). Four (4) percent of local agencies deploying ASCT do so on *50% to 74% of intersections* and 11 percent do so on *25% to 49% of intersections.*



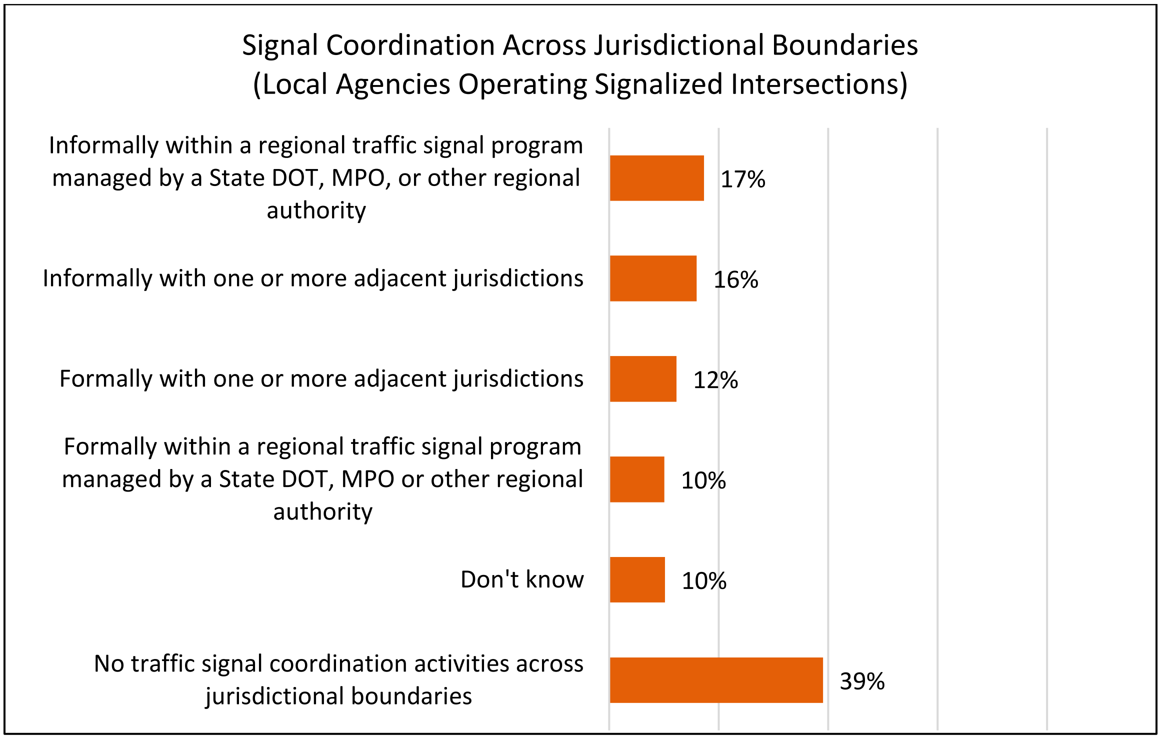
2023 Q6; (WN=46, UWN=57; 0% missing) *Source: USDOT*

Figure 42. Percent of Intersections Covered by ASCT (Local Agencies with ASCT)

Signal Coordination Among Local Agencies Operating Signalized Intersections

Of the 221 local arterial management agencies that operate signalized intersections, 50 percent participate in signal coordination across jurisdictional boundaries.

Among local agencies operating signalized intersections, Figure 43 shows that 17 percent coordinate *informally within a regional traffic signal program managed by a State DOT, MPO, or other regional authority*, 16 percent coordinate *informally with one or more adjacent jurisdictions*, 12 percent coordinate *formally with one or more adjacent jurisdiction*,[34] and 10 percent coordinate *formally within a regional traffic signal program managed by a State DOT, MPO, or other regional authority.* Ten (10) percent of local agencies operating signalized intersections reported *don't know*, while 39 percent reported *no traffic signal coordination activities across jurisdictional boundaries.*



2023 Q7; (WN=217, UWN=221; 1% missing) *Source: USDOT*

Figure 43. Signal Coordination Across Jurisdictional Boundaries (Local Agencies with Signalized Intersections)

Local agencies operating signalized intersections in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to participate in signal coordination *formally with one or more adjacent jurisdictions* (27 percent compared to 7 percent).

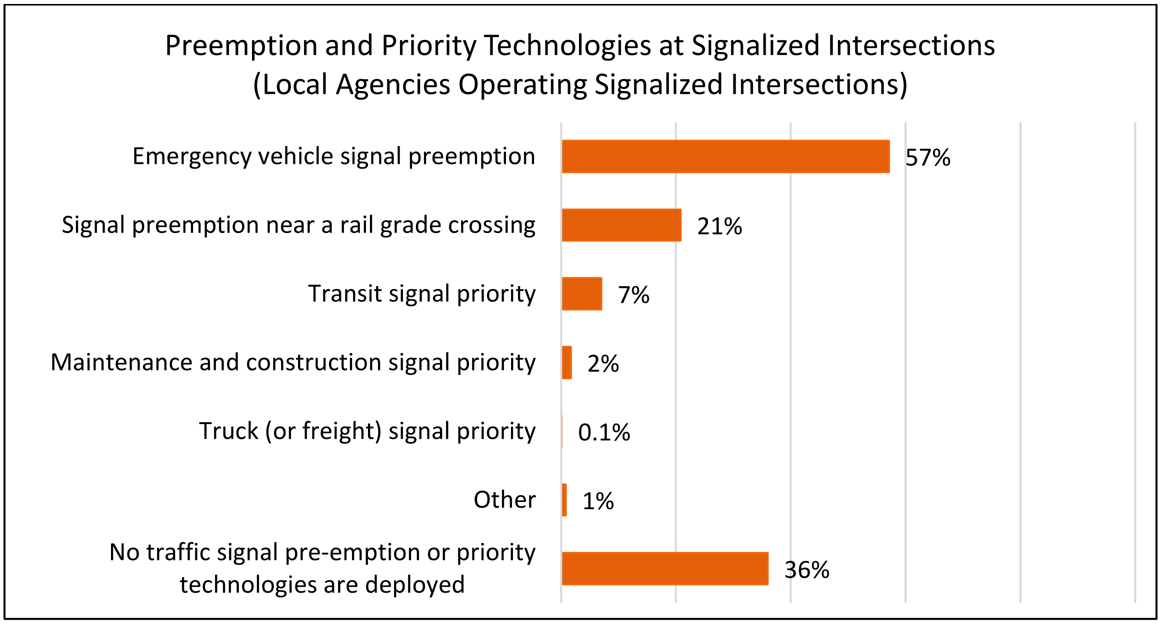
[34] The survey instrument provided examples of formal agreements, including Memorandums of Understanding and written agreements.

Preemption and Priority Technologies at Intersections Among Local Agencies Operating Signalized Intersections

Of the 221 local arterial management agencies operating signalized intersections, 62 percent deploy at least one preemption or priority technology at signalized intersections. Local agencies using preemption or priority reported deploying an average of 1.4 different technologies.

Figure 44 shows a majority of local agencies operating signalized intersections deploy *emergency vehicle signal preemption* (57 percent). About one fifth deploy s*ignal preemption near a rail grade crossing* (21 percent), and 7 percent deploy *transit signal priority*.

Maintenance and construction signal priority, a new response category in 2023, and *truck (or freight) signal priority* are each deployed by 2 percent or fewer responding local agencies. Over one third of local agencies operating signalized intersections reported *no traffic signal preemption or priority technologies are deployed* (36 percent).



2023 Q8; (WN=217, UWN=221; 2% missing) *Source: USDOT*

Figure 44. Preemption and Priority Technologies at Signalized Intersections (Local Agencies Operating Signalized Intersections)

Table 17 shows that local agencies operating signalized intersections in large metropolitan areas are significantly more likely to deploy *emergency vehicle signal preemption* than those in smaller urban and rural areas (76 percent compared to 50 percent). There is also a significant difference by statistical area in the deployment of *signal preemption near a rail grade crossing* (49 percent compared to 10 percent) and *transit signal priority* (17 percent compared to 3 percent).

Table 17. Preemption and Priority Technologies at Signalized Intersections (Local Agencies Operating Signalized Intersections): Significant Differences Between Statistical Areas

Technology	Large Metropolitan (WN=61; UWN=95)	Smaller Urban and Rural (WN=155; UWN=126)
Emergency vehicle signal preemption	76%	50%
Signal preemption near a rail grade crossing	49%	10%
Transit signal priority	17%	3%

Source: USDOT

Safety-Related ITS Technologies

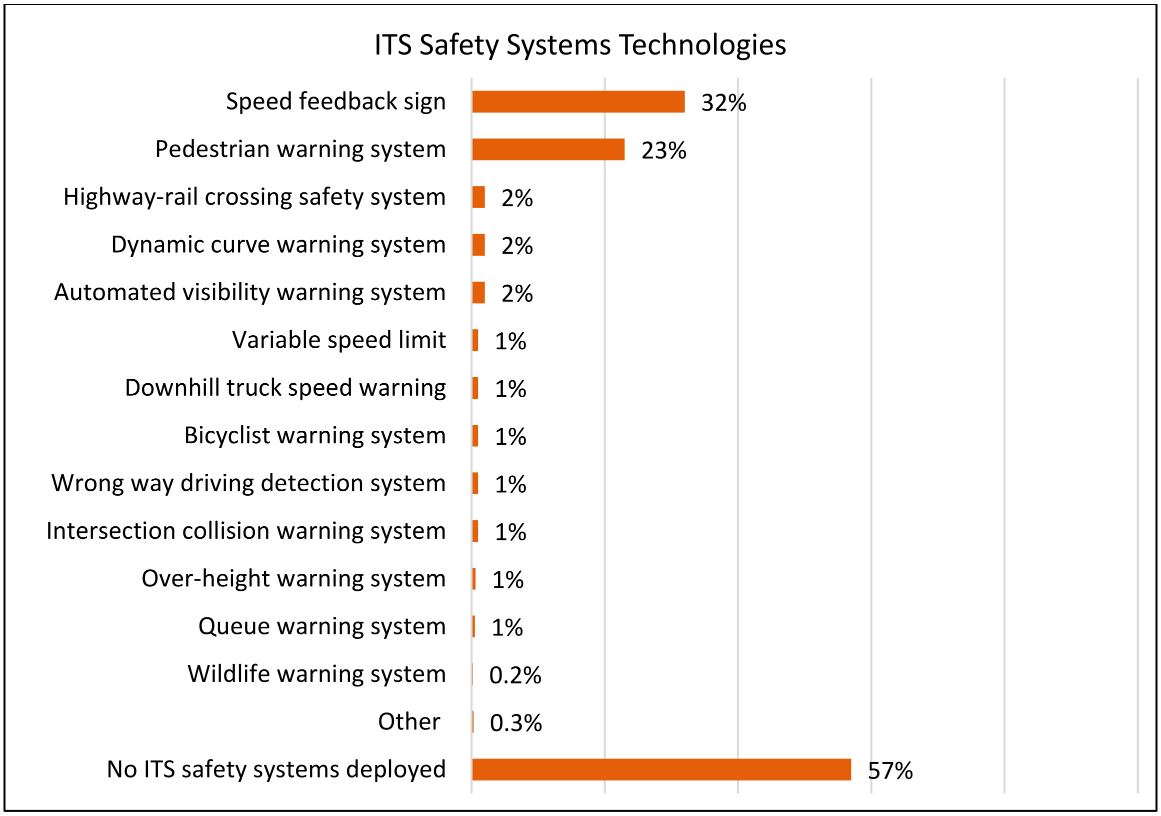
Safety-related ITS technologies include:

- ITS safety systems technologies
- Work zone ITS technologies
- ITS for road weather management
- Automated enforcement technologies
- Incident detection and verification methods

ITS Safety Systems Technologies

Among all 2023 local arterial management agency respondents, 42 percent deploy at least one ITS safety systems technology. Local agencies deploying safety systems deploy an average of 1.6 different ITS safety systems technologies.

Figure 45 shows *speed feedback signs* (32 percent) and *pedestrian warning systems* (23 percent) are the most deployed ITS safety systems technologies among responding local agencies. *Highway-rail crossing safety systems*, *dynamic curve warning systems,* and *automated visibility warning systems* are each deployed by 2 percent of local arterial management agencies. All other categories were reported by 1 percent or fewer respondents. A majority of local arterial management agencies reported *no ITS safety systems deployed* (57 percent).



2023 Q17; (n=423; 1% missing) *Source: USDOT*

Figure 45. ITS Safety Systems Technologies

Table 18 shows that place agencies are significantly more likely than county agencies to deploy the two most deployed ITS safety systems technologies—*speed feedback signs* (37 percent compared to 15 percent) and *pedestrian warning systems* (28 percent compared to 8 percent). County agencies were significantly more likely than place agencies to report *no ITS safety systems are deployed* (80 percent compared to 51 percent).

Table 18. ITS Safety Systems Technologies: Significant Differences Between Local Agency Types

Technology	Place Agencies (WN=323; UWN=263)	County Agencies (WN=100; UWN=160)
Speed feedback sign	37%	15%
Pedestrian warning system	28%	8%
No ITS safety systems are deployed	51%	80%

Source: USDOT

Table 19 shows that local arterial management agencies in large metropolitan (45 percent) are significantly more likely than those in micropolitan (26 percent) and rural areas (16 percent) to deploy *speed feedback signs.* Small metropolitan agencies (33 percent) are also significantly more likely than local agencies in rural areas to deploy *speed feedback signs*.

Local arterial management agencies in large metropolitan areas (40 percent) are significantly more likely than local agencies in any other statistical area to deploy *pedestrian warning systems*, and local agencies in small metropolitan (24 percent) and micropolitan areas (14 percent) are also significantly more likely to deploy *pedestrian warning systems* than agencies in rural areas (14 percent).

Rural agencies were significantly more likely than local agencies in all other statistical areas to report *no ITS safety systems are deployed* (82 percent of rural agencies compared to 42 percent of large metropolitan agencies, 55 percent of small metropolitan agencies, and 66 percent of micropolitan agencies). Local arterial management agencies in micropolitan areas are also significantly more likely than large metropolitan areas to report *no ITS safety systems are deployed.*

Table 19. Safety Systems Technologies: Significant Differences Between All Statistical Areas

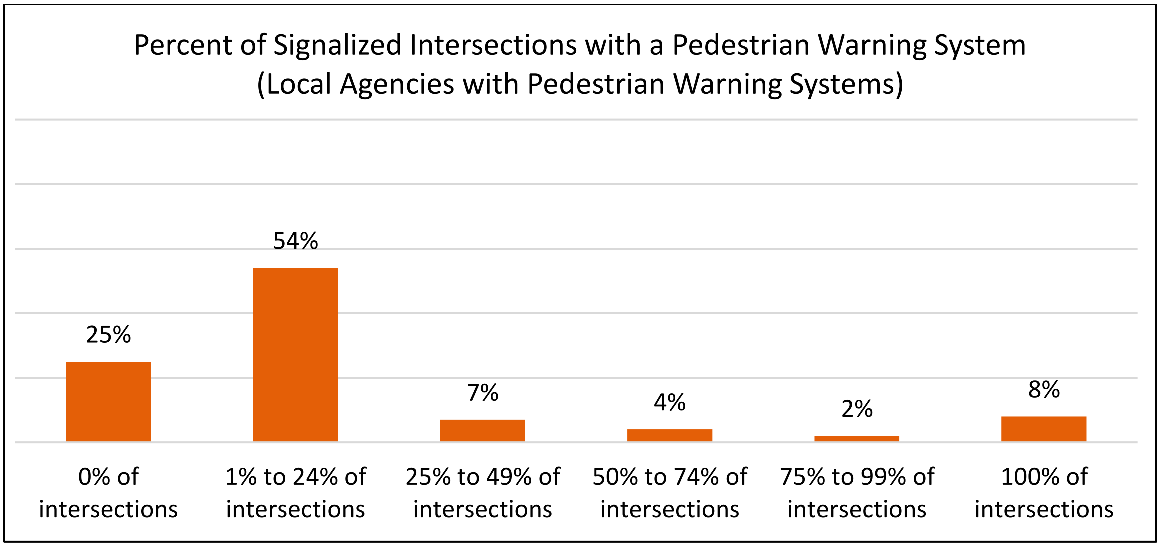
Technology	Large Metropolitan (WN=74; UWN=108)	Small Metropolitan (WN=233; UWN=149)	Micropolitan (WN=65; UWN=86)	Rural (WN=52; UWN=80)
Speed feedback sign	45% (^†)	33% (†)	26%	16%
Pedestrian warning system	40% (*^†)	24% (†)	14% (†)	5%
No ITS safety systems are deployed	42% (^†)	55% (†)	66% (†)	82%

** statistically significant difference compared to small metropolitan areas;*
^ statistically significant difference compared to micropolitan areas;
† statistically significant difference compared to rural areas

Source: USDOT

Local arterial management agencies that deploy ITS pedestrian warning systems were asked what percentage of their signalized intersections are equipped with ITS pedestrian warning technology (e.g. pedestrian hybrid beacon, passive pedestrian sensors).

Figure 46 shows that one fourth of the 97 local arterial management agencies with pedestrian warning systems equip *0% of intersections*.[35] A majority of agencies reported that *1% to 24% of intersections* (54 percent) are equipped. At the top end of deployment, 8 percent of local agencies equip *100% of intersections* with pedestrian warning systems. Less than 10 percent of local agencies reported each of the following: *25% to 49% of intersections, 50% to 74% of intersections*, and *75% to 99% of intersections.*



2023 Q18; (WN=97, UWN=97; 0.1% missing) *Source: USDOT*

Figure 46. Percent of Signalized Intersections with a Pedestrian Warning System (Local Agencies with Pedestrian Warning Systems)

Work Zone ITS Technologies

Nearly all local arterial management agencies reported *no work zone ITS technologies* (96 percent). *Temporary traffic signals* (3 percent), *portable DMS* (2 percent), and *portable dynamic speed feedback/speed radar trailers* (1 percent) are the only work zone technologies deployed by more than 1 percent of local agencies.

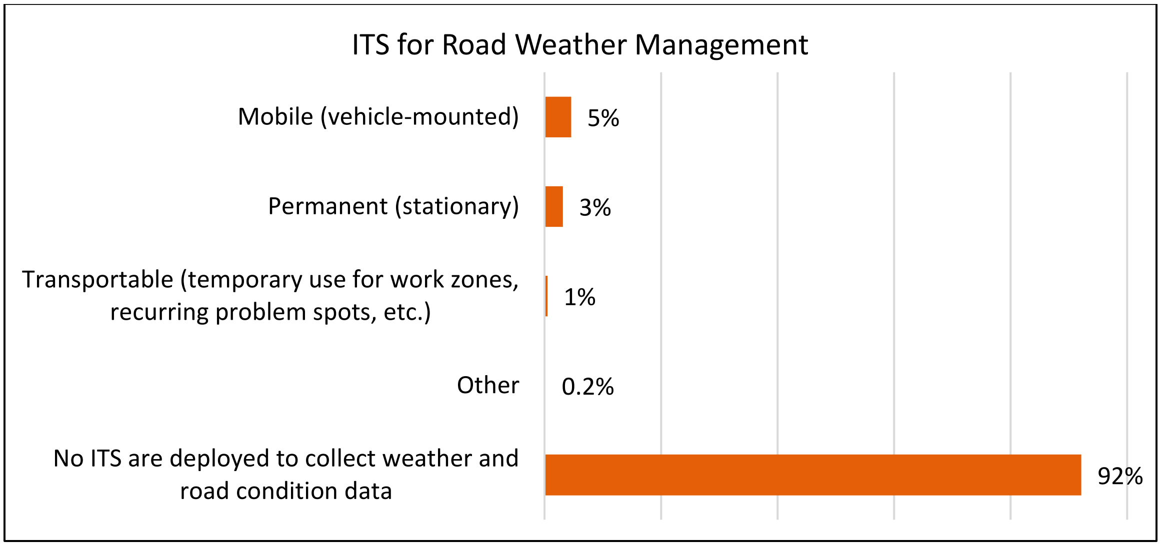
Variable speed limits, *travel time systems*, *route guidance around work zones,* and *queue detection and alert systems* are each deployed by less than 1 percent of local agencies. No local agencies reported deploying *portable traffic monitoring devices, portable CCTV, intrusion alarms,* and *dynamic lane merge systems*.

[35] Note that pedestrian warning systems can be deployed mid-block and are therefore not always placed at signalized intersections.

ITS for Road Weather Management

The survey included a question on the different types (permanent, mobile, or transportable) of Road Weather Information Systems (RWIS)/Environmental Sensor Stations (ESS) deployed by arterial management agencies. Eight (8) percent of responding local arterial management agencies use one or more of the surveyed types of RWIS/ESS.

Figure 47 shows that 5 percent of local agencies use *mobile* systems *(vehicle-mounted*), 3 percent use *permanent* systems *(stationary*), and 1 percent use *transportable (temporary use for work zones, recurring problem spots, etc.)* systems to collect weather and road conditions on arterials. Almost all local arterial management agencies reported *no ITS are deployed to collect weather and road condition data* (92 percent).



2023 Q19; (n=423; 0.02% missing) *Source: USDOT*

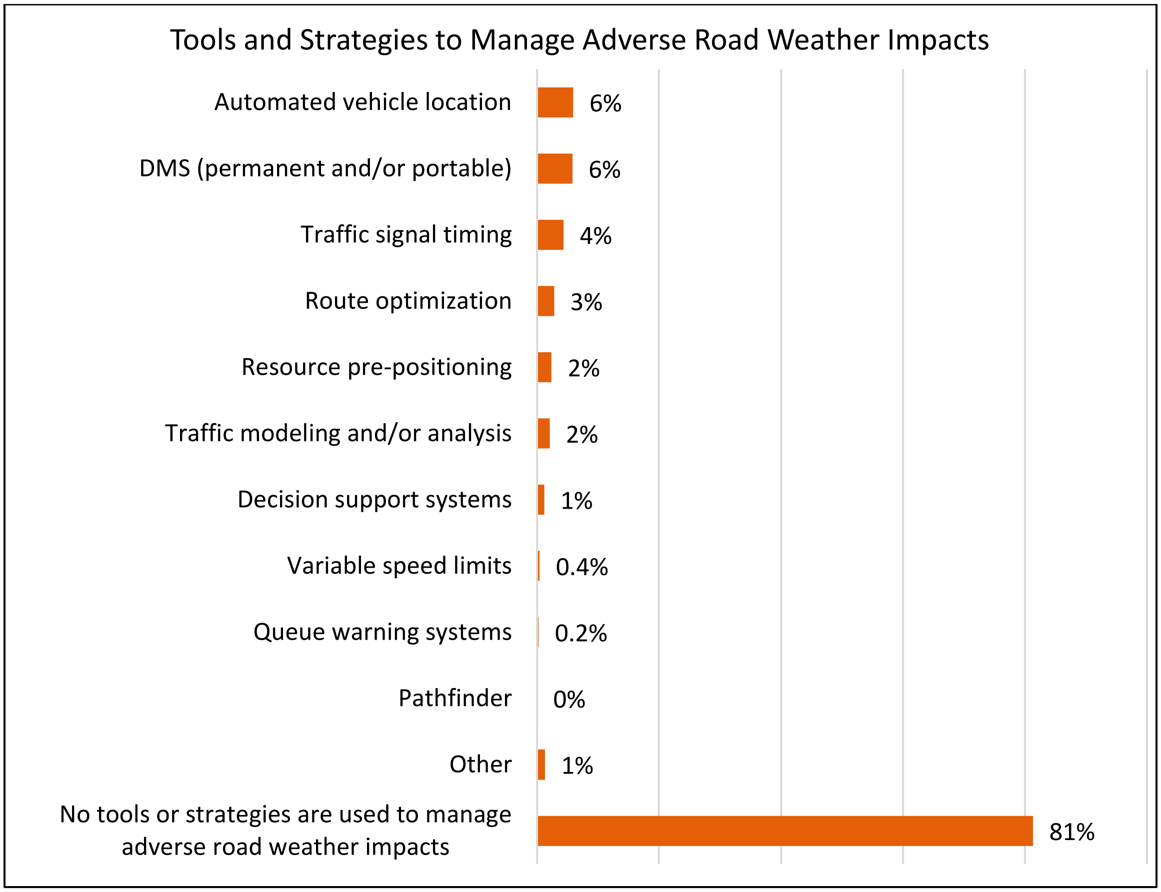
Figure 47. ITS for Road Weather Management

For the first time in 2023, the ITS Deployment Tracking Survey included a question about the tools and strategies used to manage adverse road weather impacts, which was asked of all local arterial management agencies. Eighteen (18) percent of local arterial management agencies use at least one tool or strategy, and local agencies using tools and strategies for managing adverse road weather impacts reported using an average of 1.5 different tools or strategies (out of 11 response categories).

Figure 48 shows that use of both *automated vehicle location* and *DMS (permanent and/or portable)* were reported by 6 percent of local agencies for adverse road weather impacts management. For this purpose, 4 percent use *traffic signal timing*, and 3 percent use *route optimization*.

Resource pre-positioning and *traffic modelling and/or analysis* are both used by 2 percent of local arterial management agencies, and 1 percent use *decision support systems*. *Variable speed limits* and *queue warning systems* are used by fewer than 1 percent of local arterial management agencies to manage adverse road weather impacts.

No local arterial management agencies reported using *Pathfinder*[36], and a large majority reported *no tools or strategies are used to manage adverse road weather impacts* (81 percent).



2023 Q20; (n=423; 1% missing) *Source: USDOT*

Figure 48. Tools and Strategies to Manage Adverse Road Weather Impacts

[36] "Pathfinder" is a collaborative strategy for proactive transportation system management ahead of and during adverse weather events and encourages State DOTs, National Weather Service, and weather service contractors to share and translate weather forecasts and road conditions into consistent transportation impact messages for the public. For more information, see: https://ops.fhwa.dot.gov/publications/fhwahop18034/index.htm

Table 20 shows that county agencies are significantly more likely than place agencies to use *automated vehicle location* (13 percent compared to 4 percent) to manage adverse road weather impacts. Place agencies were significantly more likely than county agencies to report *no tools or strategies are used to manage adverse road weather impacts* (85 percent compared to 70 percent).

Table 20. Tools and Strategies to Manage Adverse Road Weather Impacts: Significant Differences Between Local Agency Types

Tool or Strategy	Place Agencies (WN=323; UWN=263)	County Agencies (WN=100; UWN=160)
Automated vehicle location	4%	13%
No tools or strategies are used to manage adverse road weather impacts	85%	70%

Source: USDOT

Table 21 shows that local arterial management agencies in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to use *traffic signal timing* (18 percent compared to 1 percent) and *DMS (permanent and/or portable)* (13 percent compared to 4 percent).

Smaller urban and rural arterial management agencies were significantly more likely to report *no tools or strategies are used to manage adverse road weather impacts* compared to those in large metropolitan areas (86 percent compared to 61 percent).

Table 21. Tools and Strategies to Manage Adverse Road Weather Impacts: Significant Differences Between Statistical Areas

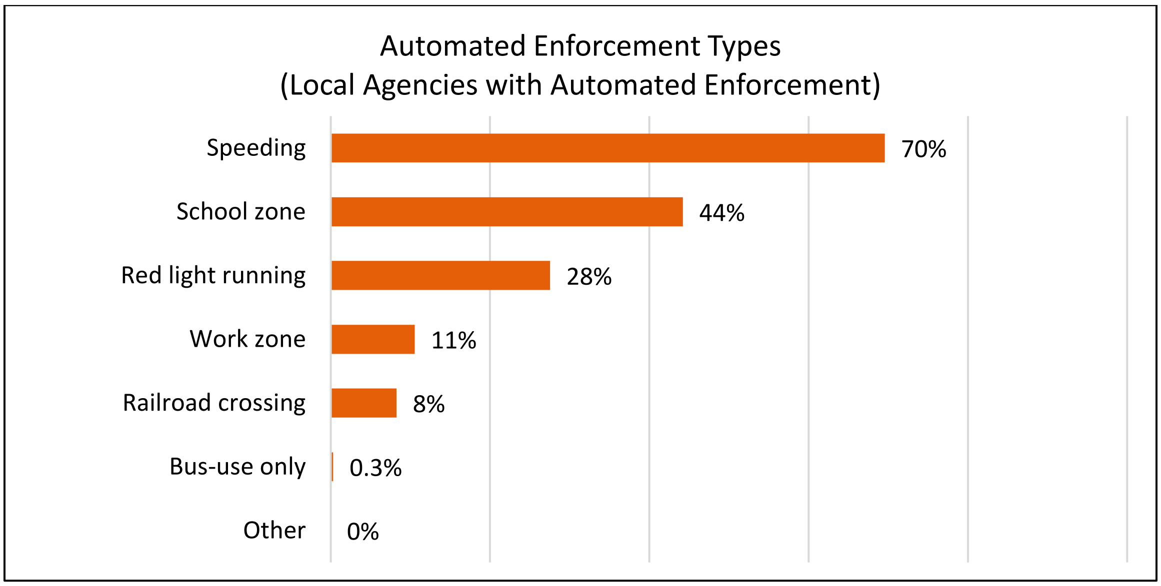
Tool or Strategy	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
Traffic signal timing	18%	1%
DMS (permanent and/or portable)	13%	4%
No tools or strategies are used to manage adverse road weather impacts	61%	86%

Source: USDOT

Automated Enforcement Technologies

In 2023, 11 percent of local arterial management agencies deploy at least one automated enforcement technology.

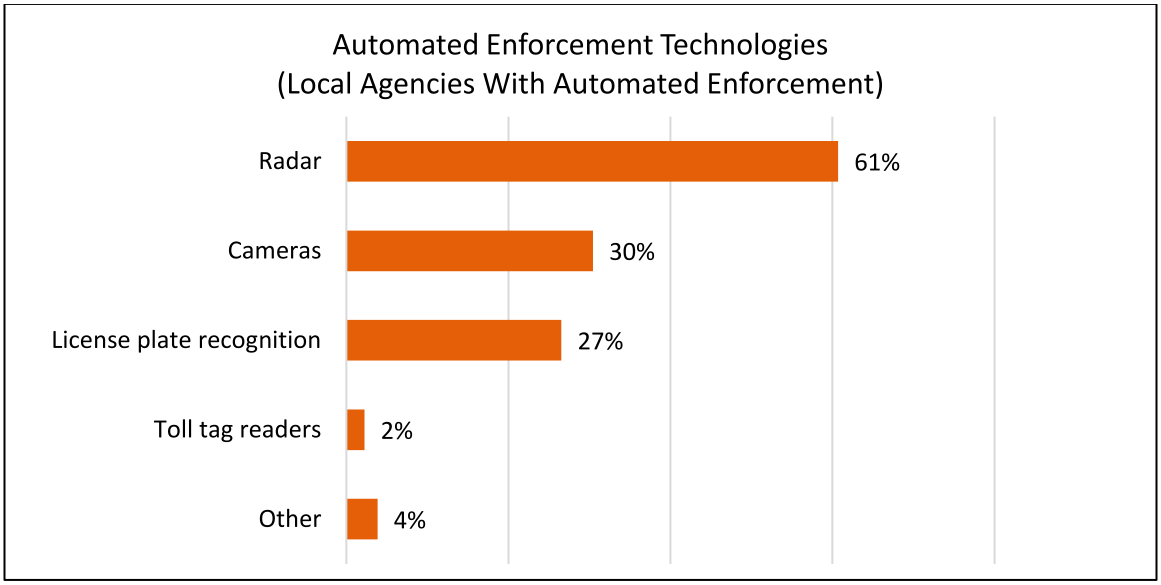
Figure 49 shows that among the 47 local agencies deploying at least one automated enforcement technology on arterials, nearly three fourths use automated enforcement technologies for *speeding* (70 percent), and 44 percent use it in *school zones*. About one fourth use automated enforcement technologies for *red light running* (28 percent), 11 percent at *work zones*, and 8 percent at *railroad crossings*. *Bus-use only* automated enforcement is used by less than 1 percent of local agencies deploying automated enforcement.



2023 Q15; (WN=45, UWN=47; 5% missing) *Source: USDOT*

Figure 49. Automated Enforcement Types (Local Agencies with Automated Enforcement)

Figure 50 shows that among the 47 local agencies deploying automated enforcement, a majority use *radar* (61 percent). About one third use *cameras* (30 percent), and about one fourth use *license plate recognition* (27 percent). Two (2) percent of local agencies with automated enforcement reported using *toll tag readers.*



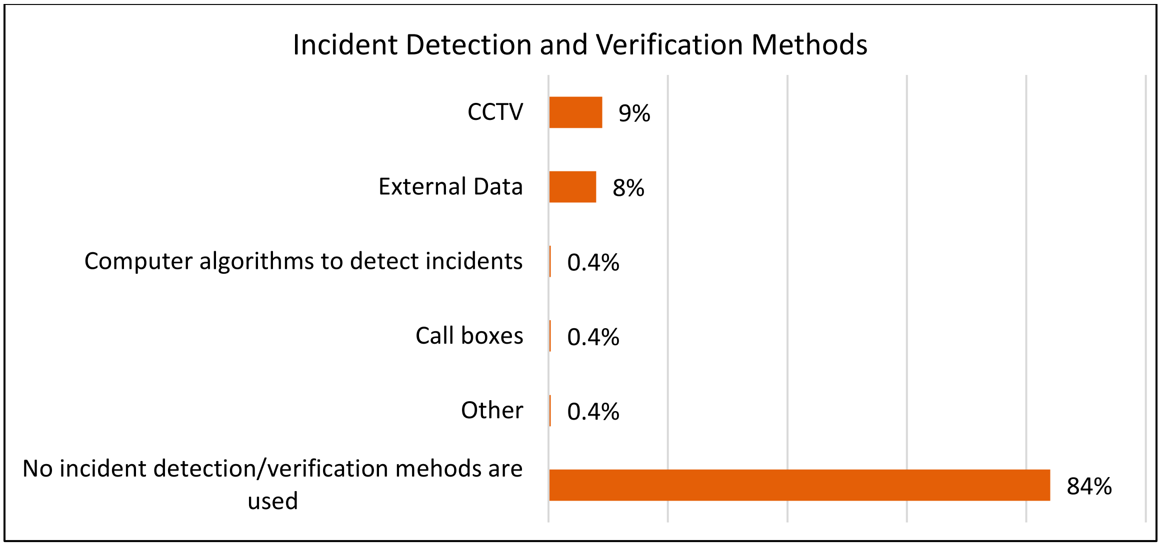
2023 Q16; (WN=45, UWN=47; 9% missing) *Source: USDOT*

Figure 50. Automated Enforcement Technologies (Local Agencies with Automated Enforcement)

Incident Detection and Verification

Fifteen (15) percent of local arterial management agencies use at least one incident detection or verification method on arterials.

Figure 51 shows that 9 percent of local arterial management agencies use *CCTV*, and 8 percent of local agencies use *external data (e.g., data provided by crowdsourcing, commercial providers, or citizen-reported)* for incident detection or verification. *Computer algorithms to detect incidents* and *call boxes* are each used by less than 1 percent of local arterial management agencies. A large majority reported *no incident detection/verification methods are used* (84 percent).



2023 Q21; (n=423; 1% missing) *Source: USDOT*

Figure 51. Incident Detection and Verification Methods

Table 22 shows that local arterial management agencies in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to use *CCTV* (30 percent compared to 4 percent) and *external data* (20 percent compared to 6 percent) for incident detection or verification. Local arterial management agencies in smaller urban and rural areas were significantly more likely than those in large metropolitan areas to report *no incident detection/verification methods are used* (90 percent compared to 59 percent).

Table 22. Incident Detection and Verification Methods: Significant Differences Between Statistical Areas

Method	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
CCTV	30%	4%
External data	20%	6%
No incident detection/ verification methods are used	59%	90%

Source: USDOT

Real-Time Data Collection

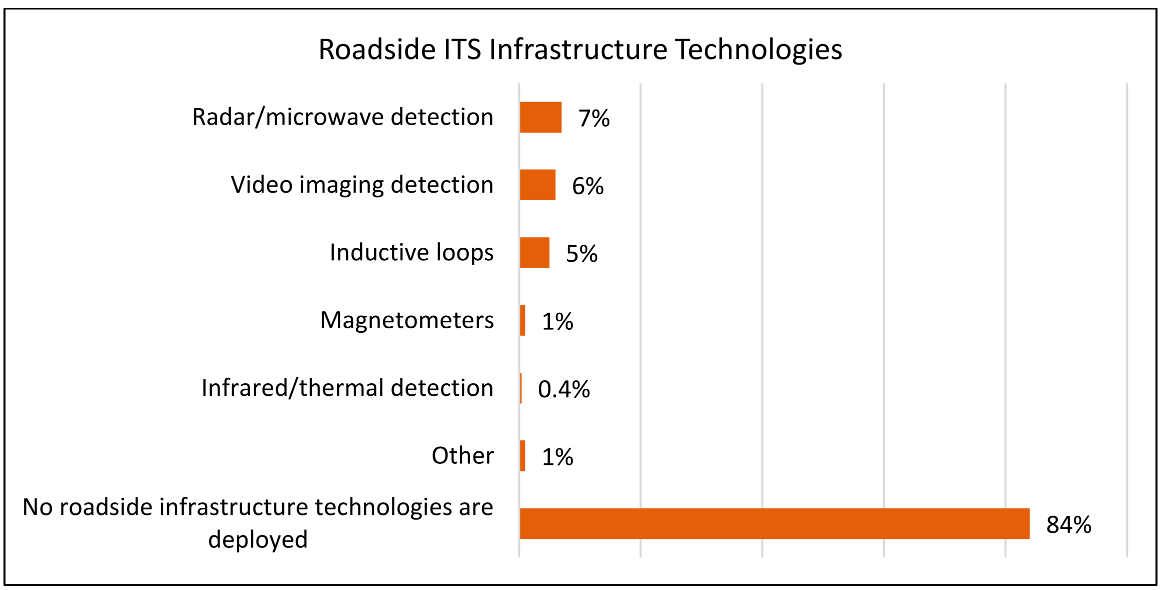
Real-time data collection includes:

- Roadside ITS infrastructure technologies
- Vehicle probe readers
- External data sources

Roadside ITS Infrastructure Technologies

Roadside ITS infrastructure technologies to collect real-time traffic data on arterials are deployed by 15 percent of responding local arterial management agencies. Among these deployers, local agencies deploy an average of 1.2 different roadside ITS technologies.

Figure 52 shows that less than 10 percent of local arterial management agencies are deploying any of the surveyed roadside ITS technologies, including *radar/microwave detection* (7 percent), *video imaging detection* (6 percent), *inductive loops* (5 percent). Fewer local agencies (1 percent or less) deploy *magnetometers* and *infrared/thermal detection*, a new response category in 2023. A large majority of local arterial management agencies reported *no roadside infrastructure technologies deployed* (84 percent).



2023 Q9; (n=423; 1% missing) *Source: USDOT*

Figure 52. Roadside ITS Infrastructure Technologies

Table 23 shows that local arterial management agencies in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to deploy *video imaging detection* (16 percent compared to 4 percent) and *radar/microwave detection* (14 percent compared to 5 percent).

By contrast, local arterial management agencies in smaller urban and rural areas were significantly more likely than those in large metropolitan areas to report *no roadside infrastructure technologies are deployed* (87 percent compared to 68 percent).

Table 23. Roadside ITS Infrastructure Technologies: Significant Differences Between Statistical Areas

Technology	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
Video imaging detection	16%	4%
Radar/microwave detection	14%	5%
No roadside infrastructure technologies are deployed	68%	87%

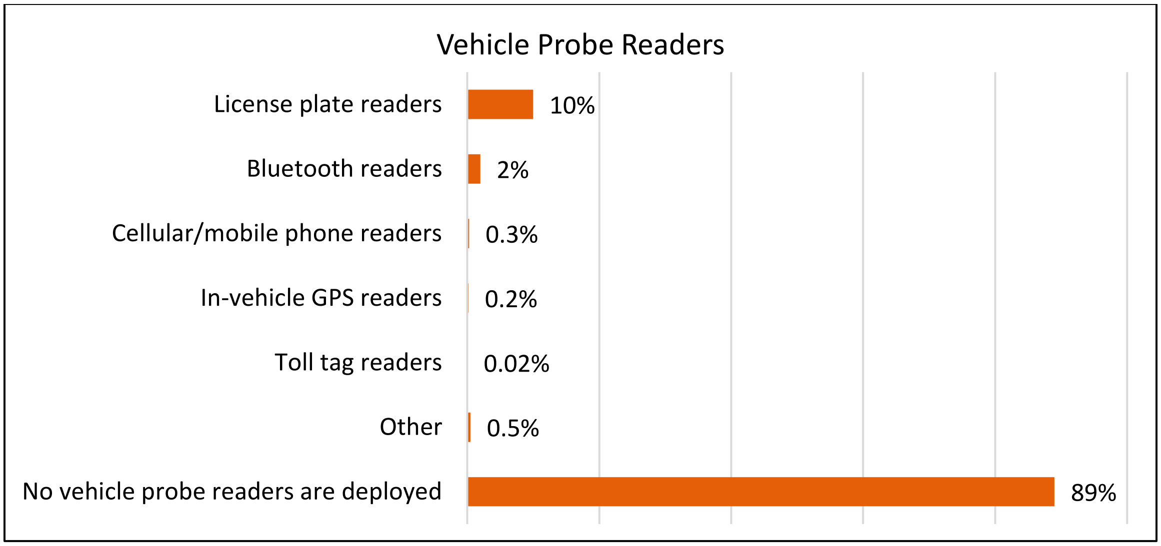
Source: USDOT

Within the smaller urban and rural agency grouping, there are some significant differences between statistical areas. Rural arterial management agencies were significantly more likely than all other statistical area groups to report *no roadside infrastructure technologies are deployed* (97 percent, compared to 68 percent of large metropolitan agencies, 84 percent of small metropolitan agencies, and 87 percent of micropolitan agencies).

Vehicle Probe Readers

Vehicle probe readers to collect real-time traffic data on arterials are deployed by 11 percent of responding local arterial management agencies. Among vehicle probe reader deployers, local agencies deploy an average of 1.1 different vehicle probe readers.

Figure 53 shows the most deployed probe readers by local arterial management agencies are *license plate readers* (10 percent). *Bluetooth readers, cellular/mobile phone readers, in-vehicle GPS readers,* and *toll tag readers* are each deployed by 2 percent or fewer local arterial management agencies. A large majority of local arterial management agencies reported *no vehicle probe readers deployed* (89 percent).



2023 Q10; (n=423; 0% missing) *Source: USDOT*

Figure 53. Vehicle Probe Readers

Table 24 shows that the deployment of *license plate readers* (18 percent compared to 8 percent) and *Bluetooth readers* (10 percent compared to 1 percent) are significantly higher among local arterial management agencies in large metropolitan areas than local agencies in smaller urban and rural areas. Local arterial management agencies in smaller urban and rural areas were significantly more likely than those in large metropolitan areas to report *no vehicle probe readers are deployed* (92 percent compared to 73 percent).

Table 24. Vehicle Probe Readers: Significant Differences Between Statistical Areas

Technology	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
License plate readers	18%	8%
Bluetooth readers	10%	1%
No vehicle probe readers are deployed	73%	92%

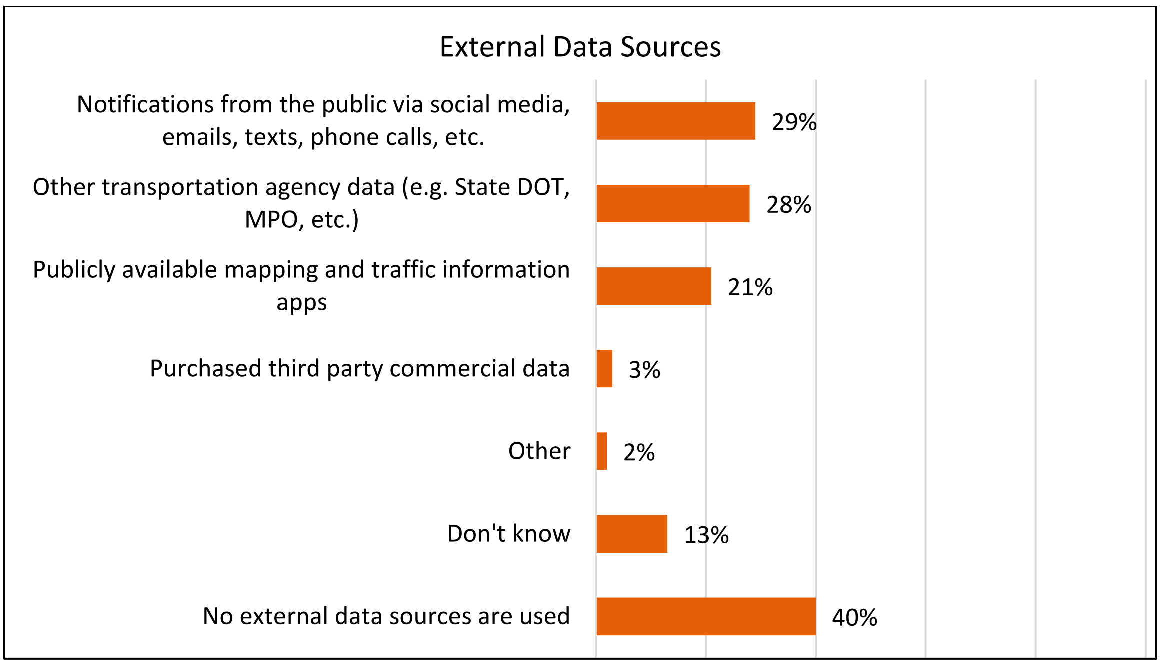
Source: USDOT

External Data Sources

Nearly half of responding local arterial management agencies use at least one source of external data (47 percent) for arterial management. Local arterial management agencies using external data use an average of 1.6 different sources.

Figure 54 shows over one fourth of local arterial management agencies use *notifications from the public via social media, emails, texts, phone calls, etc.* (29 percent) and *other transportation agency data (e.g. State DOT, MPO, etc.)* (28 percent), a new response category in 2023.

About one fifth use *publicly available mapping and traffic information apps* (21 percent) as a source of external data. Three (3) percent of local arterial management agencies use *purchased third-party commercial data*. Less than half reported *no external data sources are used* (40 percent), and 13 percent of local arterial management agencies reported *don't know.*



2023 Q11; (n=423; 0% missing) *Source: USDOT*

Figure 54. External Data Sources

Table 25 shows that county agencies are significantly more likely than place agencies to use various external data sources, including *other transportation agency data (e.g. State DOT, MPO, etc.)* (43 percent compared to 23 percent), *notifications from the public via social media, emails, texts, phone calls, etc.* (42 percent compared to 25 percent), and *publicly available mapping and traffic information apps* (31 percent compared to 18 percent).

Place agencies were significantly more likely than county agencies to report *no external data sources are used* (43 percent compared to 30 percent).

Table 25. External Data Sources: Significant Differences Between Local Agency Types

Technology	Place Agencies (WN=323; UWN=263)	County Agencies (WN=100; UWN=160)
Other transportation agency data (e.g. State DOT, MPO, etc.)	23%	43%
Notifications from the public via social media, emails, texts, phone calls, etc.	25%	42%
Publicly available mapping and traffic information apps	18%	31%
No external data sources are used	43%	30%

Source: USDOT

Table 26 shows that local arterial management agencies in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to use various external data sources, including *publicly available mapping and traffic information apps* (46 percent compared to 15 percent), *notifications from the public via social media, emails, texts, phone calls, etc.* (42 percent compared to 27 percent), *other transportation agency data (e.g. State DOT, MPO, etc.)* (42 percent compared to 25 percent), and *purchased third-party commercial data* (12 percent compared to 1 percent).

Local agencies in smaller urban and rural areas were significantly more likely than those in large metropolitan areas to report *no external data sources are used* (44 percent compared to 19 percent).

Table 26. External Data Sources: Significant Differences Between Statistical Areas

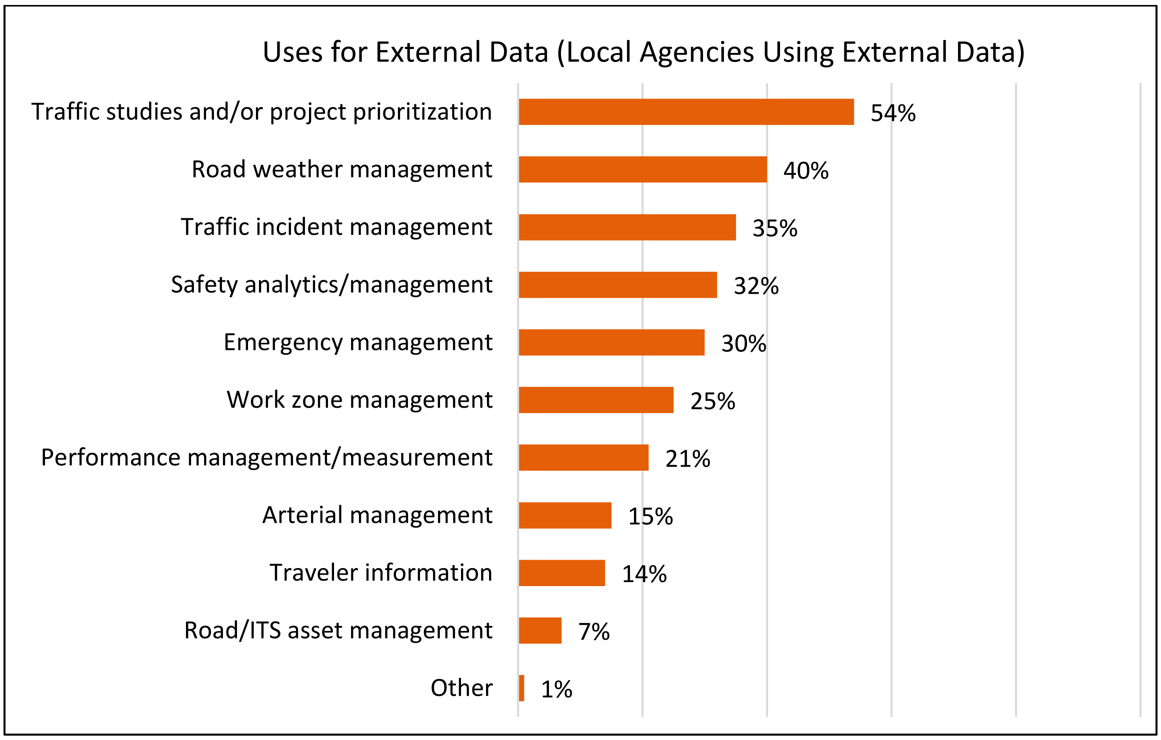
Technology	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
Publicly available mapping and traffic information apps	46%	15%
Notifications from the public via social media, emails, texts, phone calls, etc.	42%	27%
Other transportation agency data (e.g. State DOT, MPO, etc.)	42%	25%
Purchased third-party commercial data	12%	1%
No external data sources are used	19%	44%

Source: USDOT

For the first time in the 2023 Deployment Tracking Survey, agencies that reported using external data were asked how the data are used.

As shown in Figure 55, a majority of the 225 local arterial management agencies that reported use of external data use the data for *traffic studies and/or project prioritization* (54 percent). Fewer local arterial management agencies use external data for *road weather management* (40 percent), *traffic incident management* (35 percent), *safety analytics/management* (32 percent), and *emergency management* (30 percent).

About one fourth use external data for each of *work zone management* (25 percent) and *performance management/measurement* (21 percent). Fifteen (15) percent or fewer local arterial management agencies reported using external data for each of *arterial management* (15 percent), *traveler information* (14 percent), or *road/ITS asset management* (7 percent).



2023 Q12; (WN=198, UWN=225; 3% missing) *Source: USDOT*

Figure 55. Uses for External Data (Local Agencies Using External Data)

Table 27 shows local arterial management agencies in large metropolitan areas are significantly more likely than agencies in smaller urban and rural areas to use external data for *safety analytics/management* (51 percent compared to 25 percent) and *arterial management* (34 percent compared to 9 percent).

By contrast, a significantly higher percentage of local agencies in smaller urban and rural areas reported using external data for *emergency management* than those in large metropolitan areas (34 percent compared to 18 percent).

Table 27. Uses for External Data: Significant Differences Between Statistical Areas

Uses	Large Metropolitan (WN=53; UWN=82)	Smaller Urban and Rural (WN=144; UWN=143)
Safety analytics/ management	51%	25%
Arterial management	34%	9%
Emergency management	18%	34%

Source: USDOT

Telecommunications Technologies to Enable ITS

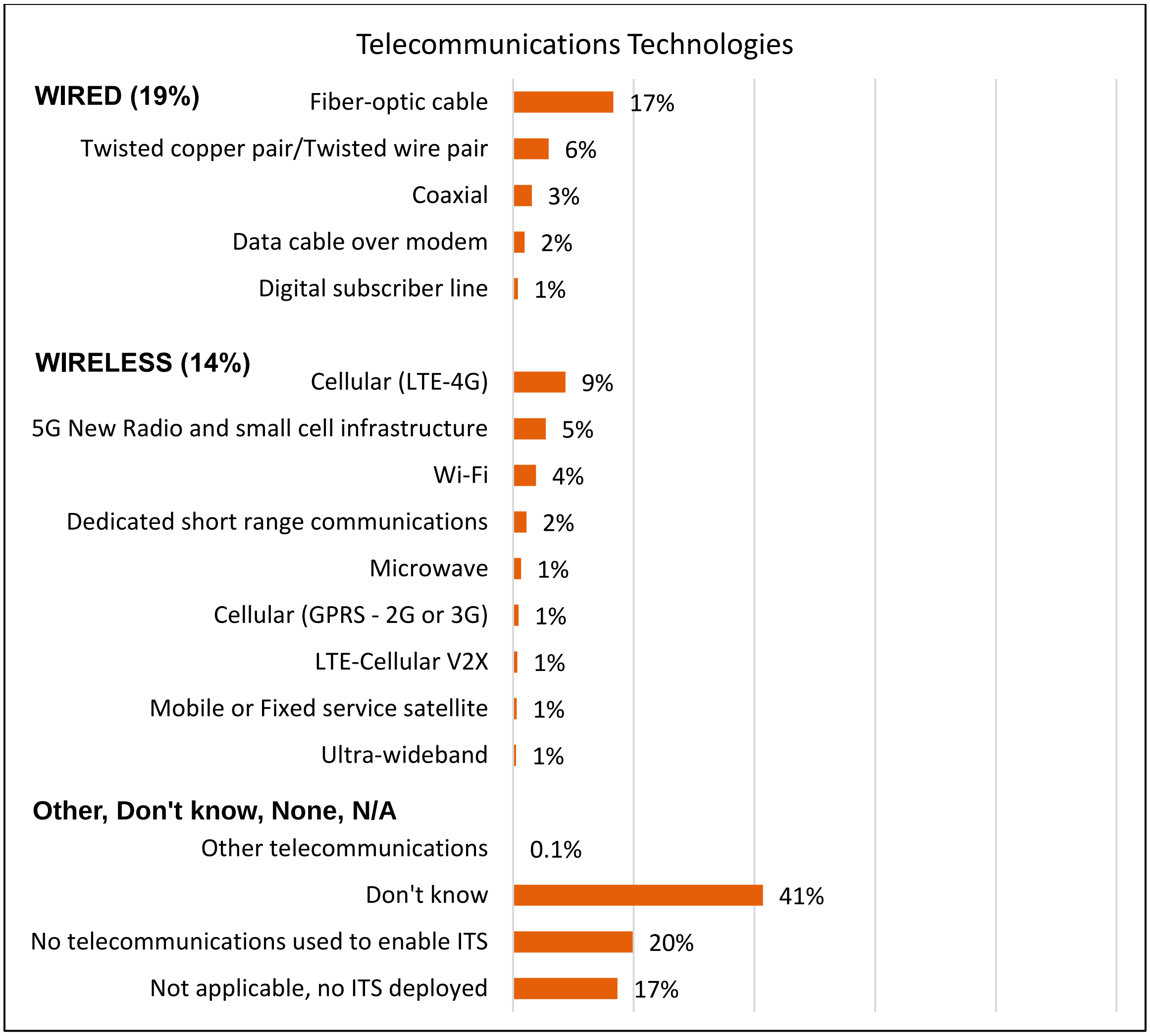
Telecommunication technologies enable communications between ITS devices, roadside devices, and/or a central processing location, typically for data collection and dissemination.

Among all local arterial management respondents, 22 percent use at least one telecommunications technology (either wired or wireless) to enable ITS on arterials. Forty-one (41) percent of local agency respondents reported *don't know*, 20 percent reported *no telecommunications used to enable ITS on arterials,* and 17 percent reported *no ITS infrastructure or devices are deployed*.

As shown in Figure 56, about one fifth of local arterial management agencies deploy at least one wired telecommunications technology (19 percent), and 14 percent deploy at least one wireless telecommunications technology. Local agencies deploying any telecommunications indicate using an average of 2.4 different wired and/or wireless telecommunication technologies to enable ITS.

Of the wired telecommunications technologies, *fiber-optic cable* (17 percent) is the most used type. Six (6) percent of local arterial management agencies use *twisted copper pair/twisted wired pair*. *Coaxial, data cable over modem,* and *digital subscriber line* are each used by less than 5 percent of local arterial management agencies.

Of the wireless telecommunications technologies, *cellular (LTE-4G)* (9 percent) is the most used type. Five (5) percent of local agencies use *5G New Radio and small cell infrastructure*, and 4 percent use *Wi-Fi*. *Dedicated short range communications*, *microwave*, *cellular (GPRS – 2G or 3G)*, *LTE-Cellular V2X (LTE-CV2X), mobile or fixed service satellite,* and *ultra-wideband* are each deployed by 2 percent or less of local arterial management agencies.



2023 Q42; (n=423; 0% missing) *Source: USDOT*

Figure 56. Telecommunication Technologies

Table 28 shows that place agencies, compared to county agencies, are significantly more likely to deploy *fiber-optic cable* (19 percent compared to 10 percent) and are also significantly more likely to report *don't know* (45 percent compared to 30 percent). County agencies are significantly more likely than place agencies to report *no ITS infrastructure or devices are deployed* (32 percent compared to 13 percent).

Table 28. Telecommunication Technologies: Significant Differences Between Local Agency Types

Technology	Place Agencies (WN=323; UWN=263)	County Agencies (WN=100; UWN=160)
Fiber-optic cable	19%	10%
Don't know	45%	30%
No ITS infrastructure or devices deployed	13%	32%

Source: USDOT

Table 29 shows that local arterial management agencies in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to deploy various wired technologies, including *fiber-optic cable* (52 percent compared to 9 percent), *twisted copper pair/twisted wire pair* (26 percent compared to 2 percent), and *coaxial* (10 percent compared to 2 percent).

Large metropolitan areas are also significantly more likely than those in smaller urban and rural areas to deploy various wireless technologies, including *cellular (LTE-4G)* (26 percent compared to 5 percent) and *5G New Radio and small cell infrastructure* (16 percent compared to 3 percent).

Also shown in Table 29, local agencies in smaller urban and rural areas were significantly more likely than those in large metropolitan areas to report *no telecommunications used to enable ITS on arterials* (23 percent compared to 6 percent) and *no ITS infrastructure or devices are deployed* (20 percent compared to 6 percent).

Table 29. Telecommunications Technologies: Significant Differences Between Statistical Areas

Technology	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
Fiber-optic cable	52%	9%
Twisted copper pair/ Twisted wire pair	26%	2%
Coaxial	10%	2%
Cellular (LTE-4G)	26%	5%
5G New Radio and Small cell infrastructure	16%	3%
No telecommunications used to enable ITS on arterials	6%	23%
No ITS infrastructure or devices are deployed	6%	20%

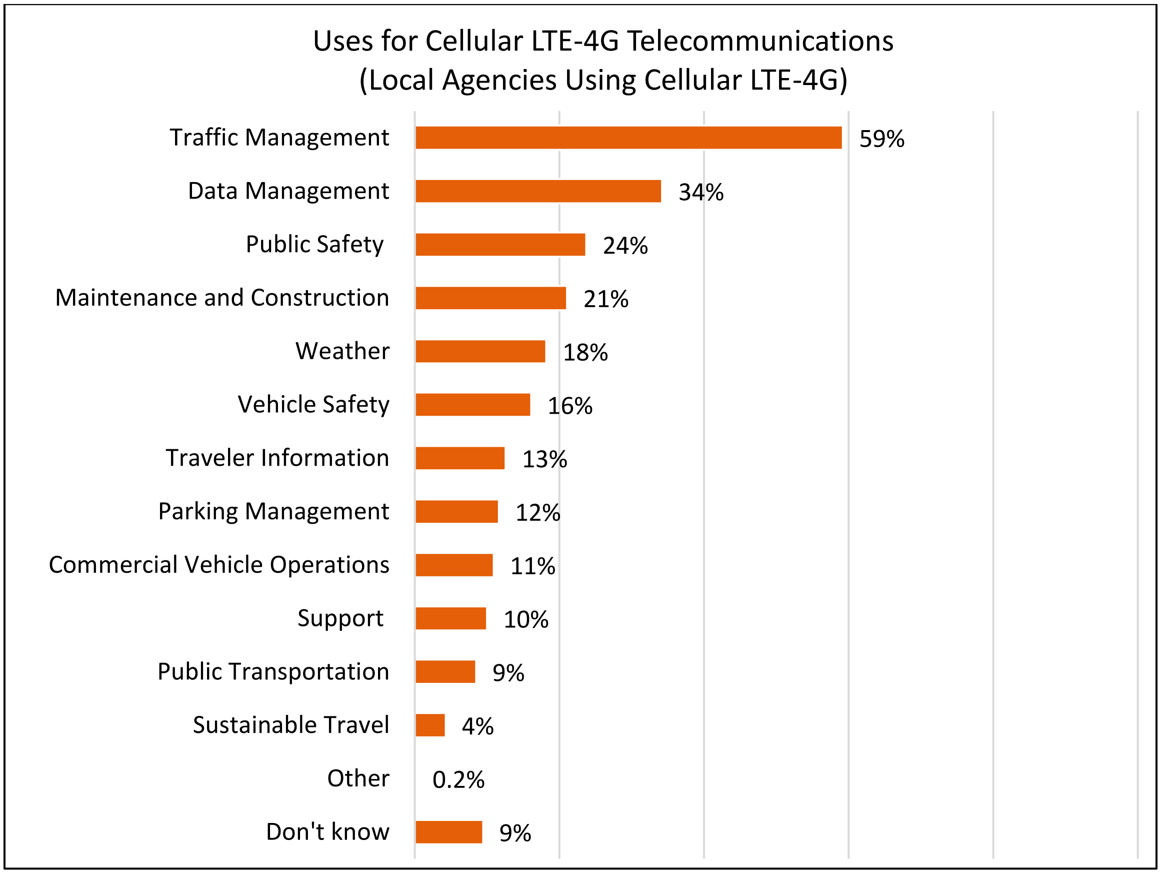
Source: USDOT

Notable within the smaller urban and rural area agency grouping is a significant difference in the deployment of *fiber-optic cable*. Twelve (12) percent of local agencies in small metropolitan areas deploy *fiber-optic cable*, which is a significantly higher percentage than the percentage of local agencies in micropolitan (3 percent) and rural (2 percent) areas deploying *fiber-optic cable*.

Rural arterial management agencies were significantly more likely to report *no ITS infrastructure or devices are deployed* (37 percent) than small metropolitan arterial management agencies (15 percent).

For the first time in 2023, survey respondents were asked how their agency uses telecommunications technologies to enable ITS.[37]

As shown in Figure 57*,* a majority of the 55 local arterial management agencies deploying cellular (LTE-4G) reported using it for *traffic management* (59 percent), and over one third reported using it for *data management* (34 percent). All other uses were each reported by less than one fourth of agencies.



2023 Q43 (WN=37, UWN=55; 4% missing) *Source: USDOT*

Figure 57. Uses for Cellular LTE-4G Telecommunications (Local Agencies Using Cellular LTE-4G)

[37] This follow-up question applied to a subset of telecommunications technologies. Excluded technologies were coaxial, fiber-optic cable, mobile or fixed service satellite, ultra-wideband, or microwave.

Connected Vehicles

The questionnaire included a number of questions on the deployment of connected vehicle (CV) technologies. Due to the complex skip logic in this section of the survey, a summary of the questions is presented here.

All 423 local arterial management agencies were asked first about whether they are currently developing, testing, or deploying CV technologies. Response options included *yes*; *no, but my agency is planning for CV*; *no plans for CV*; and *don't know*.

The subset of local arterial management agencies that reported they are not currently developing, testing, or deploying CV but are planning for CV deployment in the future were asked two follow-up questions:

- Whether their plans for CV are documented *(yes, no, don't know)*
- When they plan to begin developing, testing, or deploying CV (*within the next 3 years, in 3 to 6 years*, or *in 7 or more years*)

The subset of local arterial management agencies that reported they are currently developing, testing, or deploying CV technologies were asked two follow-up questions:

- Whether they are deploying RSUs on arterials *(yes, no, don't know)*
- Whether they are developing, testing or deploying CV applications on arterials *(yes, no, don't know)*

If a local agency reported deploying RSUs on arterials, it was asked two additional follow-up questions:

- How many RSUs are being tested or deployed on arterials
- Which standard data structures are being transmitted for the CV system by those RSUs

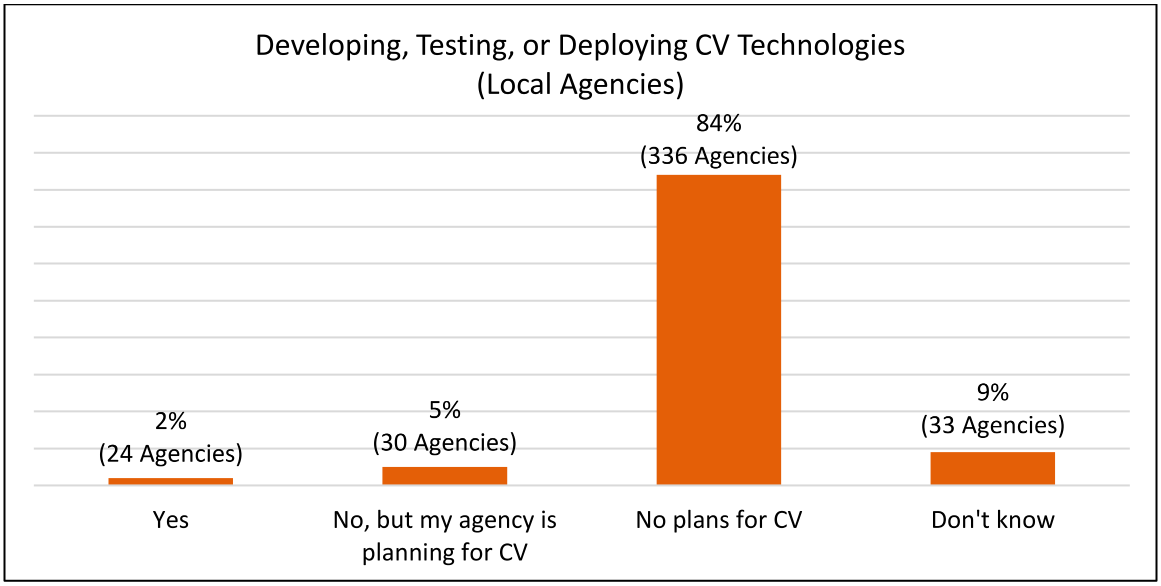
If a local agency indicated it was developing, testing, or deploying CV applications for use on arterials, it was asked a single follow-up question:

- Which specific CV applications is the agency developing, testing or deploying on arterials

The findings for all these questions are presented in this section. In the charts, the percentages (weighted) are shown for each response, as well as the unweighted number of local arterial management agencies.

Developing, Testing, Or Deploying CV Technologies

Figure 58 shows that of all 423 local arterial management agencies, 2 percent are *currently developing, testing, or deploying CV technologies*, while 5 percent are not currently developing, testing, or deploying but are *planning for CV*. A large majority reported *no plans for CV* (84 percent), and 9 percent of agencies reported *don't know*.



2023 Q28; (n=423; 0% missing) *Source: USDOT*

Figure 58. Developing, Testing, or Deploying CV Technologies (Local Agencies)

Table 30 shows that local arterial management agencies in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to be *planning for CV* (15 percent compared to 3 percent). Local arterial management agencies in smaller urban and rural areas are instead significantly more likely than those in large metropolitan areas to report *no plans for CV* (86 percent compared to 71 percent).

Table 30. Developing, Testing, or Deploying CV Technologies: Significant Differences Between Statistical Areas

Response	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
Not developing. testing or deploying CV, but my agency is planning for CV	15%	3%
No plans for CV	71%	86%

Source: USDOT

Planning For CV (But Not Currently Developing, Testing, or Deploying)

Due to the small number of respondents who received the remaining CV follow-up questions, the following results are presented using the unweighted number of local arterial management agencies.

The 30 local arterial management agencies that are not currently developing, testing, or deploying CV but are planning for CV on arterials (referred to as "agencies planning for CV" in this section, and as shown previously in Figure 58) were asked if those plans are documented.

Of these 30 local arterial management agencies planning for CV:

- Five (5) agencies *have a documented plan*
- Twenty (20) agencies *have no documented plans*
- Five (5) agencies reported *don't know*

Additionally, among these 30 local arterial management agencies, 8 local agencies expect to begin developing, testing, or deploying *within the next 3 years,* 16 agencies *in 3 to 6 years*, and no (zero) agencies *in 7 or more years*. Six (6) agencies reported *don't know.*

Deployment of RSUs and CV Applications Among Local Agencies Developing, Testing, or Deploying CV

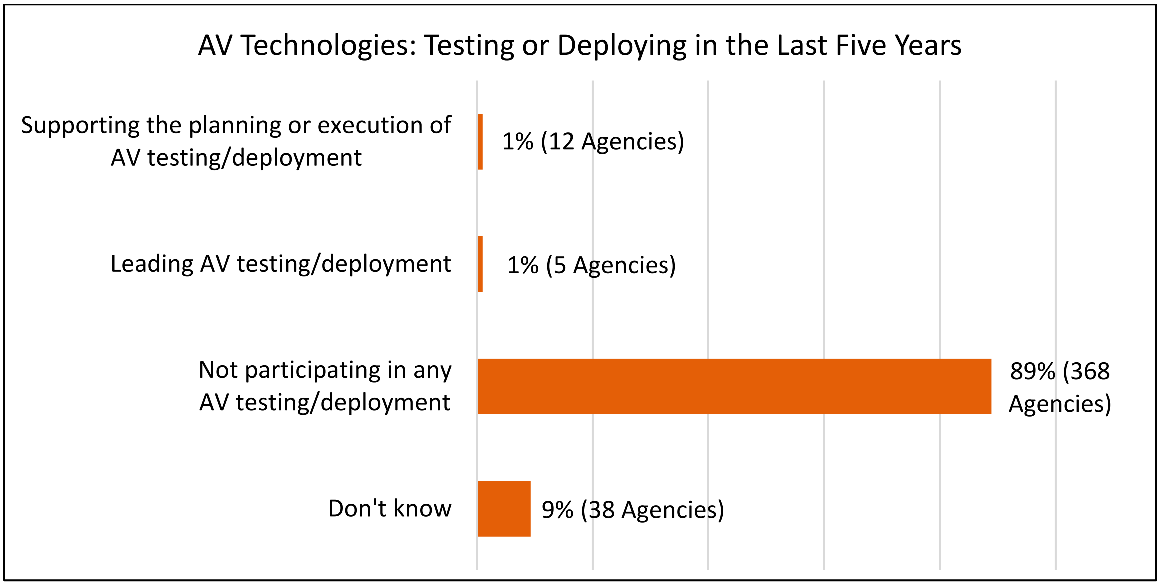
The 24 local arterial management agencies that reported they are currently developing, testing, or deploying CV were asked separate questions about their deployment of RSUs and deployment of CV applications.

Of the 24 local arterial management agencies currently developing, testing, or deploying CV, 17 agencies *deploy RSUs*, and 14 agencies are *developing, testing, or deploying CV applications*.[38] Among these local agencies, 12 reported doing both (i.e., deploying RSUs and developing, testing, or deploying CV applications).

[38] Respondents were asked, "Is your agency developing, testing, or deploying any connected vehicle applications for use on arterials, including in-vehicles (i.e., using an onboard unit (OBU), Human Machine Interface (HMI), or similar) or among pedestrians or cyclists (i.e., using a handheld device)? *This may include applications that your agency is testing either on its own fleet or in partnership with automakers/original equipment manufacturers."*

Automated Vehicles

Figure 59 shows that 1 percent of all local arterial management agencies reported *leading or has led AV testing/deployment* in the last five years, and 1 percent reported *supporting or has supported the planning or execution of an AV test/deployment* in the last five years. A large majority of local arterial management agencies are *not participating in any AV testing or deployment* (89 percent), and 9 percent reported *don't know*.



2023 Q36; (n=423; 0.4% (1 agency) missing) *Source: USDOT*

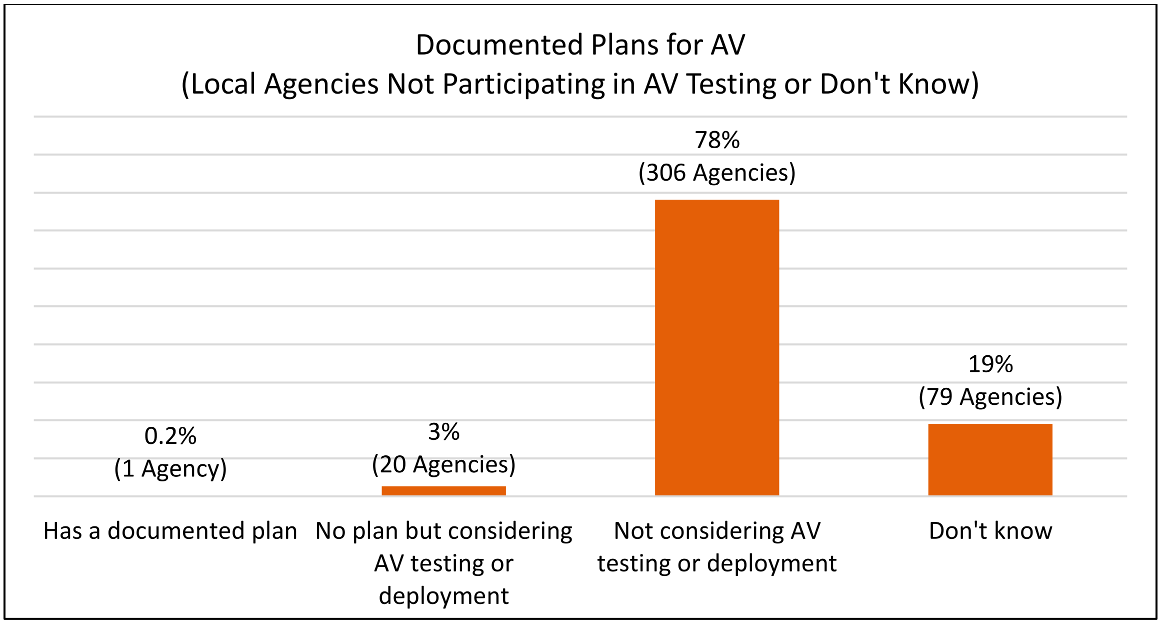
Figure 59. AV Technologies: Testing or Deploying in the Last Five Years

Local Agencies Not Participating in AV Testing/Deployment

The 406 local arterial management agencies not participating in AV testing/deployment on arterials or that reported don't know (as previously shown in Figure 59) were asked about their plans for AV.

Figure 60 shows that only 0.2 percent of these local agencies *have a documented plan to participate in AV tests or deployments*, and 3 percent are *considering AV tests or deployments.* Over three fourths indicated their agency is *not considering AV testing or deployments* (78 percent), and 19 percent responded *don't know.*

Local arterial management agencies in smaller urban and rural areas are significantly more likely than local agencies in large metropolitan areas to report *not considering AV testing or deployments* (81 percent compared to 67 percent).



2023 Q37; (WN=416, UWN=406; 0% missing) *Source: USDOT*

Figure 60. Documented Plans for AV (Local Agencies Not Participating in AV Testing/Don't Know)

Since the number of local arterial management agencies that received the remainder of the AV follow-up questions is small, results are presented by number of agencies instead of percentages.

The 21 local arterial management agencies with documented plans for AV or considering AV testing or deployment were asked about their timeline for deploying. Of these 21 local arterial management agencies, 7 agencies expect to begin pursuit *within the next 3 years,* 6 agencies *in 3 to 6 years*, and 1 agency *in 7 or more years*. Seven (7) local arterial management agencies reported *don't know.*

Traffic Management

This section of the report presents findings on different traffic management technologies and strategies, including:

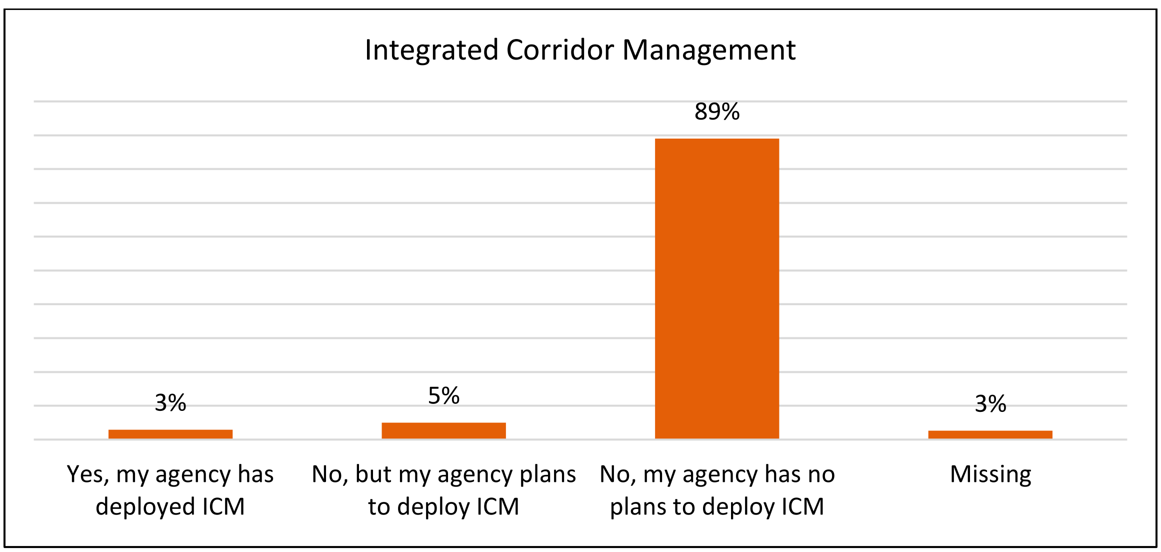
- ICM
- TSMO Plan[39]
- Parking management

Integrated Corridor Management

ICM is an approach to managing 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 includes freeway, arterial, and public transit facilities with cross-facility connections.

Figure 61 shows that 3 percent of local arterial management agencies *deploy ICM* while 5 percent *plan to deploy ICM*. A large majority of local arterial management agencies have *no plans to deploy ICM* (89 percent).

Local arterial management agencies in smaller urban and rural areas were significantly more likely than those in large metropolitan areas to report *no plans to deploy ICM* (92 percent compared to 78 percent).



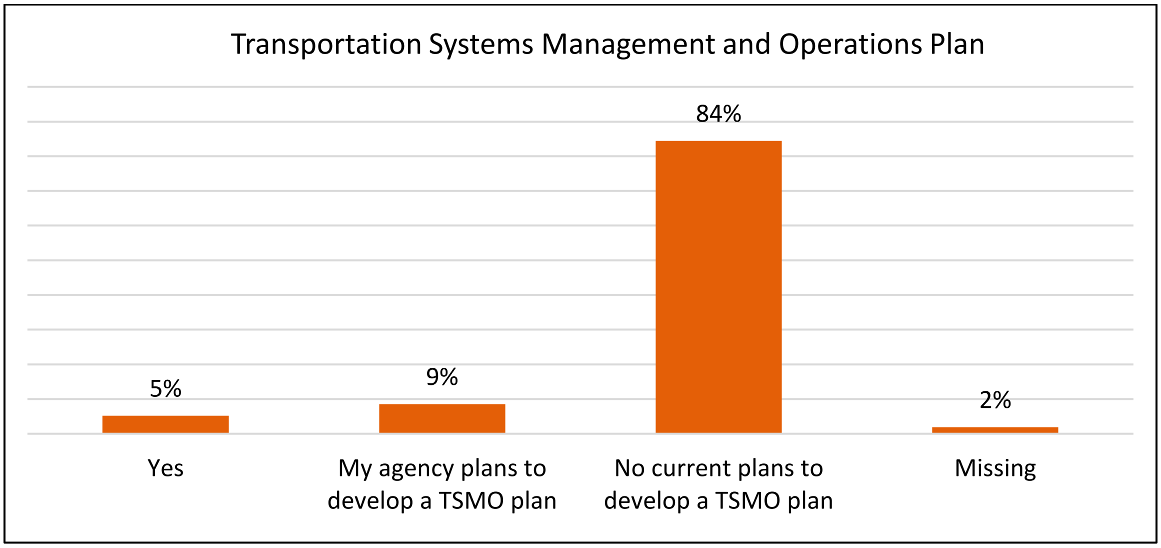
2023 Q57; (n=423) *Source: USDOT*

Figure 61. Integrated Corridor Management

[39] 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.

Transportation Systems Management and Operations Plan

Figure 62 shows that 5 percent of local arterial management agencies *have a TSMO plan*, while 9 percent *plan to develop a TSMO plan*. A large majority have *no current plans to develop a TSMO plan* (84 percent).



2023 Q47; (n=423) *Source: USDOT*

Figure 62. Transportation Systems Management and Operations Plan

Table 31 shows that local arterial management agencies in large metropolitan areas were significantly more likely than those in smaller urban and rural areas to report *plans to develop a TSMO plan* (23 percent compared to 6 percent), whereas local agencies in smaller urban and rural areas are significantly more likely to report *no current plans to develop a TSMO plan* (88 percent compared to 67 percent).

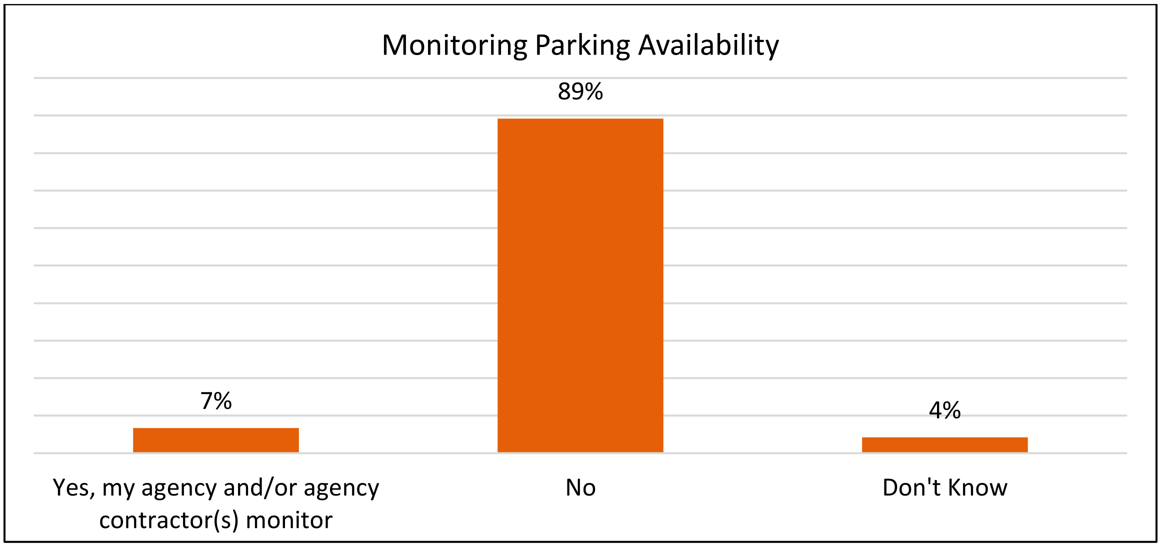
Table 31. Transportation Systems Management and Operations Plan: Significant Differences Between Statistical Areas

Technology	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
My agency plans to develop a TSMO Plan	23%	6%
No current plans to develop a TSMO Plan	67%	88%

Source: USDOT

Parking Management

As shown in Figure 63, local arterial management agencies were asked if they or their contractor(s) monitor the availability of parking (including on-street spaces or off-street lots or garages). Seven (7) percent responded *yes, my agency and/or agency contractor(s) monitor*, while a large majority responded *no* (89 percent). Four (4) percent reported *don't know.*



2023 Q26; (n=423; 0% missing) *Source: USDOT*

Figure 63. Monitoring Parking Availability

Local arterial management agencies in large metropolitan areas were significantly more likely than those in smaller urban and rural areas to *monitor parking availability* (17 percent compared to 5 percent). Notably, no (zero) rural agencies *monitor parking availability*.

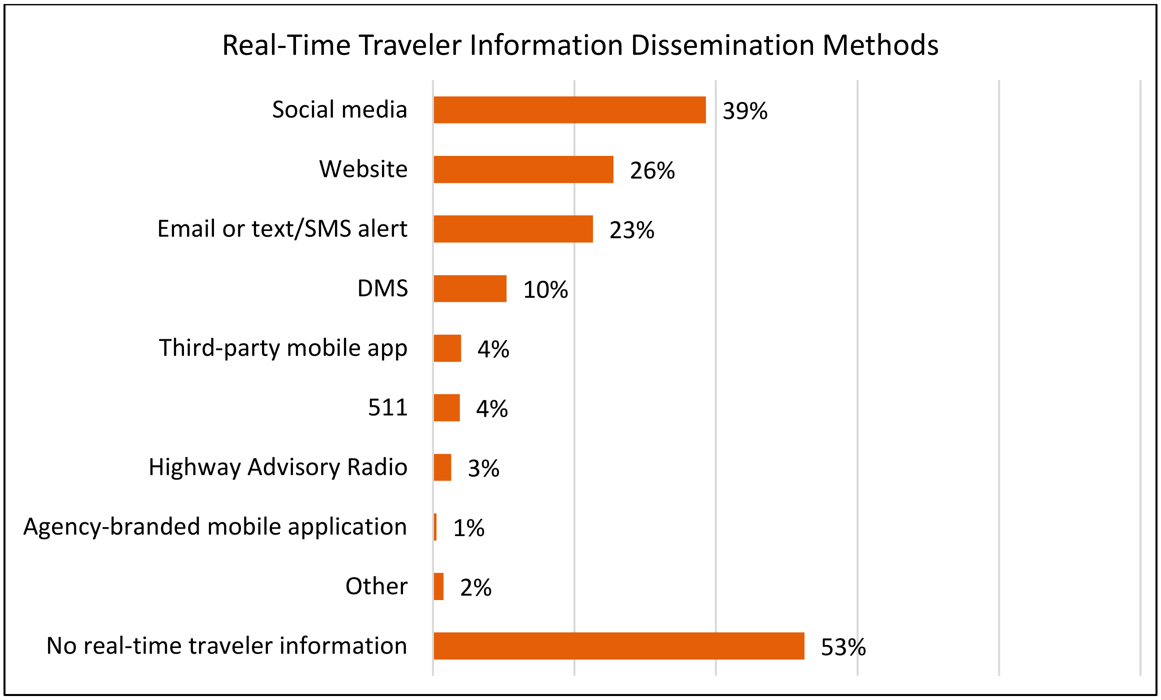
County agencies, compared to place agencies, were significantly more likely to *not monitor parking availability* (96 percent compared to 87 percent).

Traveler Information

Nearly half of local arterial management agencies disseminate real-time traveler information about arterials (47 percent), and these agencies use an average of 2.3 different methods.

As shown in Figure 64, *social media* is used by 39 percent of local arterial management agencies. About one fourth use a *website* (26 percent) and *email or text/SMS alerts* (23 percent) to disseminate real-time traveler information. Ten (10) percent use *DMS (permanent and/or portable)*.

Third-party mobile app, 511, Highway Advisory Radio, and *agency-branded mobile application* were each reported by less than 5 percent of local agencies. Over half of local agencies reported *no real-time traveler information is disseminated* (53 percent).



2023 Q24; (n=423; 0% missing) *Source: USDOT*

Figure 64. Real-Time Traveler Information Dissemination Methods

Significantly more place agencies than county agencies reported using *social media* (41 percent compared to 30 percent) as a real-time traveler information dissemination method.

As shown in Table 32, there are significant differences across the four statistical areas in the dissemination of real-time traveler information, including:

- Both large metropolitan (41 percent) and small metropolitan (42 percent) agencies are significantly more likely to use *social media* than rural agencies (23 percent).
- Large metropolitan (28 percent), small metropolitan (25 percent), and micropolitan (21 percent) agencies are all significantly more likely to use *email or text/SMS alert* than rural agencies (8 percent).
- Large metropolitan (25 percent), small metropolitan (29 percent), and micropolitan (27 percent) agencies are all significantly more likely to use *website* than rural agencies (11 percent).
- Large metropolitan (21 percent) agencies are more likely than micropolitan (5 percent) and rural (1 percent) agencies to use *DMS (permanent and/or portable)*. Small metropolitan agencies (1 percent) are also significantly more likely than rural agencies to use *DMS (permanent and/or portable)*.
- Small metropolitan (52 percent), micropolitan (58 percent), and rural (69 percent) local agencies are each significantly more likely than large metropolitan agencies (38 percent) to report *no real-time traveler information is disseminated.* Rural agencies were also significantly more likely than small metropolitan agencies to report *no real-time traveler information is disseminated*.

Table 32. Real-Time Traveler Information Dissemination Methods: Significant Differences Between Statistical Areas

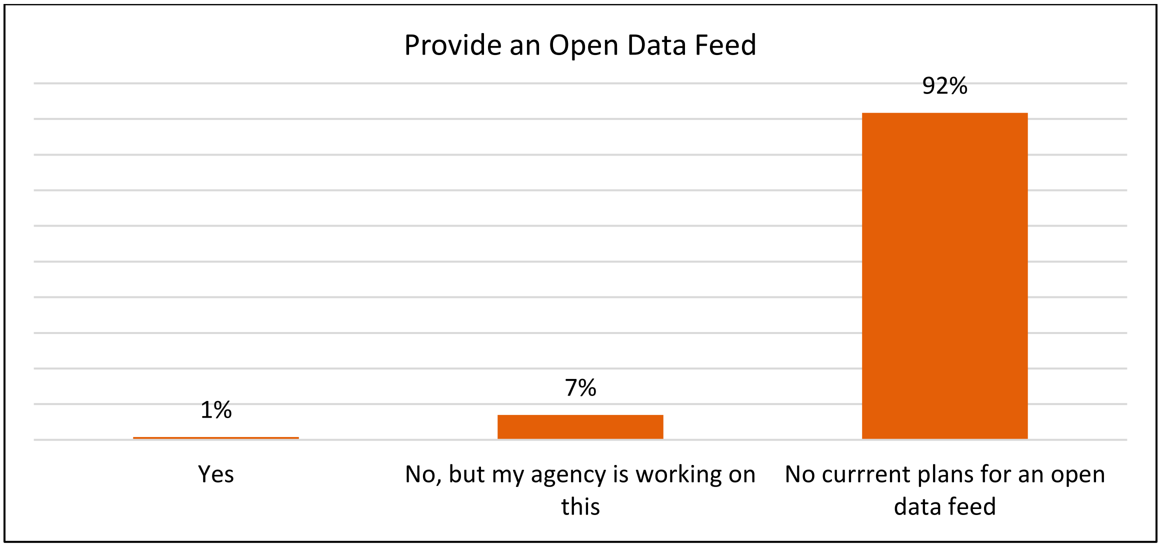
Technology	Large Metropolitan (WN=74; UWN=108)	Small Metropolitan (WN=233; UWN=149)	Micropolitan (WN=65; UWN=86)	Rural (WN=52; UWN=80)
Social media	41% (†)	42% (†)	35%	23%
Email or text/SMS alert	28% (†)	25% (†)	21% (†)	8%
Website	25% (†)	29% (†)	27% (†)	11%
DMS (permanent and/or portable)	21% (^†)	11% (†)	5%	1%
No real-time traveler information about arterials is disseminated	38% (*^†)	52% (†)	58%	69%

** statistically significant difference compared to small metropolitan areas;*
^ statistically significant difference compared to micropolitan areas;
† statistically significant difference compared to rural areas

Source: USDOT

Open Data Feed

Figure 65 shows that only 1 percent of responding local arterial management agencies *provide an open data feed* that shares real-time transportation-related data using data standards/specifications. Seven (7) percent are *working on providing an open data feed*. Almost all local arterial management agencies reported *no current plans for an open data feed* (92 percent).



2023 Q25; (n=423; 0% missing) *Source: USDOT*

Figure 65. Provide an Open Data Feed

Table 33 shows that local arterial management agencies in large metropolitan areas are significantly more likely than agencies in smaller urban and rural areas to report *working on providing an open data feed* (23 percent compared to 4 percent).

Local agencies in smaller urban and rural areas, compared to those in large metropolitan areas, were significantly more likely to report *no current plans for an open data feed* (95 percent compared to 75 percent).

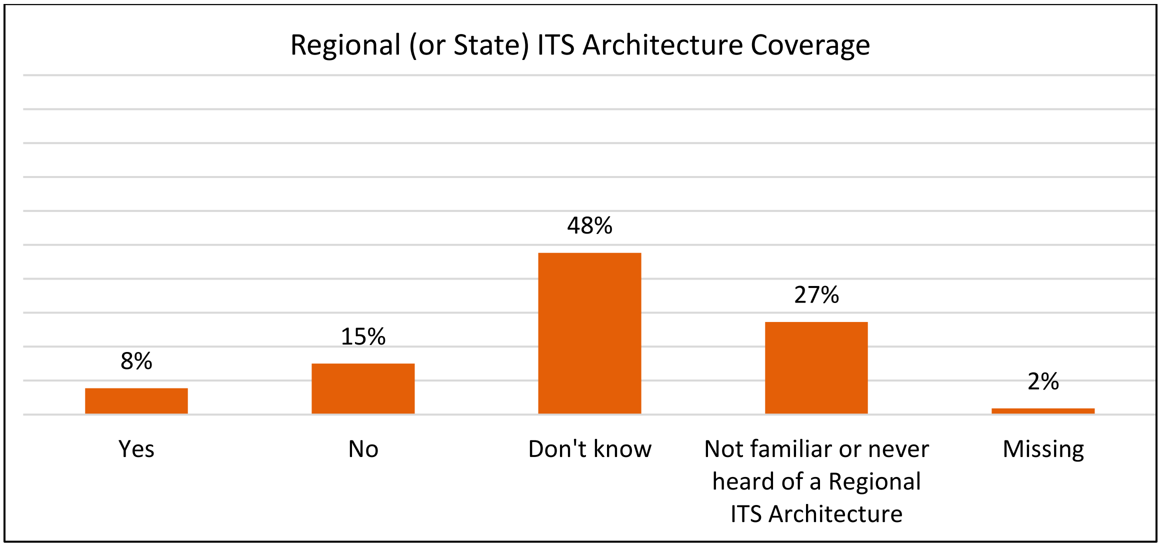
Table 33. Provide an Open Data Feed: Significant Differences Between Statistical Areas

Open Data Feed	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
No, but my agency is working on this	23%	4%
No current plans for an open data feed	75%	95%

Source: USDOT

Regional (or State) ITS Architecture

Surveyed local arterial management agencies were asked if their agency/region is covered by a Regional (or State) ITS Architecture.[40] Figure 66 shows that 8 percent of local arterial management agencies reported being *covered by a Regional (or State) ITS Architecture*, while 15 percent reported their agency/region is *not covered*. Nearly half of respondents reported *don't know* (48 percent), and over one fourth reported that they were *not familiar with or never heard of a Regional ITS Architecture* (27 percent).



2023 Q54; (n=423) *Source: USDOT*

Figure 66. Regional (or State) ITS Architecture Coverage

As shown in Table 34, local arterial management agencies in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to report being *covered by a Regional (or State) ITS Architecture* (32 percent compared to 3 percent). Local agencies in smaller urban and rural areas are significantly more likely than those in large metropolitan areas to report *don't know* (51 percent compared to 34 percent).

Table 34. Regional (or State) ITS Architecture Coverage: Significant Differences Between Statistical Areas

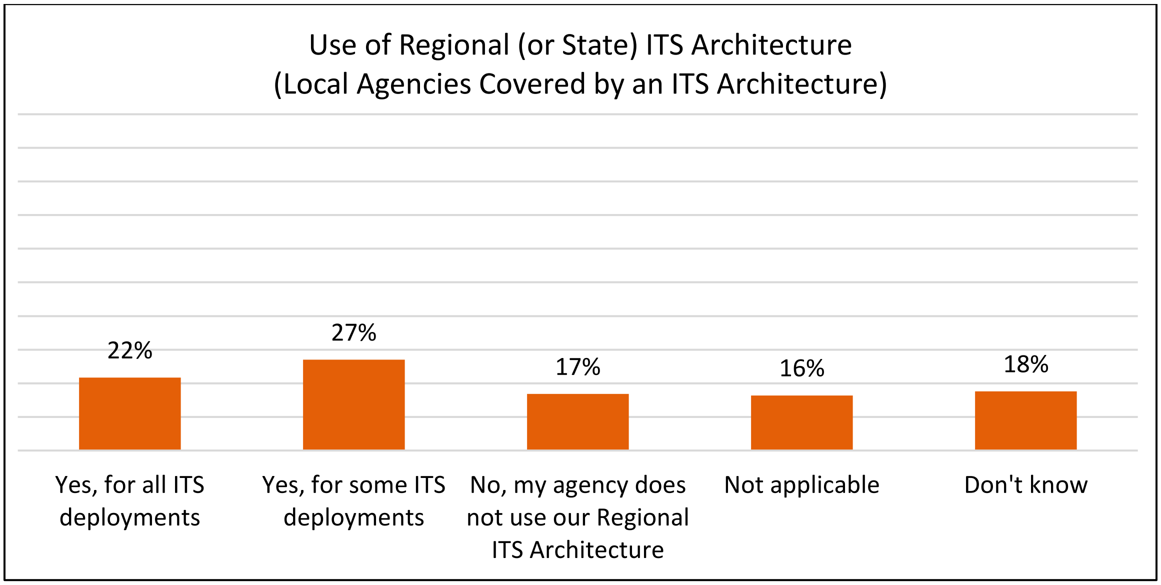
Response	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
Covered by a Regional (or State) ITS Architecture	32%	3%
Don't know	34%	51%

Source: USDOT

[40] A Regional (or State) ITS Architecture is defined as "A specific, tailored framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects in a particular region. It functionally defines what pieces of the system are linked to others and what information is exchanged between them." For more information, see https://ops.fhwa.dot.gov/plan4ops/regional_its.htm

Figure 67 shows to what extent the 58 local arterial management agencies that reported being covered by a Regional (or State) ITS Architecture use it to support ITS deployments on arterials.

About one fourth use their Regional (or State) ITS Architecture for *all ITS deployments* (22 percent), and a similar percentage use it for *some ITS deployments* (27 percent). Seventeen (17) percent of covered agencies reported *my agency does not use our Regional ITS Architecture*, and 16 percent reported *not applicable (i.e., my agency does not use federal funds for ITS deployment OR my agency has not deployed ITS)*.

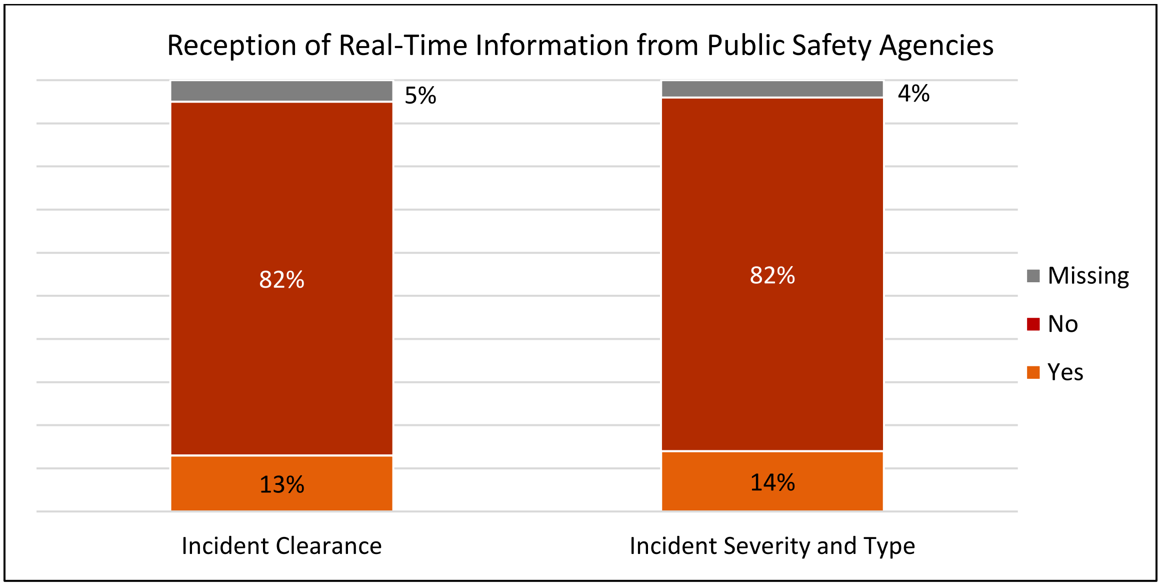


2023 Q55; (WN=33, UWN=58; 0% missing) *Source: USDOT*

Figure 67. Use of Regional (or State) ITS Architecture (Local Agencies Covered by an ITS Architecture)

Agency Coordination

Figure 68 shows that 13 percent of local arterial management agencies receive real-time *incident clearance* information, and 14 percent receive *incident severity and type* information from public safety agencies. Eighty-two (82) percent of local arterial management agencies reported both *not receiving incident clearance* information and *not receiving incident severity and type* information.

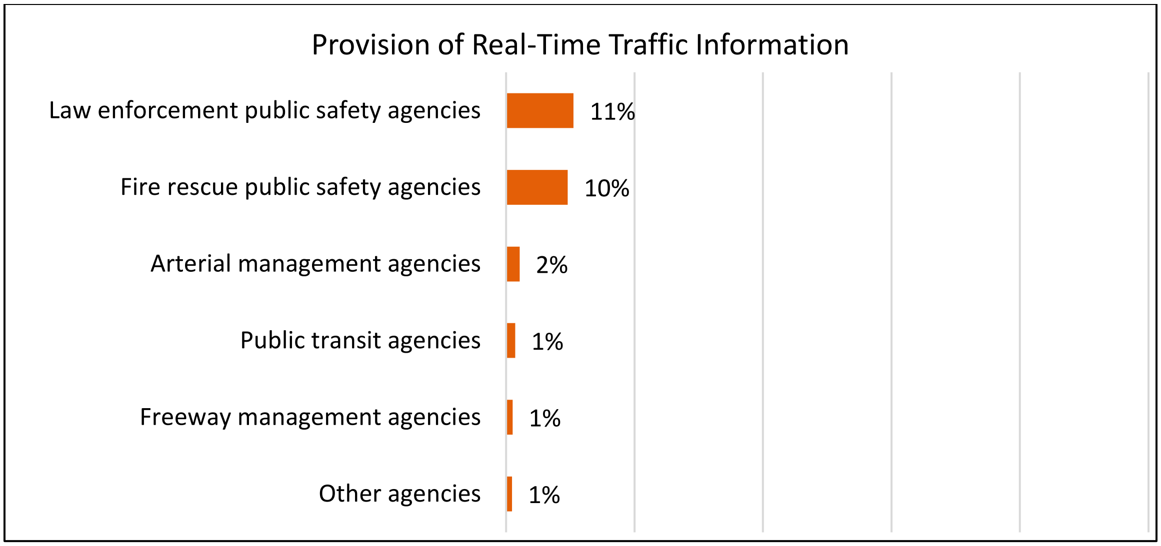


2023 Q58; (n=423) *Source: USDOT*

Figure 68. Reception of Real-Time Information from Public Safety Agencies

Along with receiving real-time information, local arterial management agencies may also provide real-time information (e.g., travel time, speed, and condition) to several different types of agencies.

Figure 69 shows that 11 percent of local arterial management agencies provide real-time traffic information to *law enforcement public safety agencies*, and 10 percent to *fire rescue public safety agencies*. Other types of agencies were less commonly reported with 2 percent of local arterial management agencies providing real-time traffic information to *arterial management agencies*, and *public transit agencies*, *freeway management agencies*, and *other agencies* were each reported by 1 percent of local arterial management agencies.

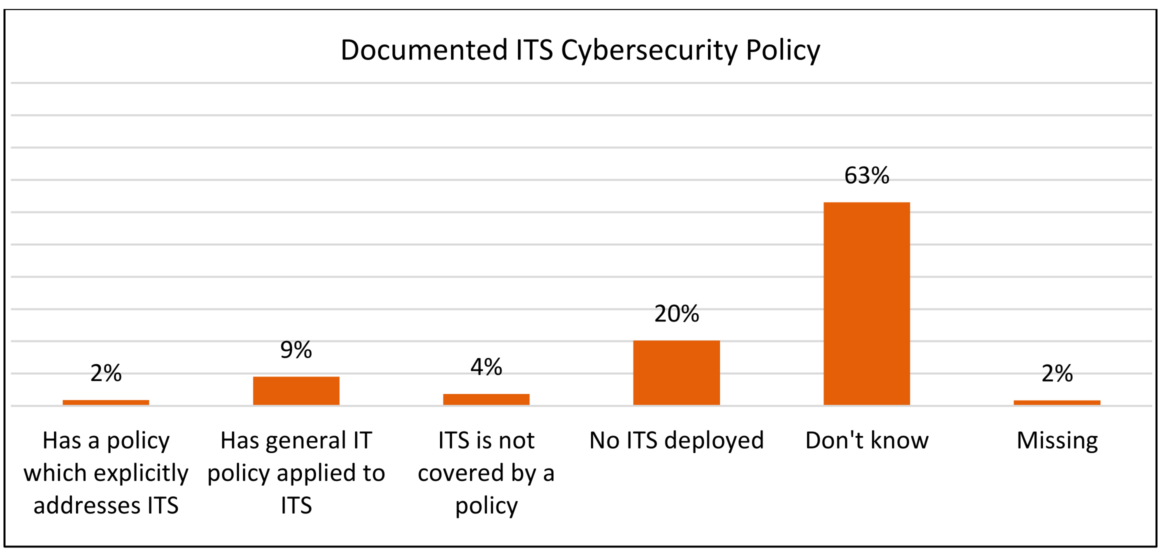


2023 Q59; (n=423) *Source: USDOT*

Figure 69. Provision of Real-Time Traffic Information

ITS Cybersecurity

Figure 70 shows that 2 percent of responding local arterial management agencies *have a cybersecurity policy which explicitly addresses ITS*, while 9 percent *have a general information technology (IT) cybersecurity policy which applies to ITS*. Four (4) percent reported that *ITS is not covered by a cybersecurity policy.* One fifth of local arterial management agencies reported they *have not deployed ITS technologies/equipment* (20 percent). About two thirds reported *don't know* (63 percent).



2023 Q48; (n=423) *Source: USDOT*

Figure 70. Documented ITS Cybersecurity Policy

As shown in Table 35, local arterial management agencies in large metropolitan areas, compared to those in smaller urban and rural areas, are significantly more likely to *have a general information technology (IT) cybersecurity policy which applies to ITS* (28 percent compared to 5 percent). Local agencies in smaller urban and rural areas were significantly more likely than those in large metropolitan areas to report they *have not deployed ITS technologies/equipment* (24 percent compared to 5 percent).

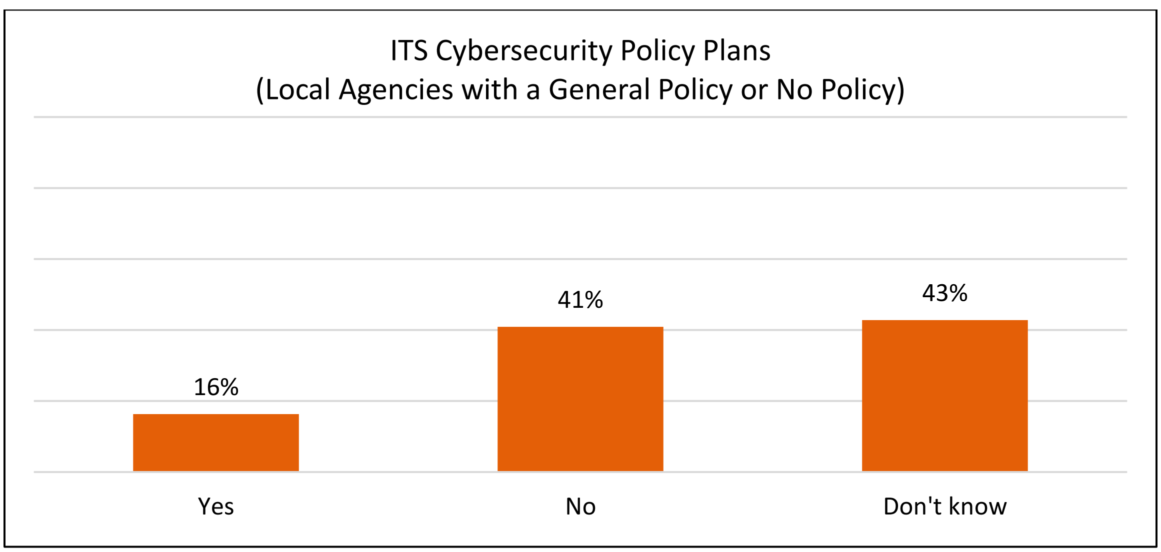
Table 35. Documented ITS Cybersecurity Policy: Significant Differences Between Statistical Areas

Response	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
Has general IT policy applied to ITS	28%	5%
No ITS deployed	5%	24%

Source: USDOT

Within the smaller urban and rural agency grouping, both small metropolitan agencies (19 percent) and micropolitan agencies (26 percent) were significantly less likely than rural agencies (41 percent) to report they *have not deployed ITS technologies/equipment.* Small metropolitan agencies were significantly more likely than rural agencies to report *don't know* (67 percent compared to 54 percent).

For the 79 local arterial management agencies which either have a general IT cybersecurity policy which applies to ITS or for which ITS is not covered by a cybersecurity policy, Figure 71 shows that 16 percent *have plans to develop a cybersecurity policy that explicitly addresses ITS*, and 41 percent reported *no plans to develop such a policy*. Forty-three (43) percent reported *don't know*.

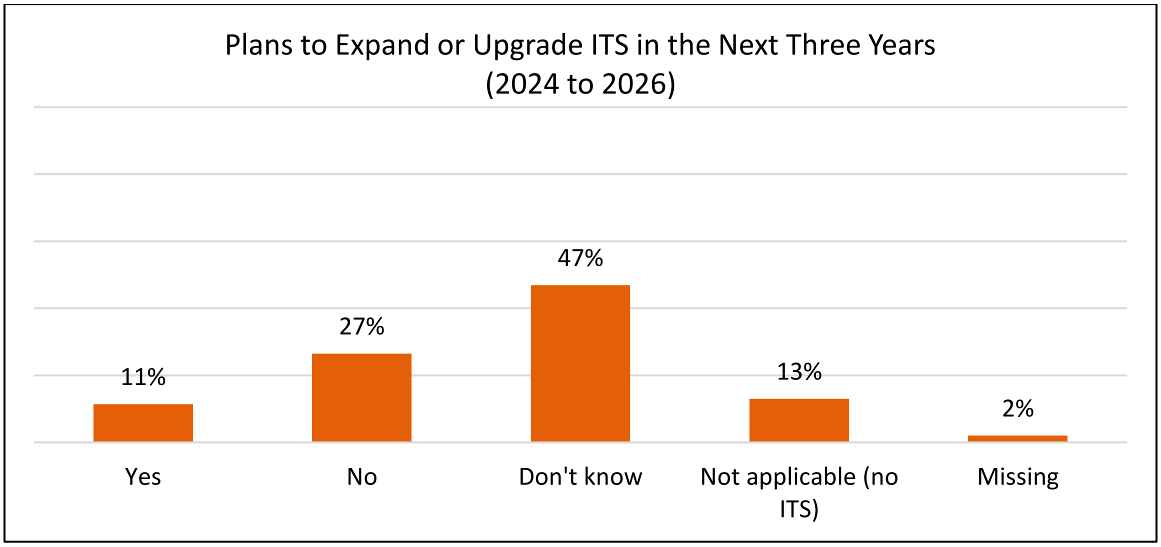


2023 Q49; (WN=54, UN=79; 0% missing) *Source: USDOT*

Figure 71. ITS Cybersecurity Policy Plans (Local Agencies with a General Policy or No Policy)

Future Deployment Planning

All surveyed local arterial management agencies were asked about their ITS deployment plans in the next three years (2024 through 2026). Figure 72 shows that 11 percent of local arterial management agencies *plan to expand or upgrade their ITS*, while over one fourth reported *no plans to expand or upgrade their ITS* (27 percent). Nearly half reported *don't know* (47 percent), and 13 percent reported *not applicable (no ITS)*.



2023 Q60; (n=423) *Source: USDOT*

Figure 72. Plans to Expand or Upgrade ITS in the Next Three Years (2024 to 2026)

Table 36 shows that local agencies in large metropolitan areas are significantly more likely than agencies in smaller urban and rural areas to *plan to expand or upgrade their ITS* (42 percent compared to 5 percent). Smaller urban and rural agencies were significantly more likely than large metropolitan agencies to report *no plans to expand or upgrade ITS* (30 percent compared to 9 percent) or *not applicable (no ITS)* (15 percent compared to 3 percent).

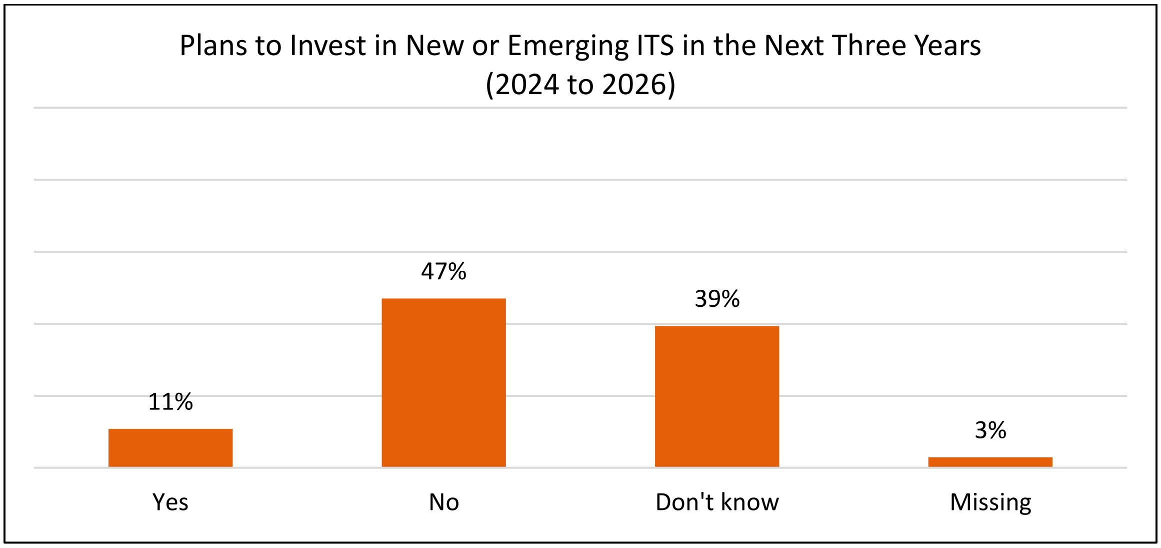
Table 36. Plans to Expand or Upgrade ITS in the Next Three Years (2024 to 2026): Significant Differences Between Statistical Areas

Response	Large Metropolitan (WN=74; UWN=108)	Smaller Urban and Rural (WN=349; UWN=315)
Plan to expand or upgrade ITS	42%	5%
No plans to expand or upgrade ITS	9%	30%
Not applicable (no ITS)	3%	15%

Source: USDOT

Within the smaller urban and rural agency grouping, there is a significant difference between statistical areas. Notably, no (zero) local agencies in rural areas reported *plans to expand or upgrade their ITS*, compared to 7 percent of small metropolitan agencies.

Figure 73 shows that 11 percent of local arterial management agencies reported *plans to invest in new or emerging ITS.* Nearly half reported *no plans to invest in new or emerging ITS* (47 percent), while 39 percent report *don't know*.



2023 Q61; (n=423) *Source: USDOT*

Figure 73. Plans to Invest in New or Emerging ITS in the Next Three Years (2024 to 2026)

Local agencies in large metropolitan areas are significantly more likely than those in smaller urban and rural areas to report *plans to invest in new or emerging ITS* (36 percent compared to 6 percent).

Chapter 5. Arterial Trend Analysis: Local Agencies

This chapter provides trend analysis (where applicable and available) for the 2023 Arterial Local Survey and previous Arterial Management Surveys (1999-2020). The trend analysis provides valuable information to the ITS JPO and its stakeholders on how ITS technologies are evolving, including which technologies have low levels of deployment, which are gaining traction, and which may have reached maturity and are mainstream.

Trend analyses compare the responses of 2023 local arterial management agencies in large metropolitan areas to previous 2020 and 2016 Arterial Management Surveys (where comparable data are available). Findings for this same subgroup of large metropolitan local agencies are shown in the previous chapter when there are significant differences between large metropolitan agencies and those in smaller urban and rural areas. To remain comparable to historical data, however, the results in this chapter are presented using unweighted data. Therefore, percentages will differ from the subgroup analysis in the previous chapter.

Local arterial management agencies in this subgroup (i.e., large metropolitan areas) include those that have been previously surveyed as part of the historical Deployment Tracking Survey (i.e., local agencies in the sample from 1999-2020) and additional sampled local agencies located in large metropolitan areas. The entire large metropolitan local agency subgroup (n=108), which includes historically surveyed local agencies (n=58) and the additionally sampled large metropolitan local agencies, were included in the trend analysis to ensure there was sufficient sample size for statistical testing.

The sample size for the 2023 large metropolitan local agencies is relatively smaller than the sample sizes for the 2020 and 2016 ITS Deployment Tracking Survey because previous surveys focused only on large metropolitan areas. The 2023 large metropolitan local agency subgroup is a subset of the full 2023 sample.[41]

Since the 2023 ITS Deployment Tracking Survey is the first year in which the survey population was expanded to include agencies in smaller urban and rural areas, trend data are not available for the “total” response this year. The trend for the total (i.e. expanded) arterial local population will be reported with the next ITS Deployment Tracking Survey.

[41] While the overall sample of agencies invited to participate in the historical Deployment Tracking Survey (1999-2020) remained stable across surveys, the agencies responding varied with each survey effort. Some agencies consistently responded to the survey, whereas others did not. The trend for a given year represents the data of responding agencies for that year.

Reporting Notes

This chapter is organized by ITS technologies and topics for which trend is available. The 2023 Deployment Tracking Survey question number is referenced at the bottom of each figure. The number of respondents is referenced in each figure with the respective survey year.

Trend may be shown for an indicator (i.e., the percentage of agencies each survey year that deployed at least one technology of a given type of ITS, such as at least one ITS safety systems technology), or trend may be shown for a list of response options for a given type of ITS.

When reporting trends, significance testing was performed at a significance level of 0.05, with a 95 percent confidence interval.

ITS Technologies at Signalized Intersections: Trend Analysis

The trends available for ITS technologies at signalized intersections include:

- ITS detection technologies at intersections
- CCTV at intersections
- ASCT
- Preemption and priority technologies at intersections

In 2023, a large majority of surveyed large metropolitan arterial local agencies reported operating signalized intersections (88 percent).[42]

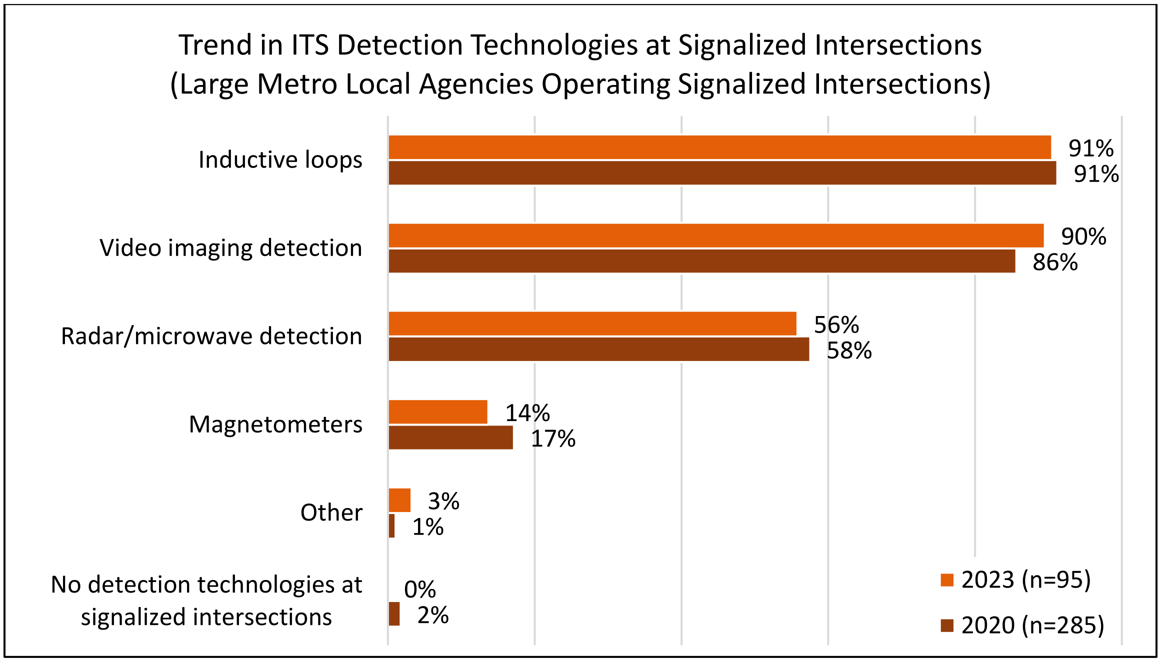
The following findings are based only on the large metropolitan local arterial management agencies that reported operating signalized intersections.

[42] Local agencies in large metropolitan areas may not operate signalized intersections. For example, they may not operate a signalized intersection where the arterials they manage intersect with arterials managed by a State DOT.

ITS Detection at Intersections Among Large Metropolitan Local Agencies Operating Signalized Intersections

Of those large metropolitan local agencies operating signalized intersections, nearly all reported deploying at least one ITS detection technology at signalized intersections (98 percent).

Figure 74 shows that the deployment rates for each surveyed ITS detection technologies remained stable between 2020 and 2023 with no significant changes.[43]



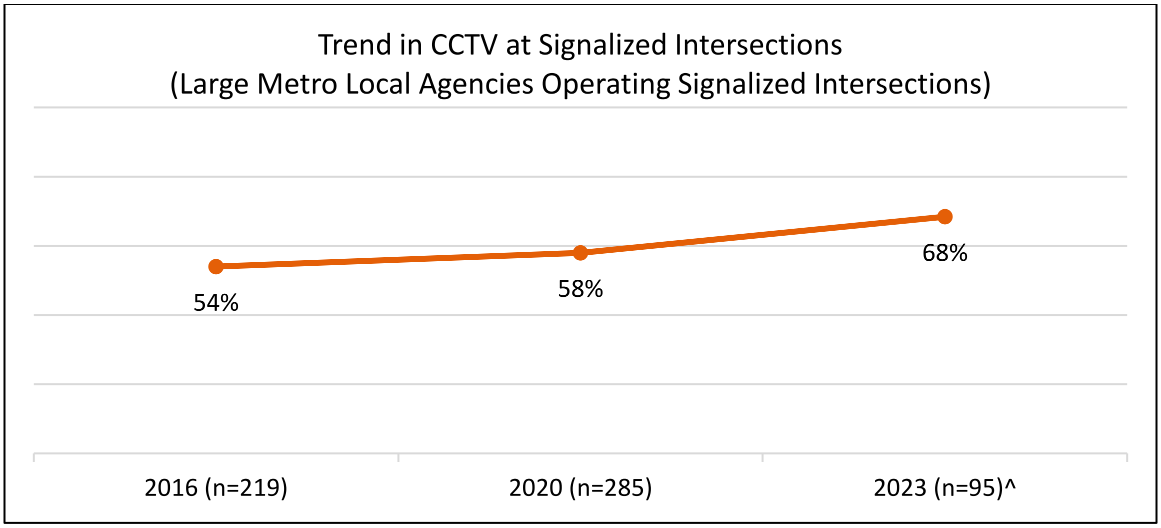
2023 Q3 Source: USDOT

Figure 74. Trend in ITS Detection Technologies at Signalized Intersections (Large Metro Local Agencies Operating Signalized Intersections)

CCTV at Intersections Among Large Metropolitan Local Agencies Operating Signalized Intersections

In 2023, about two thirds of surveyed large metropolitan local agencies that operate signalized intersections deploy *CCTV* (68 percent) for monitoring traffic flow at signalized intersections as shown in Figure 75. This is a significant increase from about half of agencies deploying in 2016 (54 percent), yet not a statistically significant difference from the 58 percent of agencies deploying in 2020.

[43] A new response option in 2023, *infrared/thermal detection,* was deployed by 22 percent of surveyed large metropolitan local agencies.

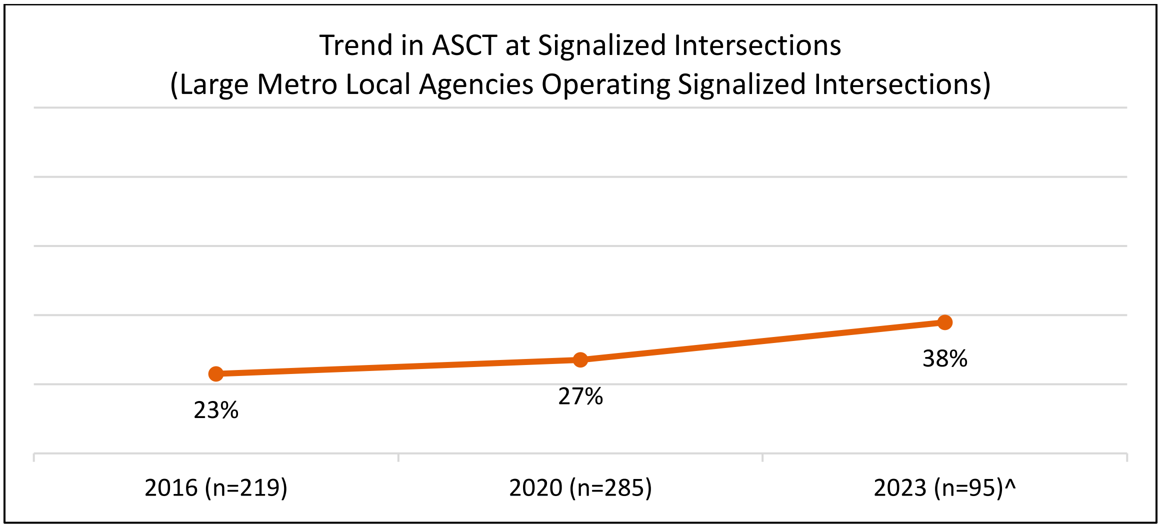


2023 Q4 *Source: USDOT*
^statistically significant difference between 2016 & 2023

Figure 75. Trend in CCTV at Signalized Intersections (Large Metro Local Agencies Operating Signalized Intersections)

Adaptive Signal Control Technology at Intersections Among Large Metropolitan Local Agencies Operating Signalized Intersections

Similar to the trend in CCTV, there is a significant increase in deployment of *ASCT* by large metropolitan local agencies that operate signalized intersections between 2016 and 2023 (23 percent to 38 percent) as shown in Figure 76. However, there is not a statistically significant increase between 2020 and 2023.

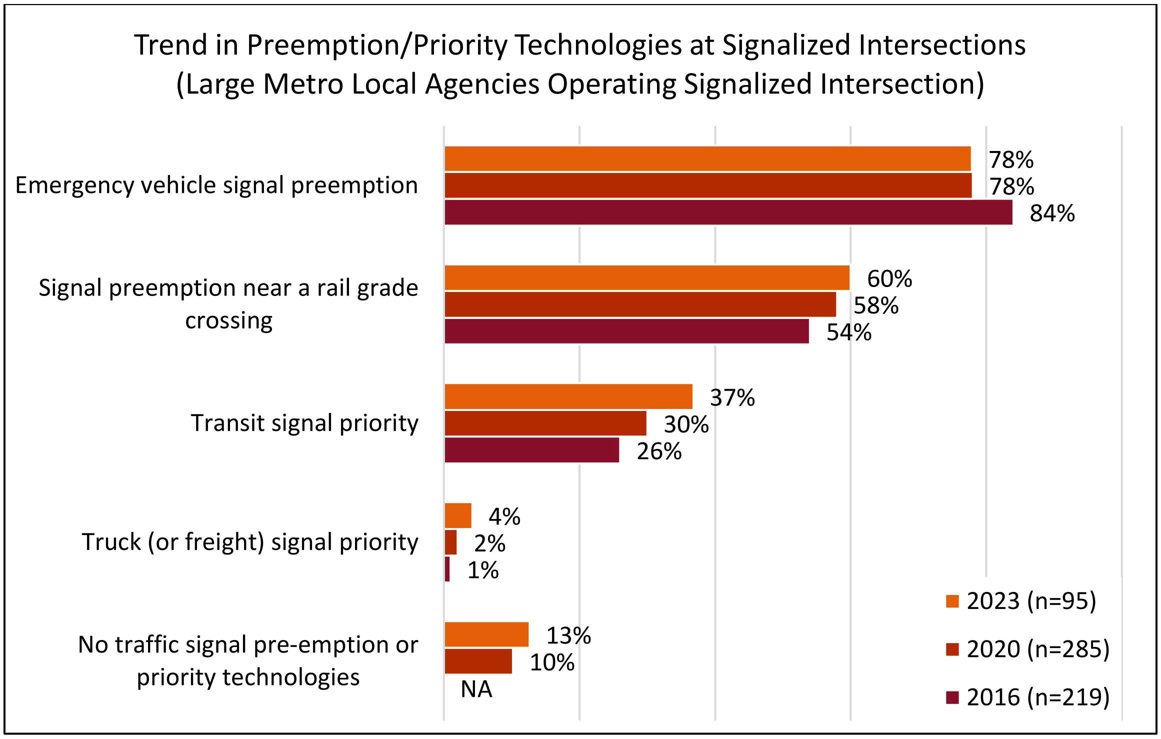


2023 Q5 *Source: USDOT*
^statistically significant difference between 2016 & 2023

Figure 76. Trend in ASCT at Signalized Intersections (Large Metro Local Agencies Operating Signalized Intersections)

Preemption and Priority at Intersections Among Large Metropolitan Agencies Operating Signalized Intersections

A large majority of surveyed large metropolitan local agencies that operate signalized intersections deploy at least one traffic signal preemption or priority technology (86 percent). Figure 77 shows there are no significant changes in deployment of individual surveyed preemption or priority technologies between 2016 and 2023 or between 2020 and 2023.[44]



2023 Q8 *Source: USDOT*

Figure 77. Trend in Preemption/Priority Technologies at Signalized Intersections (Large Metro Local Agencies Operating Signalized Intersections)

[44] *Maintenance and construction signal priority* was a new response category in 2023 and deployed by 3 percent of surveyed large metropolitan local agencies.

Safety-Related ITS Trend Analysis

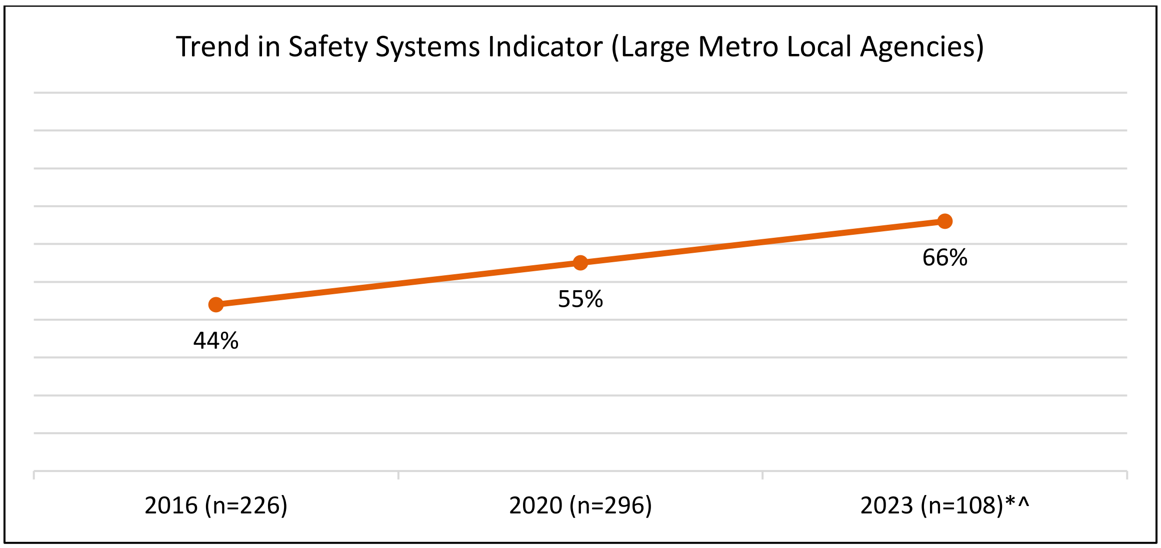
Safety-related ITS technologies for which trend are available include:

- ITS safety systems technologies
- Work zone ITS technologies
- Automated enforcement technologies
- Incident detection and verification methods

ITS Safety Systems Technologies

Figure 78 shows that two thirds of surveyed large metropolitan local arterial management agencies deploy at least one ITS safety systems technology (66 percent) in 2023.

The trend shows a significant increase in the deployment of ITS safety systems technologies since 2020 which may be due to the addition of *speed feedback signs,* a new response option to the 2023 Deployment Tracking Survey. *Speed feedback signs* are deployed by 55 percent of surveyed large metropolitan local agencies in 2023. The remaining individual surveyed safety system technologies with available trend maintained relatively consistent levels of deployment.[45]



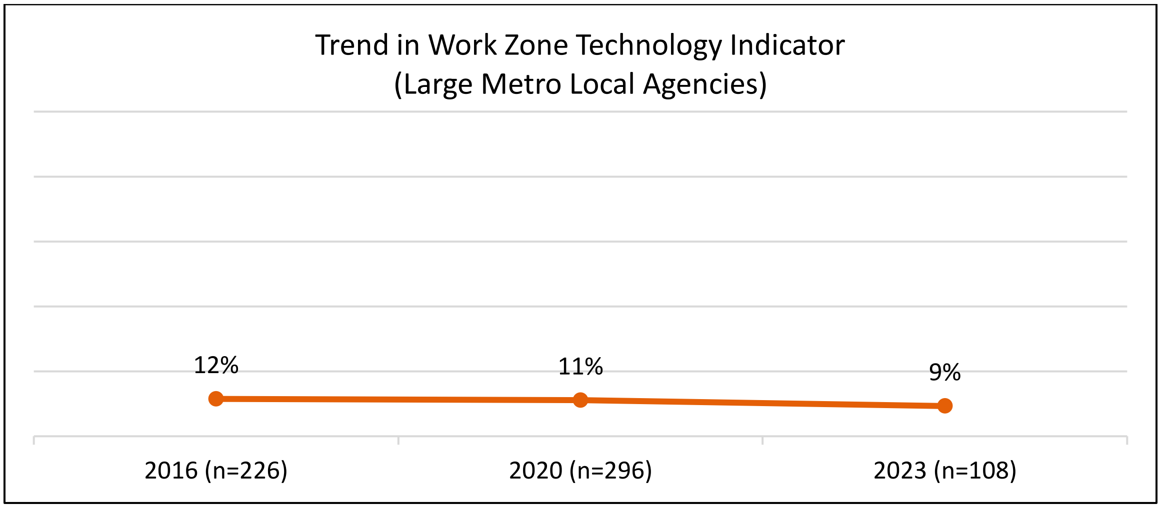
2023 Q17
**statistically significant difference between 2020 & 2023;*
^statistically significant difference between 2016 & 2023
Source: USDOT

Figure 78. Trend in Safety Systems Indicator (Large Metro Local Agencies)

[45] New response options in 2023 were *automated visibility warning systems* (deployed by 2 percent of surveyed large metropolitan local agencies), *downhill truck speed warning* (0 percent), *highway-rail crossing systems* (8 percent), *intersection collision warning systems* (1 percent), *speed feedback sign* (55 percent), *wildlife warning system* (1 percent).

Work Zone ITS Technologies

The percentage of surveyed large metropolitan local arterial management agencies deploying at least one work zone ITS technology has remained consistent at around 10 percent since 2016 as shown in Figure 79. The trend for all individually surveyed work zone ITS technologies with available trend remained relatively stable.

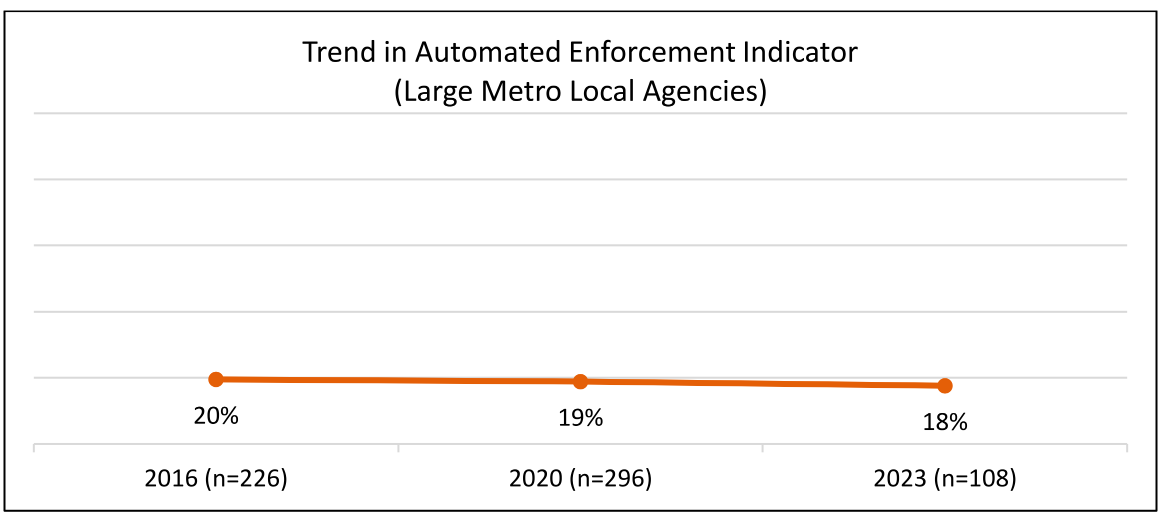


2023 Q22 *Source: USDOT*

Figure 79. Trend in Work Zone Technology Indicator (Large Metro Local Agencies)

Automated Enforcement

Figure 80 shows that the deployment of automated enforcement technologies on arterials by surveyed large metropolitan local arterial management agencies has remained stable, around 20 percent, from 2016 to 2023.

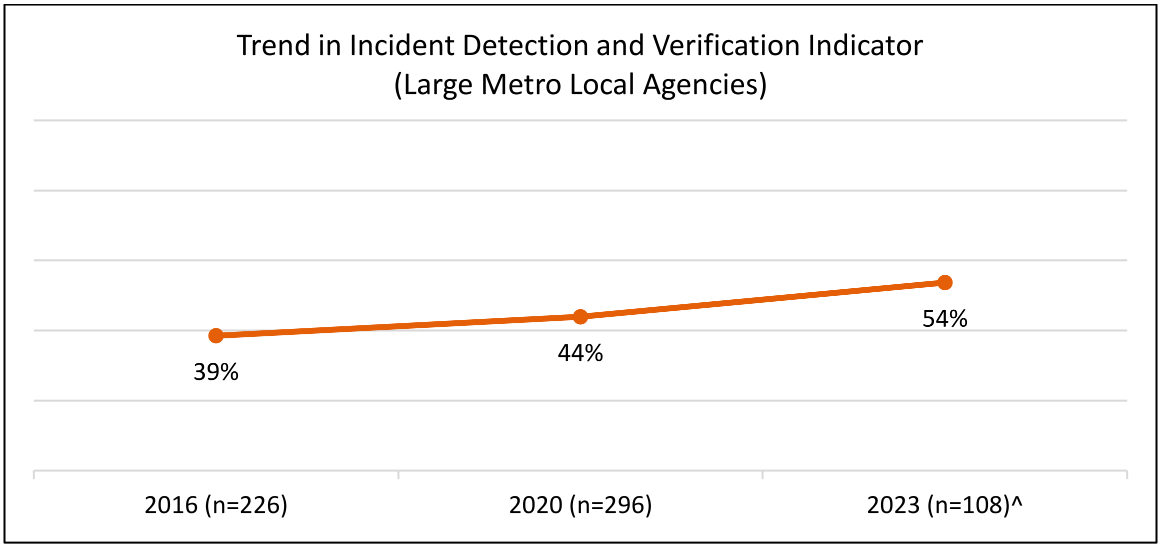


2023 Q14 *Source: USDOT*

Figure 80. Trend in Automated Enforcement Indicator (Large Metro Local Agencies)

Incident Detection and Verification

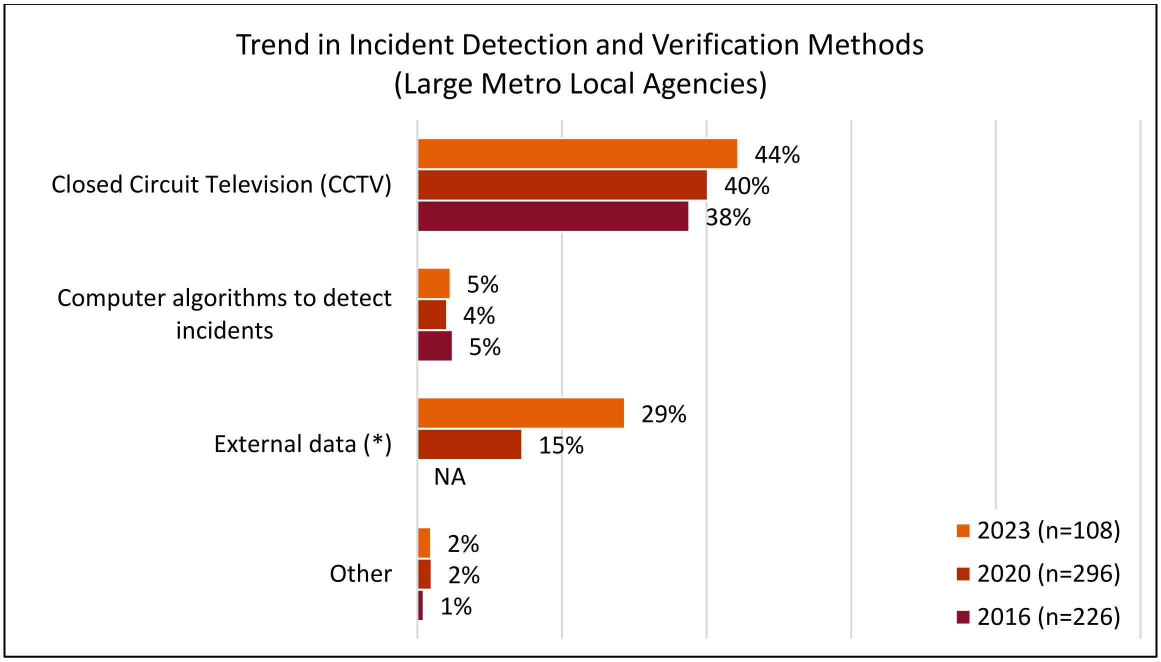
Figure 81 shows that among surveyed large metropolitan local arterial management agencies, there has been a significant increase in the percentage deploying one or more incident detection or verification methods since 2016. There is no statistically significant change from 2020.



2023 Q21 *Source: USDOT*
^statistically significant difference between 2016 & 2023

Figure 81. Trend in Incident Detection and Verification Indicator (Large Metro Local Agencies)

Figure 82 shows that the only incident detection or verification method for which use significantly changed among large metropolitan local arterial management agencies is *external data (e.g., data provided by crowdsourcing, commercial providers, or citizen-reported)*, which increased from 15 percent in 2020 to 29 percent in 2023.[46]



2023 Q23 *Source: USDOT*
**statistically significant difference between 2020 & 2023*

Figure 82. Trend in Incident Detection and Verification Methods (Large Metro Local Agencies)

[46] New response option in 2023 was *call boxes* deployed by 0 percent of surveyed large metropolitan local agencies.

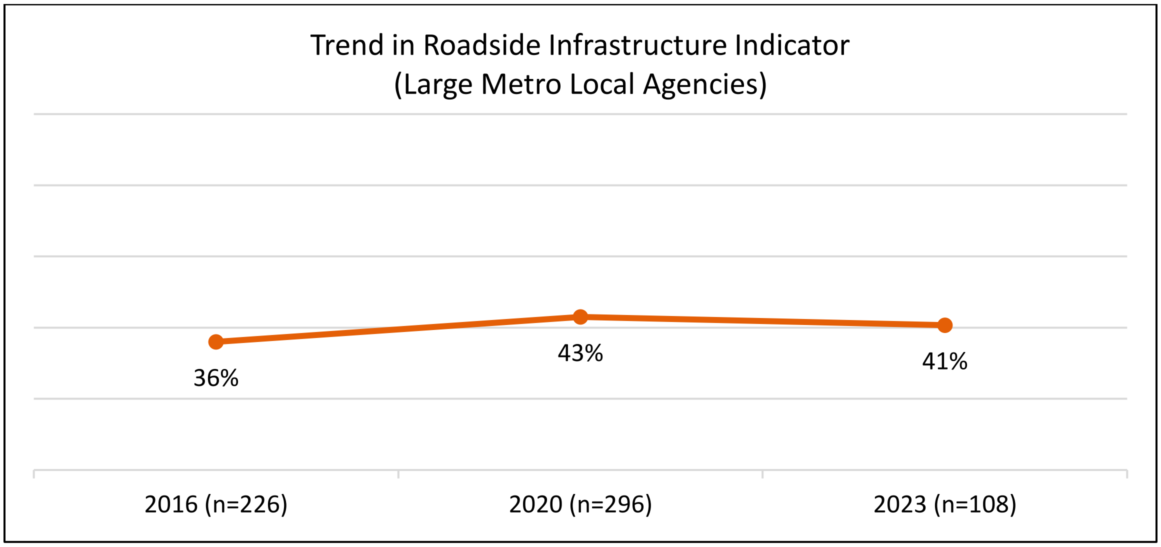
Real-Time Data Collection Trend Analysis

Real-time data collection for which trend are available include:

- Roadside ITS infrastructure technologies
- Vehicle probe readers
- External data sources

Roadside ITS Infrastructure Technologies

Of all surveyed large metropolitan local arterial management agencies, 41 percent deploy at least one roadside infrastructure technology to collect real-time traffic data on arterials in 2023. Trend has remained relatively consistent since 2016 as shown in Figure 83.[47]



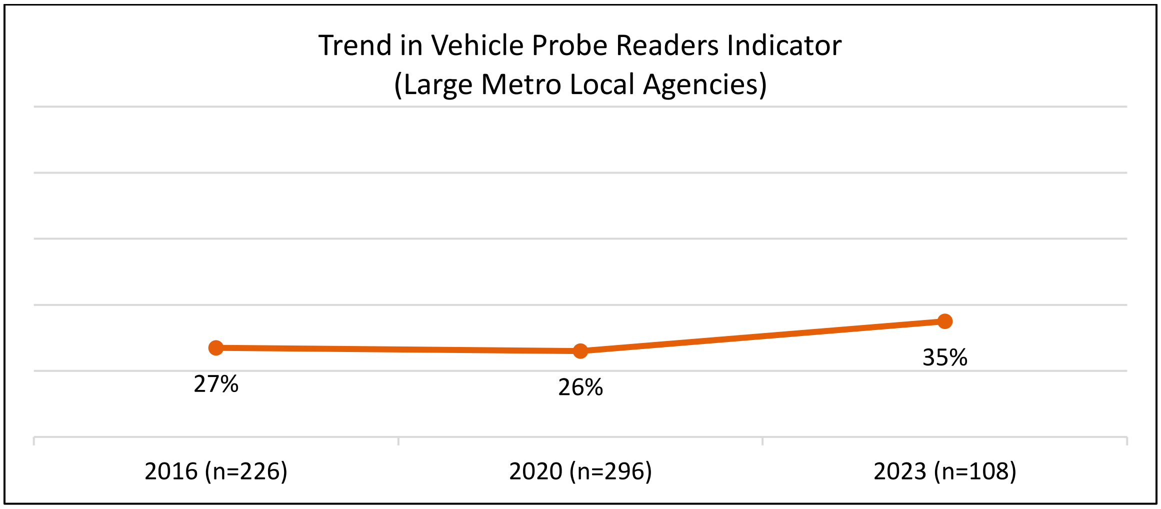
2023 Q9 *Source: USDOT*

Figure 83. Trend in Roadside Infrastructure Indicator (Large Metro Local Agencies)

[47] The previous Deployment Tracking Survey did not ask about specific roadside infrastructure technologies, so no trend can be presented.

Vehicle Probe Readers

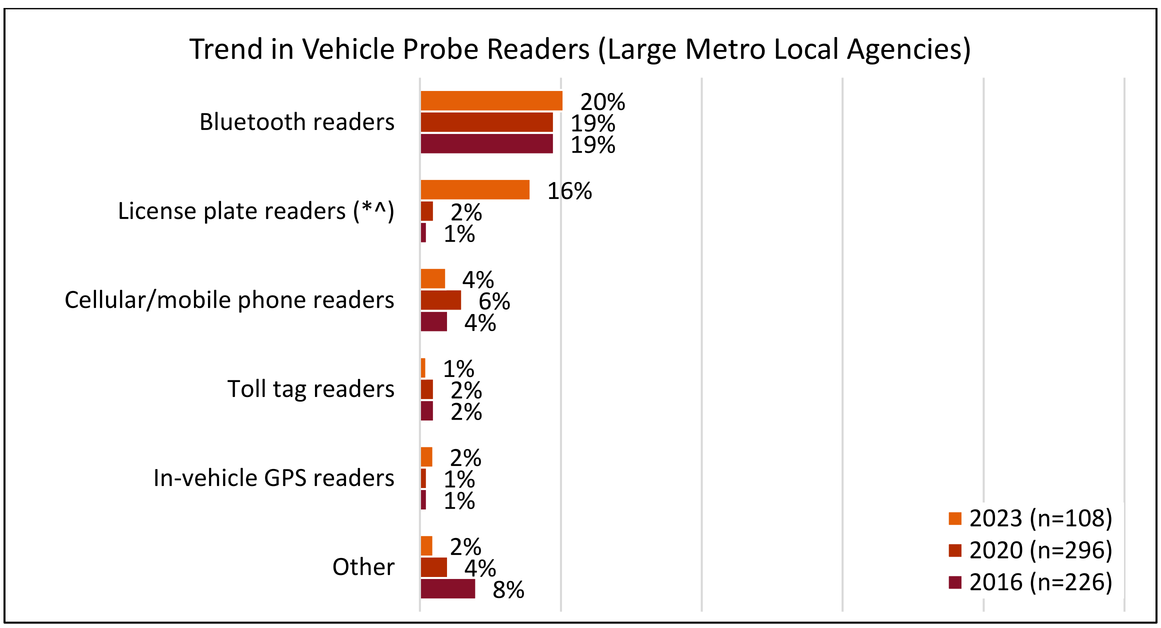
Figure 84 shows that about one third of surveyed large metropolitan local arterial management agencies deploy at least one vehicle probe reader (35 percent) to collect real-time traffic data on arterials in 2023. There is no statistically significant change in the trend across the three survey years.



2023 Q10 *Source: USDOT*

Figure 84. Trend in Vehicle Probe Readers Indicator (Large Metro Local Agencies)

Figure 85 shows the only vehicle probe reader technology type to have significant change in deployment is *license plate readers* which increased from 2 percent in 2020 to 16 percent in 2023.



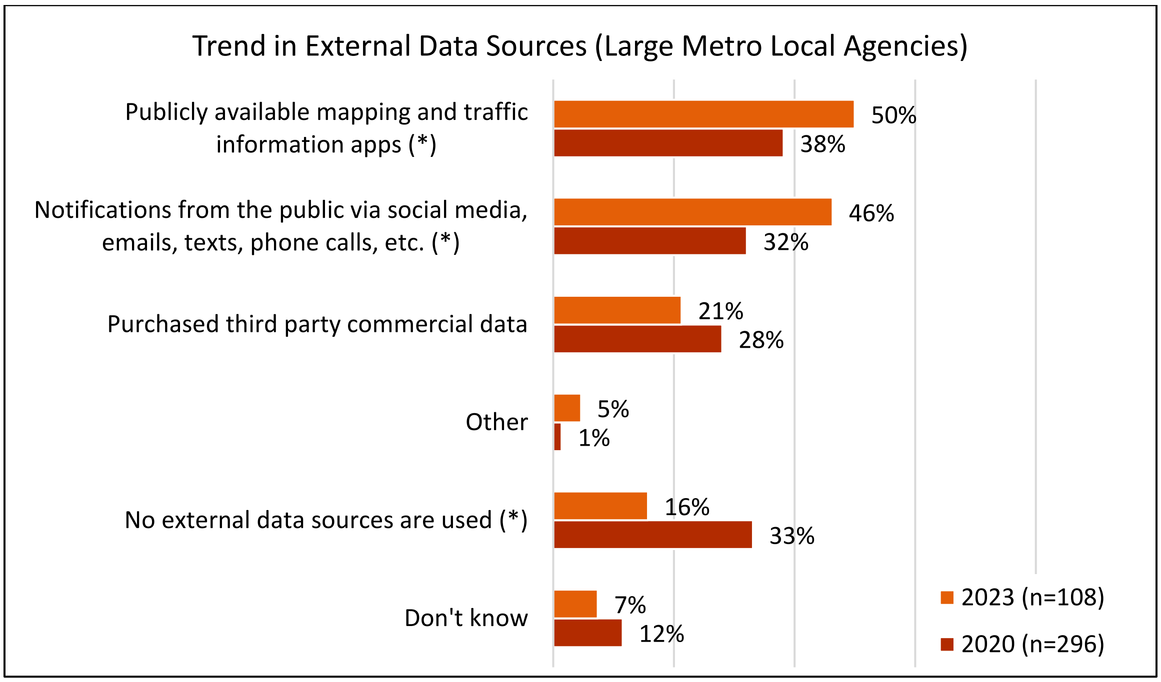
2023 Q10 *Source: USDOT*
**statistically significant difference between 2020 & 2023;*
^statistically significant difference between 2016 & 2023

Figure 85. Trend in Vehicle Probe Reader Technologies (Large Metro Local Agencies)

External Data Sources

The use of at least one external data source by large metropolitan local agencies for arterial management significantly increased from 2020 to 2023. About three fourths of surveyed large metropolitan local agencies use at least one external data source (76 percent) in 2023, which is a statistically significant increase from 55 percent of agencies in 2020.

Figure 86 shows the use of *publicly available mapping and traffic information apps* significantly increased from 38 percent of agencies in 2020 to 50 percent in 2023. Similarly, *notifications from the public via social media, emails, texts, phone calls, etc.* significantly increased from 32 percent of agencies in 2020 to 46 percent in 2023.[48]



2023 Q11 *Source: USDOT*
**statistically significant difference between 2020 & 2023*

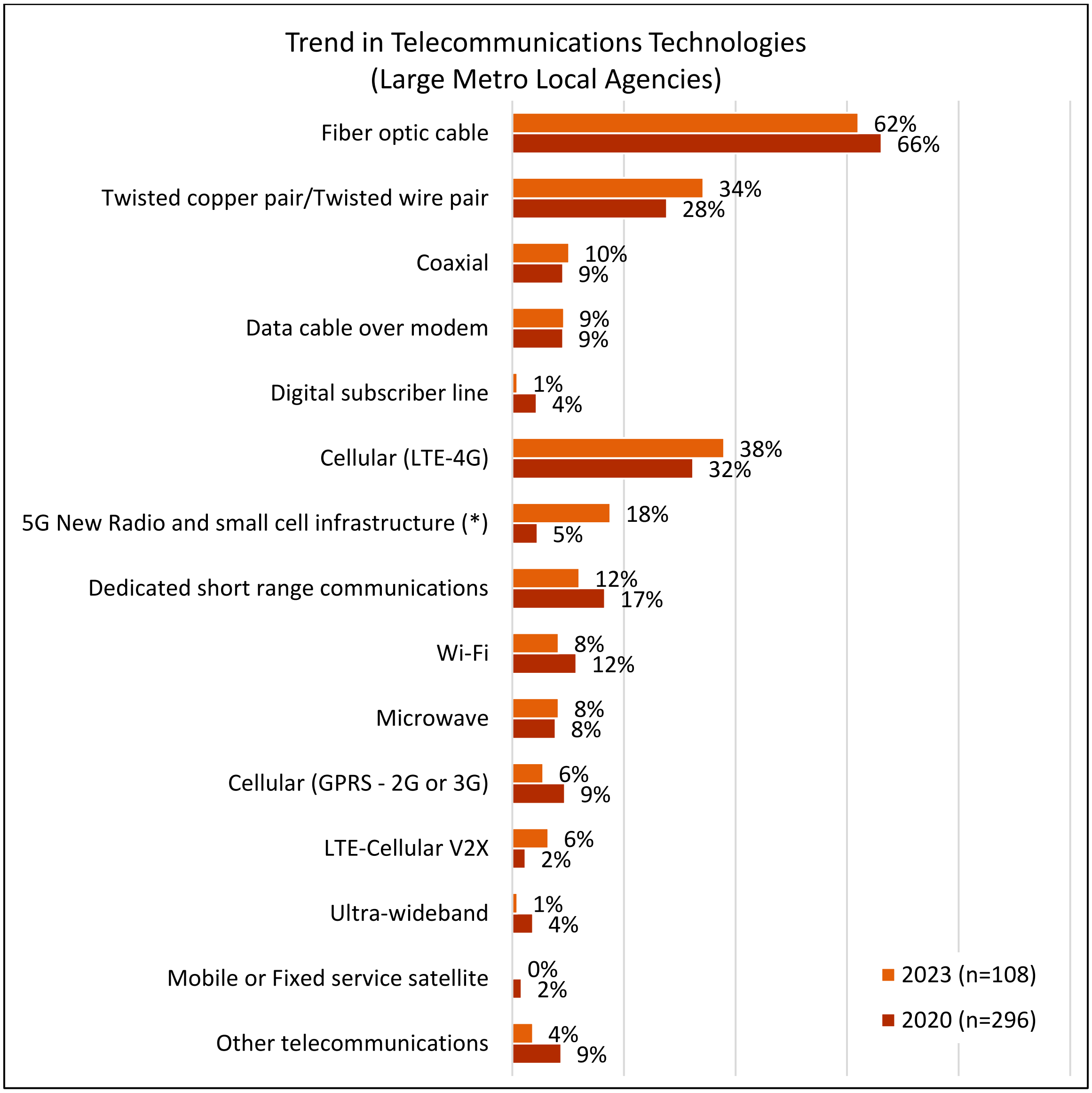
Figure 86. Trend in External Data Sources (Large Metro Local Agencies)

[48] *Other transportation agency data (e.g., State DOTs, MPOs, etc.)* was a new response option in 2023 deployed by 47 percent of surveyed large metropolitan agencies.

Telecommunications Technologies Trend Analysis

In 2023, two thirds of surveyed large metropolitan local arterial management agencies use at least one wired telecommunication technology (66 percent), and about one half use at least one wireless telecommunication technology (53 percent). This is relatively consistent compared to 2020.

Figure 87 shows that the only individual surveyed telecommunication technology to change significantly was *5G New Radio and small cell infrastructure*, which increased from 5 percent in 2020 to 18 percent in 2023 among surveyed large metropolitan local agencies.

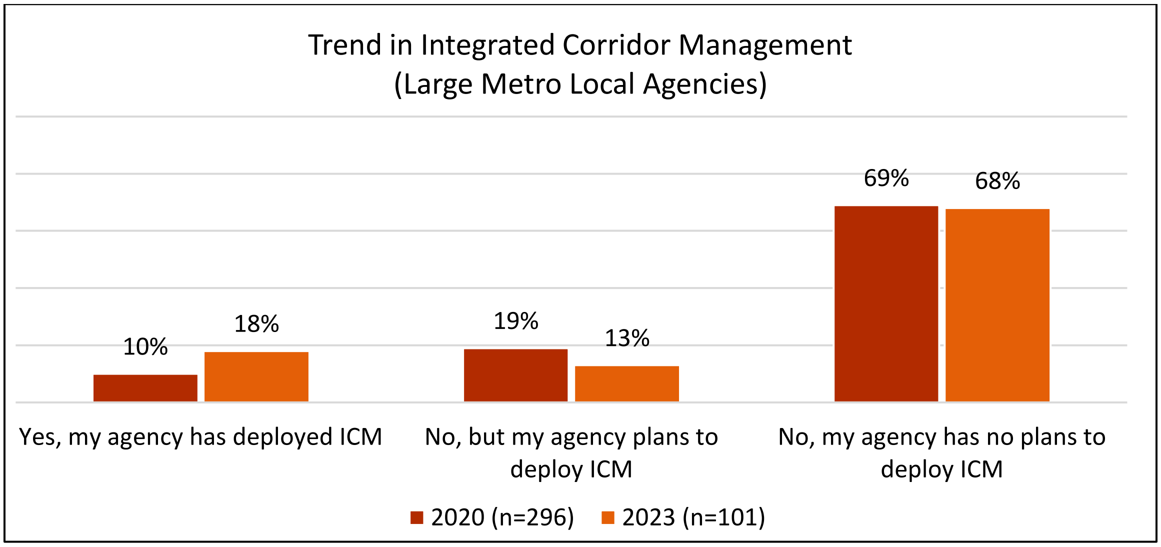


2023 Q42 *Source: USDOT*
**statistically significant difference between 2020 & 2023*

Figure 87. Trend in Telecommunication Technologies (Large Metro Local Agencies)

Integrated Corridor Management Trend Analysis

Figure 88 shows 18 percent of surveyed large metropolitan local arterial management agencies *deploy ICM*, compared to 13 percent *planning to deploy ICM* and 68 percent with *no plans to deploy ICM.* The trend is consistent with 2020, with no statistically significant changes across all response options.



2023 Q50 *Source: USDOT*

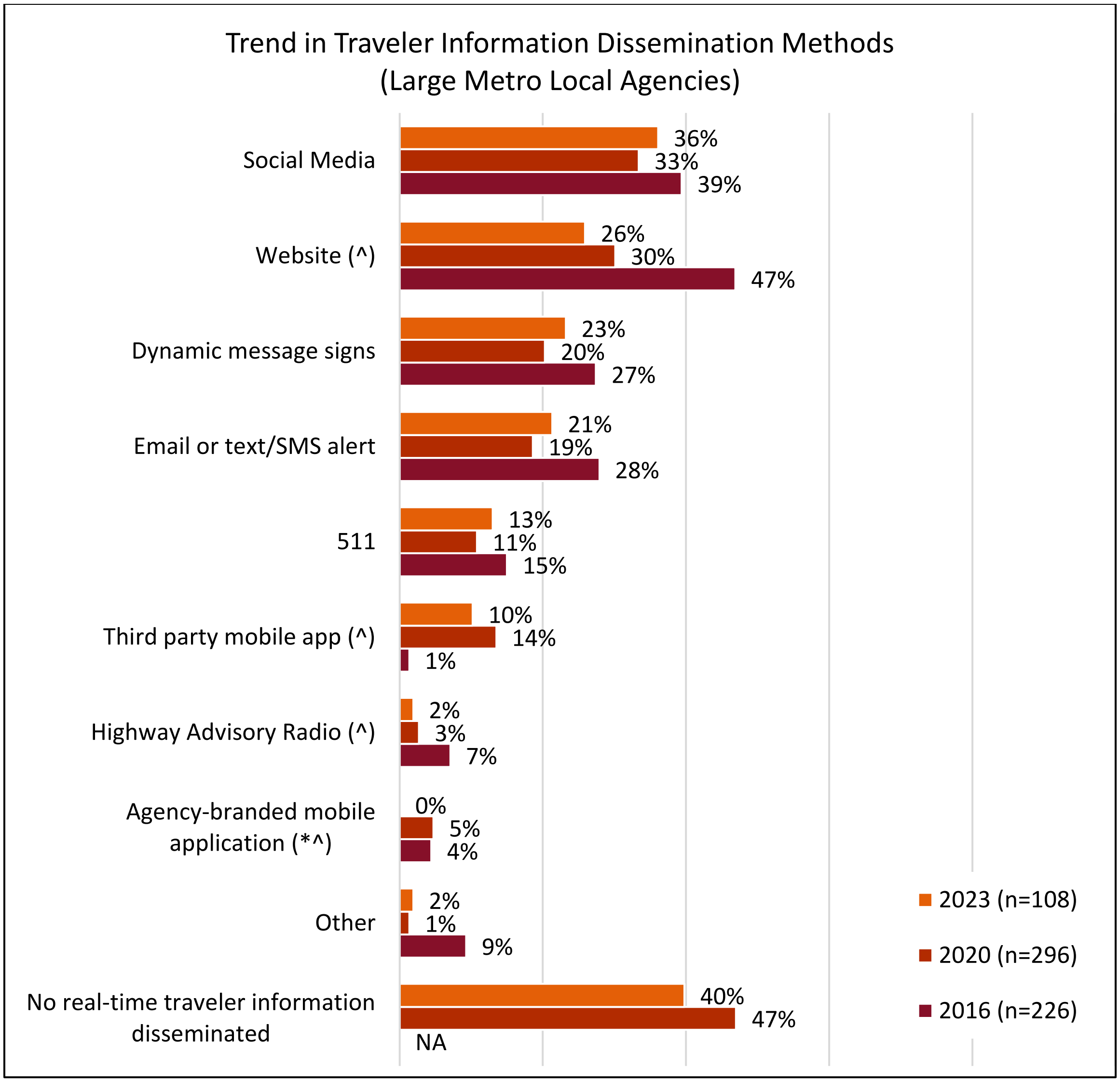
Figure 88. Trend in Integrated Corridor Management (Large Metro Local Agencies)

Traveler Information Dissemination Trend Analysis

In 2023, a majority of surveyed large metropolitan local arterial management agencies use at least one method to disseminate real-time traveler information (60 percent).

Figure 89 shows that the traveler information dissemination methods with significant decreases since 2016 (but not 2020) include *websites* (47 percent in 2016 to 26 percent in 2023), and *Highway Advisory Radio* (7 percent in 2016 to 2 percent in 2023). *Agency branded mobile apps* decreased significantly from 4 percent in 2020 to 0 percent in 2023.

The only traveler information dissemination method with a significant increase in use among large metropolitan local agencies was *third-party mobile apps* with reported use increasing from 1 percent in 2016 to 10 percent in 2023.



2023 Q24

**statistically significant difference between 2020 & 2023;*

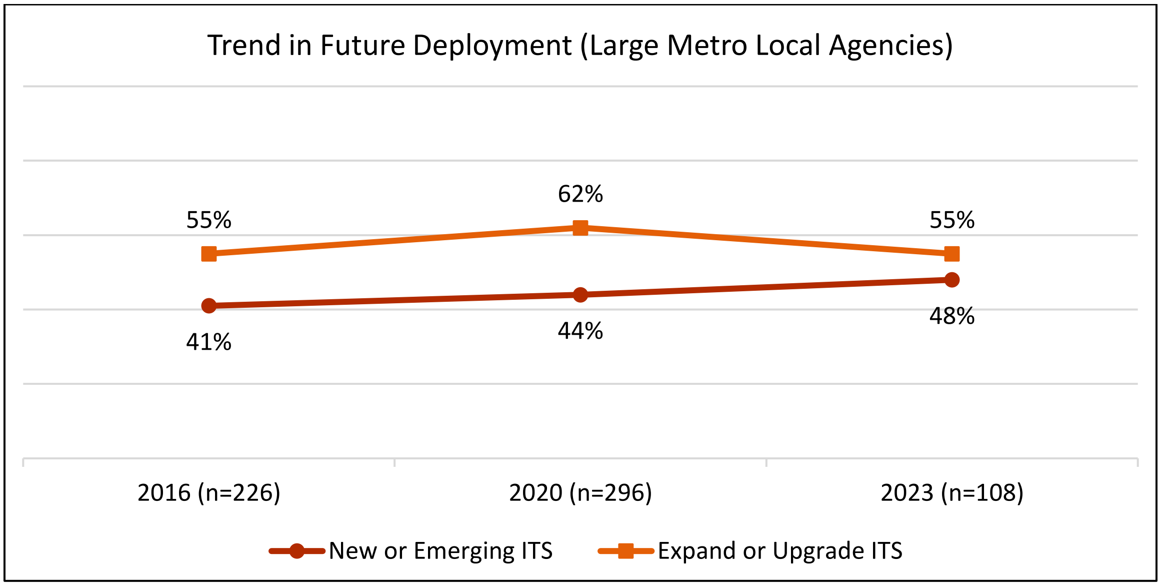
^statistically significant difference between 2016 & 2023

Source: USDOT

Figure 89. Trend in Traveler Information Dissemination Methods (Large Metro Local Agencies)

Future Deployment Planning Trend Analysis

Figure 90 shows the findings from two separate questions about future deployment planning: 1) whether agencies plan to expand or upgrade their current ITS, and 2) whether agencies plan to invest in new or emerging ITS. For both questions, the trend in response among surveyed large metropolitan local arterial management agencies remains stable from 2016 to 2023, with no statistically significant changes.



2023 Q60, Q61 *Source: USDOT*

Figure 90. Trend in Future Deployment (Large Metro Local Agencies)

Chapter 6. Conclusions

With the 2023 ITS Deployment Tracking Survey, the ITS JPO significantly expanded the geographic coverage of the Arterial Management Survey to include smaller urban and rural areas in addition to the previously surveyed subset of large metropolitan areas. The survey was administered to all State DOT districts managing arterials, as well as to a random sample of local arterial management agencies, enabling the reporting of ITS deployment nationwide.

The 2023 survey found that the deployment of ITS detection technologies at signalized intersections is nearly universal for both State DOT districts managing arterials and local agencies, with large majorities of each deploying inductive loops or video imaging detection. Emergency vehicle signal preemption is also widely deployed by both agency types. Several ITS technologies at signalized intersections, such as TSP and ASCT, have relatively lower levels of deployment among both State DOT districts managing arterials and local arterial management agencies.

For most other surveyed ITS technologies on arterials, there are apparent differences in the deployment rates of State DOT districts and local agencies. For example, more State DOT districts managing arterials than local arterial management agencies deploy ITS safety systems, work zone ITS technologies, ITS for road weather management, incident detection and verification methods, roadside ITS infrastructure, and telecommunications technologies. Nonetheless, there is room for growth even among State DOT districts managing arterials in the deployment of ITS on arterials, particularly with respect to ITS safety systems and work zone ITS technologies.

The Arterial Management Survey found that for several ITS technologies, deployment tends to be higher among State DOT districts with at least one large urban area compared to State DOT districts without a large urban area (with the notable exception of ITS for road weather management). Likewise, local arterial management agencies in large metropolitan areas tend to have significantly higher rates of ITS deployment than those in smaller urban or rural areas, and these differences are apparent for nearly all surveyed ITS technologies.

Among local arterial management agencies in large metropolitan areas, it is possible to assess trends in ITS deployment. The trend data show that for local arterial management agencies in large metropolitan areas, there is statistically significant growth since 2020 in several ITS technologies, including:

- **Incident detection and verification methods:** *external data (*from 15 percent in 2020 to 29 percent in 2023)
- **External data sources:** *publicly available mapping and traffic information apps* (from 38 percent in 2020 to 50 percent in 2023) and *notifications from the public* (from 32 percent in 2020 to 46 percent in 2023)
- **Vehicle probe readers:** *license plate readers* (from 2 percent in 2020 to 16 percent in 2023)

- **Telecommunications technologies:** *5G New Radio and small cell infrastructure* (from 5 percent in 2020 to 18 percent in 2023)

The 2023 survey is the first ITS Deployment Tracking Survey in which smaller urban and rural areas were surveyed (in addition to large metropolitan areas, which had been previously surveyed), resulting in nationwide estimates for ITS deployment. Given this new methodology, there are no trend data for these nationwide estimates. The 2023 Arterial Management Survey, however, establishes separate baselines for State DOT districts managing arterials and local arterial management agencies. With the next ITS Deployment Tracking Survey, it will be possible to assess trends for these two populations.

Appendix A. Changes in the Arterial Management Survey Methodology

As summarized in this report, the geographic coverage of the 2023 Deployment Tracking Survey was greatly expanded. The historical Deployment Tracking Survey (1999 – 2020) included a subset of large metropolitan areas, including 114 large metropolitan areas in the 2020 Deployment Tracking Survey.[49]

In 2023, survey coverage was expanded to include small metropolitan, micropolitan, and rural areas, in addition to previously surveyed large metropolitan areas. The changes to the Arterial Management Survey methodology are described below.

Table 37. Summary of Methodology Changes to the Arterial Survey and the Resulting Benefits

Arterial Management Survey Population	Historical Deployment Tracking Survey (1999 – 2020)	New Methodology (2023)	Benefits
State DOT districts managing arterials	A panel of State DOT districts managing arterials in large metropolitan areas (n=78)	A census of all State DOT districts managing arterials that manage arterials (n=355)	Enables the nationwide measurement of ITS deployment by State DOT districts managing arterials on arterials.
Local Arterial Management Agencies	A panel of local arterial management agencies in a subset of large metropolitan areas (n=432)	A stratified random sample of local arterial management agencies in metropolitan, micropolitan, and rural areas (n=896)	Enables the nationwide measurement of ITS deployment by local arterial management agencies on arterials.

[49] Originally the survey was administered to agencies in 78 large metropolitan areas, and in 2002, the survey was expanded to include 108 large metropolitan areas. Following the 2010 Census, updates were made to metropolitan area definitions, resulting in the addition of six new metropolitan areas to the 2013 Deployment Tracking Survey, for a total of 114 surveyed metropolitan areas. These 114 large metropolitan areas continued to be surveyed in 2016 and 2020.

Appendix B. 2023 Arterial Management Survey: State Department of Transportation Districts Additional Findings

This Appendix includes the findings for questions that are not reported in the main body of the report.

Q2: What is the total number of signalized intersections operated by your agency?

Table 38. Number of Signalized Intersections Operated

Range	Percent of State DOT districts managing arterials Base: State DOT districts managing arterials Operating Signalized Intersections
1 – 10	5%
11 – 50	13%
51 – 100	13%
101 – 300	27%
301 – 500	16%
501 or more	23%
Missing	4%

2023 Q2; (n=221) *Source: USDOT*

Q43: Please indicate how your agency is using Twisted copper pair/Twisted wire pair to enable ITS on arterials.

Table 39. Telecommunications Technologies: Use of Twisted copper pair/Twisted wire pair

Uses	Percent of State DOT districts managing arterials Base: State DOT districts managing arterials using Twisted copper pair/Twisted wire pair
Commercial Vehicle Operations	10%
Data Management	39%
Maintenance and Construction	29%
Parking Management	1%
Public Safety	10%
Public Transportation	7%
Support	26%
Sustainable Travel	0%
Traffic Management	70%
Traveler Information	56%
Vehicle Safety	7%
Weather	43%
Other	0%
Don't know	6%
Missing	17%

2023 Q43; (n=70) *Source: USDOT*

Q43: Please indicate how your agency is using Digital subscriber line to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 40. Telecommunications Technologies: Use of Digital subscriber line

Uses	Number of State DOT districts managing arterials Base: State DOT districts managing arterials using Digital subscriber line
Commercial Vehicle Operations	8
Data Management	19
Maintenance and Construction	18
Parking Management	4
Public Safety	15
Public Transportation	5
Support	12
Sustainable Travel	2
Traffic Management	31
Traveler Information	34
Vehicle Safety	4
Weather	27
Other	0
Don't know	2
Missing	3

2023 Q43; (n=43) *Source: USDOT*

Q43: Please indicate how your agency is using Data cable over modem to enable ITS on arterials.

Table 41. Telecommunications Technologies: Use of Data cable over modem

Uses	Percent of State DOT districts managing arterials Base: State DOT districts managing arterials using Data cable over modem
Commercial Vehicle Operations	6%
Data Management	31%
Maintenance and Construction	20%
Parking Management	3%
Public Safety	11%
Public Transportation	13%
Support	14%
Sustainable Travel	5%
Traffic Management	61%
Traveler Information	31%
Vehicle Safety	9%
Weather	28%
Other	0%
Don't know	11%
Missing	20%

2023 Q43; (n=64) *Source: USDOT*

Q43: Please indicate how your agency is using Cellular (GPRS - 2G or 3G) to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 42. Telecommunications Technologies: Use of Cellular (GPRS - 2G or 3G)

Uses	Number of State DOT districts managing arterials Base: State DOT districts managing arterials using Cellular (GPRS - 2G or 3G)
Commercial Vehicle Operations	9
Data Management	8
Maintenance and Construction	10
Parking Management	0
Public Safety	9
Public Transportation	1
Support	5
Sustainable Travel	0
Traffic Management	15
Traveler Information	17
Vehicle Safety	7
Weather	18
Other	0
Don't know	2
Missing	5

2023 Q43; (n=26) *Source: USDOT*

Q43: Please indicate how your agency is using LTE-Cellular V2X to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 43. Telecommunications Technologies: Use of LTE-Cellular V2X

Uses	Number of State DOT districts managing arterials Base: State DOT districts managing arterials using LTE-Cellular V2X
Commercial Vehicle Operations	3
Data Management	7
Maintenance and Construction	8
Parking Management	0
Public Safety	11
Public Transportation	9
Support	4
Sustainable Travel	0
Traffic Management	26
Traveler Information	22
Vehicle Safety	8
Weather	12
Other	0
Don't know	3
Missing	2

2023 Q43; (n=44) *Source: USDOT*

Q43: Please indicate how your agency is using Dedicated short range communications to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 44. Telecommunications Technologies: Use of Dedicated short range communications

Uses	Number of State DOT districts managing arterials Base: State DOT districts managing arterials using Dedicated short range communications
Commercial Vehicle Operations	0
Data Management	4
Maintenance and Construction	4
Parking Management	0
Public Safety	11
Public Transportation	1
Support	3
Sustainable Travel	0
Traffic Management	18
Traveler Information	14
Vehicle Safety	3
Weather	6
Other	0
Don't know	3
Missing	2

2023 Q43; (n=29) *Source: USDOT*

Q43: Please indicate how your agency is using Wi-Fi to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 45. Telecommunications Technologies: Use of Wi-Fi

Uses	Number of State DOT districts managing arterials Base: State DOT districts managing arterials using Wi-Fi
Commercial Vehicle Operations	4
Data Management	16
Maintenance and Construction	10
Parking Management	4
Public Safety	11
Public Transportation	2
Support	3
Sustainable Travel	1
Traffic Management	19
Traveler Information	15
Vehicle Safety	5
Weather	14
Other	0
Don't know	5
Missing	5

2023 Q43; (n=34) *Source: USDOT*

Q43: Please indicate how your agency is using Ultra-wideband to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 46. Telecommunications Technologies: Use of Ultra-wideband

Uses	Number of State DOT districts managing arterials Base: State DOT districts managing arterials using Ultra-wideband
Commercial Vehicle Operations	1
Data Management	2
Maintenance and Construction	2
Parking Management	0
Public Safety	3
Public Transportation	0
Support	2
Sustainable Travel	0
Traffic Management	5
Traveler Information	2
Vehicle Safety	1
Weather	2
Other	0
Don't know	2
Missing	1

2023 Q43; (n=10) *Source: USDOT*

Q45: Does your agency utilize an asset management system to track Intelligent Transportation Systems (ITS) inventory and/or ITS maintenance and operations activity on arterials?

Table 47. Asset Management System

Response	Percent of State DOT districts managing arterials
Yes, system tracks inventory of ITS field devices	70%
Yes, system tracks inventory of ITS central systems/software	30%
Yes, system tracks maintenance and operations of ITS field devices	56%
Yes, system tracks maintenance and operations of ITS central systems/software	28%
No, my agency does not have an ITS asset management system	18%
Not applicable, my agency has not deployed ITS	3%
Missing	2%

2023 Q45; (n=276) *Source: USDOT*

Q46: What is your agency's primary approach for conducting maintenance activities on arterial ITS assets?

Table 48. Primary Approach for Conducting Maintenance

Response	Percent of State DOT districts managing arterials Base: State DOT districts managing arterials Indicating ITS (i.e., exclude agencies responding Not Applicable to Q45)
My agency primarily schedules maintenance based on the regularly monitored condition of arterial ITS	21%
My agency primarily schedules maintenance of arterial ITS assets based on regular intervals	27%
My agency primarily conducts maintenance in response to reported arterial ITS asset failures or events, such as a vehicle collision or component failure	35%
Other	4%
Don't know	8%
Missing	6%

2023 Q46; (n=264) *Source: USDOT*

Q56 a/b. What are key reasons for NOT using your Regional (or State) ITS Architecture to support arterial ITS deployments?

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 49. Key Reasons for Not Using Regional (or State) ITS Architecture for All Deployments

Response	Number of State DOT districts managing arterials Base: State DOT districts managing arterials Not Using Architecture for All Deployments
Lack of experience/technical expertise with the Regional ITS Architecture	9
The Regional ITS Architecture is out of date	11
The scope and/or scale of my agencies' ITS projects are generally too small	12
No perceived technical or operational benefit to using the Regional ITS Architecture	9
Other	3
Missing	1

2023 Q56a; Q56b; (n=33) *Source: USDOT*

Appendix C. 2023 Arterial Management Survey: Local Agencies Additional Findings

This Appendix includes the findings for questions that are not reported in the main body of the report.

Q2: What is the total number of signalized intersections operated by your agency?

Table 50. Number of Signalized Intersections Operated

Range	Percent of Local Agencies Base: Local Agencies Operating Signalized Intersections
1 – 10	48%
11 – 50	27%
51 – 100	7%
101 – 300	8%
301 – 500	3%
501 or more	2%
Missing	5%

2023 Q2; (WN=217; UWN=221) *Source: USDOT*

Q13: You indicated that your agency purchases third-party commercial data. What type(s) of arterial data is your agency purchasing?

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 51. Types of Third-Party Data Purchased

Response	Number of Local Agencies Base: Local Agencies Purchasing Third-Party Data
Vehicle probe data	19
Connected vehicle data	7
Multimodal probe data	3
Origin-destination (trip) data	1
Non-recurring event data (e.g. incidents, closures, road weather events)	2
Other	2
Missing	4

2023 Q13; (UWN=28) *Source: USDOT*

Q27: Does your agency do any of the following?

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 52. Strategies to Monitor the Availability

Response	Number of Local Agencies Base: Local Agencies Monitoring the Availability of Parking
Disseminate parking availability information to drivers	11
Use a parking pricing strategy (e.g. peak period surcharges) to manage congestion	3
Allow drivers to reserve a parking space at a destination facility on demand to ensure availability	6
None of the above	14
Missing	0

2023 Q27; (UWN=29) *Source: USDOT*

Q32: Approximately how many roadside units (RSUs) is your agency currently testing or deploying on arterials?

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 53. Number of RSUs Deployed

Range	Number of Local Agencies Base: Local Agencies Deploying RSUs
1-10	10
11-50	2
51-150	4
151 or more	1
Missing	0

2023 Q32; (UWN=17) *Source: USDOT*

Q33: On arterials, what standard data structures are being transmitted for your connected vehicle system?

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 54. Data Structures Used for CV

Response	Number of Local Agencies Base: Local Agencies Deploying RSUs
Basic Safety Message (BSM)	9
MAP data	7
Pedestrian Safety Message (PSM)	5
Position Correction Message (RTCM)	1
Roadside Safety Message (RSM)	3
Sensor Data Sharing Message (SSDM)	3
Signal Phase and Timing (SPaT)	14
Signal Request Message (SRM)	4
Signal Status Message (SSM)	7
Traveler Information Message (TIM)	1
Other	0
Don't know	2
Missing	0

2023 Q33; (UWN=17) *Source: USDOT*

Q35: Which connected vehicle (CV) applications is your agency developing, testing, or deploying on arterials?

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 55. CV Applications

Response	Number of Local Agencies Base: Local Agencies Developing, Testing, or Deploying CV Applications
Curve Speed Warning (CSW)	1
Pedestrian in Signalized Crosswalk Warning	9
Red Light Violation Warning (RLVW)	5
Reduced Speed/Work Zone Warning (RSWZ)	2
Blind Spot/Lane Change Warning (BSW/LCW)	1
Emergency Electronic Brake Lights (EEBL)	1
Forward Collision Warning (FCW)	1
Intersection Movement Assist (IMA)	2
Vehicle Turning Right in Front of Bus Warning (VTRFBW)	1
Emergency Vehicle Preemption (PREEMPT)	8
Freight Signal Priority	2
Integrated Dynamic Transit Operations (IDTO) (e.g., Connection Protection (T-CONNECT), Dynamic Transit Operations (T-DISP), and Dynamic Ridesharing (D-RIDE))	3
Intelligent Traffic Signal System (I-SIG)	6
Queue Warning (Q-WARN)	2
Transit Signal Priority	7
Dynamic Eco-Routing	0
Eco-Approach and Departure at Signalized Intersections	1
Agency Data Applications	5
Road Weather Warnings	3
Other CV applications	1
Missing	0

2023 Q35; (UWN=14) *Source: USDOT*

Q39A/B: Which entity(ies) are/were supporting/leading the automated vehicle testing or deployment on arterials?

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 56. Entities Supporting/leading AV Testing or Deployment

Response	Number of Local Agencies Base: Local Agencies Supporting/Leading AV Testing/Deployment
Automakers or Original Equipment Manufacturers (OEMs), including Transit Vehicle Manufacturers	5
Advanced Driver Assistance Systems (ADAS) Developers (or Driver Support Features Developers)	1
Automated Driving Systems (ADS) Developers	3
Transportation Network Companies (TNCs)	2
State agencies	8
Metropolitan Planning Organizations (MPOs)	3
Universities	6
Transit agencies	2
Other local agencies	2
Private sector consultants	4
Other	1
Don't know	0
Missing	0

2023 Q39a; Q39b; (UWN=16) *Source: USDOT*

Q40: Which of the following automated vehicle (AV) tests or deployments on arterials has your agency led or supported in the last five years?

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 57. Entities Supporting/leading AV Testing or Deployment

Response	Number of Local Agencies Base: Local Agencies Supporting/Leading AV Testing/Deployment
Automated Bus Rapid Transit (BRT)	1
Automated Passenger Fixed Route	7
Automated Passenger On-Demand	3
Automated Maintenance and Bus Yard Operations	0
Automated Personal Delivery Device (e.g., sidewalk delivery robot)	0
Automated Last Mile Delivery (e.g., light duty vehicle)	0
Automated Regional or Long-Haul Trucking	1
Truck Platooning	1
Automated Logistics Yard Operation (e.g., automated yard trucks)	0
Construction or Maintenance Operations (e.g., automated truck mounted attenuators)	0
Automated light duty passenger vehicle test/deployment	3
Other AV test/deployment	0
Missing	4

2023 Q40; (UWN=16) *Source: USDOT*

Q43: Please indicate how your agency is using Twisted copper pair/Twisted wire pair to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 58. Telecommunications Technologies: Use of Twisted copper pair/Twisted wire pair

Uses	Number of Local Agencies Base: Local Agencies using Twisted copper pair/Twisted wire pair
Commercial Vehicle Operations	1
Data Management	9
Maintenance and Construction	1
Parking Management	1
Public Safety	6
Public Transportation	4
Support	6
Sustainable Travel	0
Traffic Management	29
Traveler Information	4
Vehicle Safety	0
Weather	0
Other	0
Don't know	3
Missing	4

2023 Q43; (UWN=41) *Source: USDOT*

Q43: Please indicate how your agency is using Data cable over modem to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 59. Telecommunications Technologies: Use of Data cable over modem

Uses	Number of Local Agencies Base: Local Agencies using Data cable over modem
Commercial Vehicle Operations	0
Data Management	2
Maintenance and Construction	1
Parking Management	0
Public Safety	2
Public Transportation	2
Support	0
Sustainable Travel	0
Traffic Management	3
Traveler Information	2
Vehicle Safety	0
Weather	0
Other	0
Don't know	1
Missing	4

2023 Q43; (UWN=13) *Source: USDOT*

Q43: Please indicate how your agency is using 5G New Radio and Small cell infrastructure to enable ITS on arterials.

Table 60. Telecommunications Technologies: Use of 5G New Radio and Small cell infrastructure

Uses	Number of Local Agencies Base: Local Agencies using 5G New Radio and Small cell infrastructure
Commercial Vehicle Operations	0
Data Management	8
Maintenance and Construction	2
Parking Management	0
Public Safety	4
Public Transportation	1
Support	2
Sustainable Travel	0
Traffic Management	13
Traveler Information	1
Vehicle Safety	1
Weather	2
Other	0
Don't know	4
Missing	0

2023 Q43; (UWN=27) *Source: USDOT*

Q43: Please indicate how your agency is using Dedicated short range communications to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 61. Telecommunications Technologies: Use of Dedicated short range communications

Uses	Number of Local Agencies Base: Local Agencies using Dedicated short range communications
Commercial Vehicle Operations	1
Data Management	3
Maintenance and Construction	2
Parking Management	0
Public Safety	3
Public Transportation	3
Support	2
Sustainable Travel	0
Traffic Management	13
Traveler Information	1
Vehicle Safety	1
Weather	1
Other	0
Don't know	0
Missing	1

2023 Q43; (UWN=16) *Source: USDOT*

Q43: Please indicate how your agency is using Wi-Fi to enable ITS on arterials.

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 62. Telecommunications Technologies: Use of Wi-Fi

Uses	Number of Local Agencies Base: Local Agencies using Wi-Fi
Commercial Vehicle Operations	1
Data Management	5
Maintenance and Construction	4
Parking Management	2
Public Safety	3
Public Transportation	2
Support	4
Sustainable Travel	0
Traffic Management	9
Traveler Information	1
Vehicle Safety	2
Weather	4
Other	0
Don't know	2
Missing	2

2023 Q43; (UWN=19) *Source: USDOT*

Q45. Does your agency utilize an asset management system to track intelligent Transportation Systems (ITS) inventory and/or ITS maintenance operations activity on arterials?

Table 63. Asset Management System

Response	Percent of Local Agencies
Yes, system tracks inventory of ITS field devices	5%
Yes, system tracks inventory of ITS central systems/software	3%
Yes, system tracks maintenance and operations of ITS field devices	6%
Yes, system tracks maintenance and operations of ITS central systems/software	3%
No, my agency does not have an ITS asset management system	74%
Not applicable, my agency has not deployed ITS	17%
Missing	2%

2023 Q45; (n=423) *Source: USDOT*

Q46: What is your agency's primary approach for conducting maintenance activities on arterial ITS assets?

Table 64. Primary Approach for Conducting Maintenance

Response	Percent of Local Agencies Base: Local Agencies Indicating ITS (i.e., exclude agencies responding Not Applicable to Q45)
My agency primarily schedules maintenance based on the regularly monitored condition of arterial ITS	5%
My agency primarily schedules maintenance of arterial ITS assets based on regular intervals	8%
My agency primarily conducts maintenance in response to reported arterial ITS asset failures or events, such as a vehicle collision or component failure	17%
Other	2%
Don't know	24%
Missing	44%

2023 Q46; (WN=346; UWN=341) *Source: USDOT*

Q56 a/b. What are key reasons for NOT using your Regional (or State) ITS Architecture to support arterial ITS deployments?

Due to the small sample size, this table shows counts of agencies rather than percentages.

Table 65. Key Reasons for Not Using Regional (or State) ITS Architecture for All Deployments

Response	Number of Local Agencies Base: Local Agencies Not Using Architecture for All Deployments
Lack of experience/technical expertise with the Regional ITS Architecture	5
The Regional ITS Architecture is out of date	6
The scope and/or scale of my agencies' ITS projects are generally too small	16
No perceived technical or operational benefit to using the Regional ITS Architecture	5
Other	1
Missing	1

2023 Q56a; Q56b; (UWN=28) *Source: USDOT*

Appendix D. 2023 Arterial Management Survey Questionnaire

Prior to administering the Arterial Survey, the ITS JPO consulted with subject matter experts (SMEs) on the survey content to determine if any questions should be revised, or if questions should be eliminated or added. This appendix contains the 2023 Arterial Management Survey Questionnaire. New questions in the 2023 Deployment Tracking Survey are marked with a (+). Notably, questions 28 through 41 were adapted from the 2019 Connected Vehicle and Automated Vehicle Survey.

Welcome to the Arterial Management Survey!

Before you get started, please review the following definitions:

Intelligent Transportation Systems (ITS) encompass the electronic, communication, and information processing technologies that enable transportation agencies to collect and transmit data in real time (or near real time) for use in transportation operations. ITS are deployed to support safety, mobility, environmental, and other goals. A few examples of ITS technologies for arterial roads include adaptive signal control, transit signal priority, dynamic/changeable message signs, and pedestrian warning systems.

Arterial roadways, also referred to as "**arterials**" throughout the survey: include **roads with uncontrolled access**, **often with at-grade intersections**. Arterials are represented by the following Federal Highway Administration's Highway Functional Classifications (see: https://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section00.cfm):

- Other principal arterials (functional class 3)
- Minor arterials (functional class 4)
- Major and minor collectors (functional classes 5, 6)
- Local Roads (functional class 7)

Navigating the Survey:

Use the "Next" and "Previous" buttons below to navigate the survey. Answers from each survey page are automatically saved when you go to the NEXT survey page.

To return to the dashboard, click on the "Return to Dashboard" button on the bottom of the page.

For many questions, there will be terms that are underlined. In this reference pdf, additional information for these terms is provided in a box below the question.

Note: The instructions in red font show the survey skip logic, which is automated in the online survey.

Signalized Intersections

1. [ASK ALL] **Does your agency operate signalized intersections?** *Please select one.*
   - ○ Yes
   - ○ No – SKIP TO Q9

2. [IF Q1=YES] **What is the total number of signalized intersections operated by your agency?** *If you don't know the exact number, please provide your best estimate.*

   Number of intersections: __________

3. [IF Q1=YES] **Does your agency deploy any of the following detection technologies at signalized intersections?** *Please select all that apply.*

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

DEFINITIONS SHOWN IN HOVER BOXES:

Inductive loop detectors are comprised of a series of wired loops that sense the presence of a vehicle on the roadway and transfer the signal to an electronic unit housed in a controller cabinet on the side of the roadway.

Radar/microwave detection identifies vehicles by transmitting an electromagnetic signal that gets reflected to the radar sensor once a vehicle passes through the area.

Video imaging detection (e.g., traffic and infrared cameras) uses cameras above traffic to capture images of passing vehicles. These images are analyzed by a vision processor using application specific algorithms to detect vehicles and monitor traffic.

Magnetometers detect a vehicle whenever a sufficient portion of its magnetic shadow falls on a sensor probe.

Infrared/Thermal detection identifies vehicles by transmitting infrared light or heat from a transmitter to a receiver placed on the opposite side of the road perpendicular to the direction of travel.

4. [IF Q1=YES] **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

5. [IF Q1=YES] **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 Q7

DEFINITION SHOWN IN HOVER BOX:
Adaptive signal control technology monitors traffic on a roadway and automatically adjusts signal timing (when and how long the signals should remain green) to accommodate the current traffic.

6. [IF Q5 = YES] **What percentage of signalized intersections are operated using adaptive signal control technology (ASCT)?** *Please select one.*
   - 1% to 24% of intersections
   - 25% to 49% of intersections
   - 50% to 74% of intersections
   - 75% to 99% of intersections
   - 100% of intersections

7. [IF Q1=YES] **Does your agency participate in traffic signal coordination activities across jurisdictional boundaries?** *Please select all that apply.*
   - ❑ Yes, informally with 1 or more adjacent jurisdictions.
   - ❑ Yes, informally within a regional traffic signal program managed by a State Department of Transportation, Metropolitan Planning Organization (MPO), or other regional authority.
   - ❑ Yes, formally (e.g., Memorandums of Understanding, written agreements), with 1 or more adjacent jurisdictions.
   - ❑ Yes, formally (e.g., Memorandums of Understanding, written agreements), within a regional traffic signal program managed by a State Department of Transportation, Metropolitan Planning Organization (MPO), or other regional authority.
   - ❑ No traffic signal coordination activities across jurisdictional boundaries.
   - ❑ Don't know

Traffic Signal Preemption and Priority

8. [IF Q1 = YES] **Does your agency deploy any traffic signal preemption or priority technologies at signalized intersections?** *Please select all that apply.*
   - ❑ Emergency vehicle signal preemption
   - ❑ Transit signal priority
   - ❑ Truck (or freight) signal priority
   - ❑ Signal preemption near a rail grade crossing
   - ❑ Maintenance and construction signal priority
   - ❑ Other (please specify): _______________
   - ❑ No traffic signal preemption or priority technologies are deployed

DEFINITIONS SHOWN IN HOVER BOXES:

Emergency vehicle signal preemption interrupts normal traffic signal timing to provide a green light to approaching emergency vehicles so that they can pass through intersections to get to emergencies safely and quickly.

Transit signal priority (TSP) makes it more likely that the light is green when a transit vehicle reaches a signalized intersection. This strategy reduces travel times for transit vehicles by avoiding the need to stop and start at signalized intersections.

Truck (or freight) signal priority provides extra green light time so that a heavy truck can move through a traffic signal without stopping.

Signal preemption near a rail grade crossing connects signals with railroad crossings to ensure that people and/or traffic queues have moved away from a railroad grade crossing prior to the arrival of the train, restricting movements towards the track.

Maintenance and construction signal priority allows a maintenance and construction vehicle (e.g., a snowplow or a lane striping vehicle) to request priority at one or a series of intersections.

Real-Time Traffic Data Collection on Arterials

9. [ASK ALL] **Does your agency deploy any roadside infrastructure technologies to collect real-time traffic data on arterials?** *Please* ***do not*** *include technologies deployed at intersections. Please select all that apply.*

- ❑ Inductive Loop
- ❑ Radar/microwave detection
- ❑ Video imaging detection
- ❑ Magnetometers
- ❑ Infrared/thermal detection
- ❑ Other (please specify): ____________________
- ❑ No roadside infrastructure technologies are deployed

DEFINITIONS SHOWN IN HOVER BOXES:

Inductive loop detectors are comprised of a series of wired loops that sense the presence of a vehicle on the roadway and transfer the signal to an electronic unit housed in a controller cabinet on the side of the roadway.

Radar/microwave detection identifies vehicles by transmitting an electromagnetic signal that gets reflected to the radar sensor once a vehicle passes through the area.

Video imaging detection (e.g., traffic and infrared cameras) uses cameras above traffic to capture images of passing vehicles. These images are analyzed by a vision processor using application specific algorithms to detect vehicles and monitor traffic.

Magnetometers detect a vehicle whenever a sufficient portion of its magnetic shadow falls on a sensor probe.

Infrared/Thermal detection identifies vehicles by transmitting infrared light or heat from a transmitter to a receiver placed on the opposite side of the road perpendicular to the direction of travel.

10. [ASK ALL] **Has your agency deployed any vehicle probe readers to collect real-time traffic data on arterials?** *Please select all that apply.*

Please note that your response should include your agency's deployed equipment only; please ***do not*** *include vehicle probe reader data purchased or obtained from an external source.*

- ❑ Toll tag readers
- ❑ License plate readers
- ❑ Bluetooth readers
- ❑ Cellular/mobile phone readers
- ❑ In-vehicle GPS readers
- ❑ Other (please specify): ______
- ❑ No vehicle probe readers are deployed

DEFINITIONS SHOWN IN HOVER BOXES:

Toll tag readers match tag numbers read at the starting and ending points of the segment of road to estimate travel times.

License plate readers use optical cameras to capture images of oncoming or receding traffic and use video image processing to "read" the license plates. License plate numbers can also be matched at sensor locations downstream.

Bluetooth readers work by actively searching for in-range Bluetooth devices and capturing the unique address of each device.

Cellular/mobile phone readers automatically and anonymously downloaded phone location information from cellular network switching centers in real time. The location of a cell phone on a roadway is determined by cell phone network handoff or signal tower triangulation and compared to a map database.

In-vehicle GPS readers are used in vehicles equipped with GPS to transmit positional information via GPS signal to a central control center.

11. [ASK ALL] **Does your agency use any external data sources (i.e., collected outside of your agency) for arterial management (e.g., incidents, road weather, traffic, etc.)?** *Please select all that apply.*

- ❑ Notifications from the public via social media, emails, texts, phone calls, etc.
- ❑ Publicly available mapping and traffic information apps (e.g., Google Maps, Waze, etc.)
- ❑ Purchased third-party commercial data (e.g., Inrix, HERE, TomTom)
- ❑ Other transportation agency data (e.g., State DOT, MPO, etc.)
- ❑ Other (Please specify): _______________
- ❑ No external data sources are used – SKIP TO Q14
- ❑ Don't know – SKIP TO Q14

12. (+) [IF Q11 = OPTIONS 1, 2, 3, 4, or 5] **How is your agency using the arterial data obtained from external sources?** *Please select all that apply.*

- ❑ Traffic incident management
- ❑ Work zone management
- ❑ Road weather management
- ❑ Traveler information
- ❑ Arterial management
- ❑ Performance management/measurement
- ❑ Road/Intelligent Transportation Systems (ITS) asset management
- ❑ Emergency management
- ❑ Traffic studies and/or project prioritization
- ❑ Safety analytics/management
- ❑ Other (please specify): ____________________

13. (+) [IF Q11 = OPTION 3 THIRD PARTY COMMERCIAL DATA] **You indicated that your agency purchases third-party commercial data. What type(s) of arterial data is your agency purchasing?** *Please select all that apply.*

- ❑ Vehicle probe data
- ❑ Connected vehicle data
- ❑ Multimodal probe data
- ❑ Origin-destination (trip) data
- ❑ Non-recurring event data (e.g., incidents, closures, road weather events)
- ❑ Other (please specify): ______________

Automated Enforcement

14. [ASK ALL] **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 Q17

15. [IF Q14=YES] **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): ___________

16. [IF Q14=YES] **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): ___________

DEFINITIONS SHOWN IN HOVER BOXES:

Toll tag readers match tag numbers read at the starting and ending points of the segment of road to estimate travel times.

License plate recognition uses optical cameras to capture images of oncoming or receding traffic and use video image processing to "read" the license plates. License plate numbers can also be matched at sensor locations downstream.

Radar detects vehicles by transmitting an electromagnetic signal that gets reflected to the radar sensor once a vehicle passes through the area.

Safety and Road Weather Management

17. [ASK ALL] **Has your agency deployed any Intelligent Transportation Systems (ITS) safety systems on arterials?** *Please select all that apply.*

- ❑ Automated visibility warning system
- ❑ Bicyclist warning system
- ❑ Downhill truck speed warning
- ❑ Dynamic curve warning system
- ❑ Highway-rail crossing safety system
- ❑ Intersection collision warning system
- ❑ Over-height warning system (e.g., bridge, tunnel, gantries)
- ❑ Pedestrian warning system (e.g., pedestrian hybrid beacon, passive pedestrian sensors)
- ❑ Queue warning system
- ❑ Speed feedback sign
- ❑ Variable speed limit
- ❑ Wildlife warning system
- ❑ Wrong way driving detection system
- ❑ Other (please specify): ______
- ❑ No ITS safety systems are deployed

DEFINITIONS SHOWN IN HOVER BOXES:

Automated visibility warning system uses weather sensors to detect reduced visibility conditions and then trigger a dynamic message sign with a warning indicating the adverse driving conditions.

Bicycle warning system alerts drivers (e.g., flashing beacons) of bicyclists using the roadway or shoulder

Downhill truck speed warning alerts drivers (e.g., illuminated signs) to slow down if their vehicle speed is too high to travel safely downhill.

Dynamic curve warning system detects vehicles approaching a curve and activates a warning to drivers (e.g., illuminated signs, flashing beacons, etc.) to slow down if their vehicle speed is too high to travel safely through the curve.

Highway-rail crossing safety system detects drivers approaching an at-grade rail crossing and alerts drivers of oncoming trains (e.g., illuminated signs).

Intersection collision warning system alerts the crossing or entering vehicles if there is an approaching vehicle. These systems are used at intersections where one direction is stop-controlled while the other is uncontrolled.

Over-height warning system detects vehicles and activates a warning to drivers (e.g., illuminated signs, flashing beacons, etc.) identifying upcoming tunnels, bridges, or other obstacles that may limit the size of the vehicle that can pass.

Pedestrian warning systems detect pedestrians and activates a warning to drivers (e.g., in-pavement lights, illuminated crosswalk signs, flashing beacons, etc.) to slow to a stop, allowing pedestrians to safely pass through the crosswalk.

Queue warning system uses sensors to display messages on dynamic message signs to warn drivers about stopped or slowed traffic ahead.

Speed feedback sign is a traffic control device that displays a driver's speed or provides a message to drivers exceeding a certain speed threshold.

Variable speed limit uses current traffic conditions to determine the appropriate speed at which drivers should be traveling and displays this information on dynamic message signs.

Wildlife warning system detects the presence of an animal on or near the road and activates a warning to drivers (e.g., illuminated signs, flashing beacons, etc.).

Wrong way driving detection system detects vehicles traveling in the wrong direction and alerts the driver. May also have a traffic or CCTV camera to record the incident.

18. [IF Q17 = OPTION 8 PEDESTRIAN WARNING SYSTEM] **What percentage of signalized intersections are equipped with ITS pedestrian warning technology (e.g., pedestrian hybrid beacon, passive pedestrian sensors)?** *Please select one.*

- ○ 0% of intersections
- ○ 1% to 24% of intersections
- ○ 25% to 49% of intersections
- ○ 50% to 74% of intersections
- ○ 75% to 99% of intersections
- ○ 100% of intersections

19. [ASK ALL] **Does your agency use any ITS <u>Road Weather Information Systems (RWIS)/Environmental Sensor Stations (ESS)</u> to collect weather and road condition data on arterials?** *Please select all that apply.*

- ❑ Mobile (vehicle-mounted)
- ❑ Permanent (stationary)
- ❑ Transportable (temporary use for work zones, recurring problem spots, etc.)
- ❑ Other (Please specify): ______________
- ❑ No ITS (RWIS/ESS) are deployed to collect weather and road condition data

DEFINITIONS SHOWN IN HOVER BOXES:

Environmental sensor stations (ESS) are at a fixed roadway location with one or more sensors measuring atmospheric, pavement, and/or water level conditions.

Road Weather Information Systems (RWIS) are comprised of environmental sensor stations (ESS), a communication system for data transfer, and a central system to collect and process the field data. The data is used to disseminate road weather information.

20. (+) [ASK ALL] **Does your agency use any tools and strategies to manage adverse road weather impacts on arterials?** *Please select all that apply.*

- ❑ Automated vehicle location (AVL)
- ❑ Decision support systems
- ❑ Dynamic message signs (permanent and/or portable)
- ❑ Pathfinder
- ❑ Queue warning systems
- ❑ Resource pre-positioning (e.g., pre-positioning trucks for plowing)
- ❑ Route Optimization
- ❑ Traffic modeling and/or analysis
- ❑ Traffic signal timing
- ❑ Variable speed limits
- ❑ Other (please specify): _______________
- ❑ No tools or strategies are used to manage adverse road weather impacts

DEFINITIONS SHOWN IN HOVER BOXES:

Pathfinder is a communication and collaboration strategy developed by Federal Highway Administration and supported by National Weather Service. For more information, see: https://ops.fhwa.dot.gov/publications/fhwahop18034/index.htm.

Route Optimization is a static or adaptive routing response tool and/or strategy based on road weather conditions, incidents, recurring problem areas, etc.

Incident Detection

21. [ASK ALL] **Does your agency use any incident detection/verification methods on arterials?** *Please select all that apply.*

- ❑ 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):___________________
- ❑ No incident detection/verification methods are used

Work Zone Management

22. [ASK ALL] **Does your agency deploy Intelligent Transportation Systems (ITS) technology at work zones on arterials?** *Please select one.*
    - Yes
    - No – SKIP TO Q24

23. [IF Q22 = YES] **Which ITS technologies does your agency deploy at work zones on arterials?** *Please select all that apply.*
    - ❑ Dynamic lane merge system
    - ❑ Intrusion alarm
    - ❑ Portable Closed Circuit Television (CCTV)
    - ❑ Portable dynamic message sign
    - ❑ Portable dynamic speed feedback/speed radar trailer
    - ❑ Portable traffic monitoring device
    - ❑ Queue detection and alert system
    - ❑ Route guidance around work zones
    - ❑ Temporary traffic signal
    - ❑ Travel time system
    - ❑ Variable speed limit
    - ❑ Other (please specify): ___________

DEFINITIONS SHOWN IN HOVER BOXES:

Dynamic lane merge system uses dynamic message signs and other devices to control vehicle merging behavior.

Intrusion alarm detects errant vehicles entering the work zone and alerts workers.

Portable CCTV system provides visual surveillance and is typically mounted in a light truck or van or on a trailer.

Portable dynamic message sign (DMS) displays a variety of messages to inform motorists of unusual driving conditions.

Portable dynamic speed feedback/speed radar trailer systems are portable traffic control devices that display a driver's speed or provide a message to drivers exceeding a certain speed threshold.

Portable traffic monitoring device uses radar or microwave detection to collect traffic-related data and communicates this information in real-time to a central server, which can also be automatically conveyed to motorists via a public website or portable dynamic message signs.

Queue detection and alert system uses sensors upstream of a work zone and displays messages on dynamic message signs to warn drivers about stopped or slowed traffic ahead.

Route guidance around work zones advises drivers of alternative routes when work zones necessitate lane closures or other types of diversions.

Temporary traffic signal is installed for a limited time and then removed when conditions no longer warrant a signal.

Travel time system measures actual traffic flow conditions using vehicle travel time detectors and displays current travel time information (e.g., on messaging signs, websites, etc.).

Variable speed limit uses current traffic conditions to determine the appropriate speed at which drivers should be traveling and displays this information on dynamic message signs.

Traveler Information

24. [ASK ALL] **What methods does your agency use to disseminate real-time traveler information about arterials?** *Please select all that apply.*

- ❑ 511
- ❑ Social media
- ❑ Email or text/SMS alert
- ❑ Agency-branded mobile application (e.g., white-label commercial app, custom built)
- ❑ Third party mobile app (e.g., Google Maps, Waze)
- ❑ Dynamic message signs (permanent and/or portable)
- ❑ Website
- ❑ Highway Advisory Radio
- ❑ Other (please specify): _______________
- ❑ No real-time traveler information about arterials is disseminated

25. [ASK ALL] **Does your agency provide an open data feed that shares real-time transportation-related data using data standards/specifications?** *Please select one.*

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

25a. (+) [IF Q25=YES] **What data standards/specifications are used to share real-time transportation-related data in your agency's open data feed?**

- ❑ Work Zone Data Exchange (WZDx) specification
- ❑ Traffic Management Data Dictionary (TMDD) standard
- ❑ PC5-based C-V2X specification (5.9GhZ)
- ❑ Other communications interface, data format, and/or protocol (please specify): ________
- ❑ Don't know

DEFINITIONS SHOWN IN HOVER BOXES:

Work Zone Data Exchange (WZDx) specification enables infrastructure owners and operators (IOOs) to make harmonized work zone data available for third-party use. The goal of WZDx is to enable widespread access to up-to-date information about dynamic conditions occurring on roads such as construction events.

Traffic Management Data Dictionary (TMDD) standards were developed to support center-to-center communications. TMDD provides the dialogs, message sets, data frames, and data elements to manage the shared use of Intelligent Transportation Systems (ITS) devices and the regional sharing of data and incident management responsibility.

PC5-based C-V2X specification (5.9GhZ) uses device-to-device radio access technology for direct low latency connectivity between user equipment within a wide-area network independent of the traditional cellular network.

Parking Management Capabilities

26. [ASK ALL] **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 – SKIP TO Q28
- ○ Don't know – SKIP TO Q28

27. [IF Q26=YES] **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

Connected Vehicle Technologies

This section includes questions about your agency's deployment of connected vehicle (CV) technologies. Your responses should only include CV technologies deployed on ARTERIALS (do not include CV deployment on freeways.

28. (+) [ASK ALL] **Is your agency currently developing, testing, or deploying connected vehicle (CV) technology on arterials?** *Please select one.*
- ○ Yes – SKIP TO Q31
- ○ No, but my agency is planning for CV
- ○ No plans for CV – SKIP TO Q36
- ○ Don't know – SKIP TO Q36

DEFINITION SHOWN IN HOVER BOX:

Connected vehicle (CV) technologies enable vehicles, roadway infrastructure, and mobile devices to wirelessly exchange data and "talk" to one another. Connected vehicles encompass vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-pedestrian (V2P) communications, collectively known as "V2X." When integrated into a vehicle, roadway infrastructure, or mobile device, these technologies can deliver significant transportation safety, mobility, and environmental benefits.

29. (+) [IF Q28 = NO, BUT PLANNING FOR CV] **Does your agency have any documented plans (e.g., internal planning documents, State Transportation Improvement Plan (STIP), etc.) to develop, test, or deploy connected vehicle technology on arterials?** *Please select one.*
- ○ Yes
- ○ No
- ○ Don't know

30. (+) [IF Q28 = NO, BUT PLANNING FOR CV] **When do you expect to begin developing, testing, or deploying connected vehicle technology on arterials?** *Please select one.*
- ○ Within the next 3 years – SKIP TO Q36
- ○ In 3 to 6 years – SKIP TO Q36
- ○ In 7 or more years – SKIP TO Q36
- ○ Don't know – SKIP TO Q36

31. (+) [IF Q28 = YES] **Is your agency deploying roadside units (RSUs) on arterials to support connected vehicle and/or automated vehicle testing/deployment?** *Please select one.*

- ○ Yes
- ○ No – SKIP TO Q34
- ○ Don't know – SKIP TO Q34

32. (+) [IF Q31 = YES] **Approximately how many roadside units (RSUs) is your agency currently testing or deploying on arterials?** *Please select one.*

- ○ 1-10
- ○ 11-50
- ○ 51-150
- ○ 151 or more

33. (+) [IF Q31 = YES] **On arterials, what standard data structures are being transmitted for your connected vehicle system (e.g., from your roadside units, connected vehicles, etc.)?** *Please select all that apply.*

- ❑ Basic Safety Message (BSM)
- ❑ MAP data
- ❑ Pedestrian Safety Message (PSM)
- ❑ Position Correction Message (RTCM)
- ❑ Roadside Safety Message (RSM)
- ❑ Sensor Data Sharing Message (SSDM)
- ❑ Signal Phase and Timing (SPaT)
- ❑ Signal Request Message (SRM)
- ❑ Signal Status Message (SSM)
- ❑ Traveler Information Message (TIM)
- ❑ Other (please specify): __________
- ❑ Don't know

34. (+) [IF Q28 = YES] **Is your agency developing, testing, or deploying any connected vehicle applications for use on arterials, including in-vehicles (i.e., using an onboard unit (OBU), Human Machine Interface (HMI), or similar) or among pedestrians or cyclists (i.e., using a handheld device)?** *This may include applications that your agency is testing either on its own fleet or in partnership with automakers/original equipment manufacturers. Please select one.*

- ○ Yes
- ○ No – SKIP TO Q36
- ○ Don't know – SKIP TO Q36

35. (+) [IF Q34 = YES] **Which connected vehicle (CV) applications is your agency developing, testing, or deploying on arterials?** *This may include applications that your agency is testing either on its own fleet or in partnership with automakers/original equipment manufacturers. Please select all that apply.*

Safety Applications (Vehicle to Infrastructure (V2I)):

- ❑ Curve Speed Warning (CSW)
- ❑ Pedestrian in Signalized Crosswalk Warning
- ❑ Red Light Violation Warning (RLVW)
- ❑ Reduced Speed/Work Zone Warning (RSWZ)

Safety Applications (Vehicle to Vehicle (V2V)):

- ❑ Blind Spot/Lane Change Warning (BSW/LCW)
- ❑ Emergency Electronic Brake Lights (EEBL)
- ❑ Forward Collision Warning (FCW)
- ❑ Intersection Movement Assist (IMA)
- ❑ Vehicle Turning Right in Front of Bus Warning (VTRFBW)

Mobility Applications:

- ❑ Emergency Vehicle Preemption (PREEMPT)
- ❑ Freight Signal Priority
- ❑ Integrated Dynamic Transit Operations (IDTO) (e.g., Connection Protection (T-CONNECT), Dynamic Transit Operations (T-DISP), and Dynamic Ridesharing (D-RIDE))
- ❑ Intelligent Traffic Signal System (I-SIG)
- ❑ Queue Warning (Q-WARN)
- ❑ Transit Signal Priority

Environment Applications:

- ❑ Dynamic Eco Routing
- ❑ Eco-Approach and Departure at Signalized Intersections

Agency and Road Weather Applications:

- ❑ Agency Data Applications (e.g., probe data collection, CV-enabled data collection etc.)
- ❑ Road Weather Warnings (e.g., Motorist Advisories and Warnings (MAW); Enhanced Maintenance Decision Support System (MDSS))

Other CV Applications being developed, tested, or deployed:

Please specify any other CV applications: ______________________________

DEFINITIONS SHOWN IN HOVER BOXES:

Curve Speed Warning (CSW) alerts a driver if current speed is too fast for an approaching curve.

Pedestrian in Signalized Crosswalk Warning notifies a driver when a pedestrian is using a crosswalk in the vehicle's projected path.

Red Light Violation Warning (RLVW) issues a warning when a driver is about to run a red light.

Reduced Speed/Work Zone Warning (RSWZ) alerts a driver to use caution when traveling through a work zone.

Blind Spot/Lane Change Warning (BSW/LCW) alerts a driver changing lanes if there is a vehicle in the driver's blind spot.

Emergency Electronic Brake Lights (EEBL) application notifies a driver if there is a sudden-braking vehicle ahead (or several vehicles ahead).

Forward Collision Warning (FCW) alerts a driver when a vehicle ahead is stopped or traveling slower and there is a risk of a rear-end collision.

Intersection Movement Assist (IMA) warning notifies a driver if it is not safe to enter an intersection - for example, if another vehicle is running a red light or making a sudden turn.

Vehicle Turning Right in Front of Bus Warning (VTRFBW) notifies a bus driver when a vehicle attempts to turn right in front of the bus as the bus pulls away from a bus stop.

Emergency Vehicle Preemption (PREEMPT) is an application that gives emergency response vehicles a green light on their approach to a signalized intersection, allowing them to proceed through the intersection more quickly and under safer conditions.

Freight Signal Priority gives signal priority to freight vehicles approaching a signalized intersection, taking into consideration the vehicle’s location, speed, type, and weight.

Integrated Dynamic Transit Operations (IDTO) includes three applications that improve transit mobility, operations, and services: Transfer Connection Protection dynamically holds vehicles at bus stops to meet with connecting passengers; Dynamic Transit Operations adjusts transit routing to pick up passengers or avoid congestion; and Dynamic Rideshare facilitates first-mile and last-mile shared riders.

Intelligent Traffic Signal System (I-SIG) uses high-fidelity data collected from vehicles (through V2V and V2I wireless communications), pedestrian, and non-motorized travelers to control traffic signals and maximize flows in real time, and

may also seek to optimize overall network performance (i.e., accommodating transit or freight signal priority, preemption, and pedestrian movements).

Queue Warning (Q-WARN) provides a vehicle operator with sufficient warning of an impending queue backup, allowing the operator to brake safely, change lanes, or modify the route such that secondary collisions can be minimized or even eliminated. It is distinct from collision warning, which pertains to events or conditions that require immediate or emergency actions.

Transit Signal Priority is an application that allows transit agencies to manage bus service by granting buses priority at intersections. Decisions are made using information communicated by the transit vehicle (e.g., passenger count data, service type, scheduled and actual arrival time, and heading information) to roadside equipment via an on-board device.

Dynamic Eco-Routing application determines the most eco-friendly route, in terms of minimum fuel consumption or emissions, for individual travelers. This application recommends routes that produce the fewest emissions or reduce fuel consumption based on historical, real-time, and predicted traffic and environmental data (e.g., prevailing weather conditions).

Eco-Approach and Departure at Signalized Intersections is an application that uses traffic signal phase and timing (SPaT) data to determine speed advice that can be presented to drivers, allowing them to adapt their vehicle's speed to pass the next traffic signal on green or to decrease to a stop in the most eco-friendly manner.

Agency Data Applications include applications used to collect, transmit, analyze, or report local data related to traffic conditions, road conditions, travel patterns, or other metrics. Examples include: Probe-based Pavement Maintenance, Probe-based Traffic Monitoring, CV-enabled Origin-destination Studies, Work Zone Travel Information applications, etc.

Road Weather Warnings issue alerts and advisories to travelers about deteriorating road and weather conditions on specific roadway segments.

Automated Vehicle Technologies

This section asks about automated vehicle tests and deployments **on arterials**; your responses should also include any pilots or demonstrations related to automated vehicles.

36. (+) [ASK ALL] **Has your agency participated in any automated vehicle (AV) tests or deployments on arterials in the last five years?** *Please select all that apply.*

- ❑ Yes, my agency is leading or has led AV testing/deployment (i.e., completed or in progress) – SKIP TO Q39
- ❑ Yes, my agency is supporting or has supported the planning or execution of AV testing/deployment – SKIP TO Q39
- ❑ No, my agency is not participating in any AV testing/deployment
- ❑ Don't know

DEFINITION SHOWN IN HOVER BOX:

Automated vehicles (AVs) are those in which at least some aspect of a safety-critical control function (e.g., steering, throttling, or braking) occurs without direct driver input. AVs may include light duty vehicles, transit vehicles, commercial motor vehicles, and small delivery devices, among others. Automated vehicles are widely categorized by their levels of driving automation defined by the Society of Automotive Engineers (SAE). These levels begin with Level 0 (no driving automation) and conclude with Level 5 (full driving automation).

37. (+) [IF Q36 = NO or DON'T KNOW] **Does your agency have any documented plans (e.g., planning documents, State Transportation Improvement Plan (STIP), etc.) to participate in automated vehicle (AV) testing or deployment on arterials in the future?** *Please select one.*

- ○ Yes, my agency has a documented plan
- ○ No, but my agency is considering AV testing or deployment
- ○ No, my agency is not considering AV testing or deployment – SKIP TO Q42
- ○ Don't know – SKIP TO Q42

38. (+) [IF Q37 =YES HAS PLAN OR CONSIDERING AV)] **When does your agency expect to participate in automated vehicle testing or deployment on arterials?** *Please select one.*

- ○ Within the next 3 years – SKIP TO Q42
- ○ In 3 to 6 years – SKIP TO Q42
- ○ In 7 or more years – SKIP TO Q42
- ○ Don't know – SKIP TO Q42

39. a. (+) [IF Q36 = AGENCY SUPPORTING (AND ONLY OPTION 2 SELECTED)]: **Which entity(ies) are/were leading the automated vehicle testing or deployment on arterials?** *Please select all that apply.*

- ❑ Automakers or Original Equipment Manufacturers (OEMs), including Transit Vehicle Manufacturers
- ❑ Advanced Driver Assistance Systems (ADAS) Developers (or Driver Support Features Developers)
- ❑ Automated Driving Systems (ADS) Developers
- ❑ Transportation Network Companies (TNCs) (e.g., Uber or Lyft)
- ❑ State agencies
- ❑ Metropolitan Planning Organizations (MPOs)
- ❑ Universities
- ❑ Transit agencies
- ❑ Other local agencies
- ❑ Private sector consultants (please specify):
- ❑ Other (please specify): __________
- ❑ Don't know

39. b. (+) [IF Q36 = AGENCY LEADING (OPTION 1 ONLY) OR BOTH OPTIONS 1 AND 2] **For the automated vehicle testing or deployment on arterials that your agency is/was leading, what other entity(ies) are/were you partnering with?** *Please select all that apply.*

- ❑ Automakers or Original Equipment Manufacturers (OEMs), including Transit Vehicle Manufacturers
- ❑ Advanced Driver Assistance Systems (ADAS) Developers (or Driver Support Features Developers)
- ❑ Automated Driving Systems (ADS) Developers
- ❑ Transportation Network Companies (TNCs) (e.g., Uber or Lyft)
- ❑ State agencies
- ❑ Metropolitan Planning Organizations (MPOs)
- ❑ Universities
- ❑ Transit agencies
- ❑ Other local agencies
- ❑ Private sector consultants (please specify):
- ❑ Other (please specify): __________
- ❑ Don't know

40. (+) [IF Q36 = AGENCY LEADING OR SUPPORTING] **Which of the following automated vehicle (AV) tests or deployments on arterials has your agency led or supported in the last five years?** Please include Advanced Driver Assistance Systems (ADAS) or Automated Driving Systems (ADS) tests or deployments**.** *Please select all that apply.*

Automated Transit/ On-Demand Tests/Deployments:

- ❑ Automated Bus Rapid Transit (BRT)
- ❑ Automated Passenger Fixed Route
- ❑ Automated Passenger On-Demand
- ❑ Automated Maintenance and Bus Yard Operations

Automated Delivery/Freight/Commercial Motor Vehicle Tests/Deployments:

- ❑ Automated Personal Delivery Device (e.g., sidewalk delivery robot) – OMIT FROM Q41
- ❑ Automated Last Mile Delivery (e.g., light duty vehicle) – OMIT FROM Q41
- ❑ Automated Regional or Long-Haul Trucking – OMIT FROM Q41
- ❑ Truck Platooning – OMIT FROM Q41
- ❑ Automated Logistics Yard Operations (e.g., automated yard trucks) – OMIT FROM Q41
- ❑ Construction or Maintenance Operations (e.g., automated truck mounted attenuators) – OMIT FROM Q41

Automated Light Duty Passenger Vehicle Tests/Deployments:

- ❑ Automated light duty passenger vehicle test/deployment – OMIT FROM Q41

Other AV Tests/Deployments on arterials:

- ❑ Other AV test/deployment (please specify): ________ – OMIT FROM Q41

DEFINITIONS SHOWN IN HOVER BOXES:

Automated Bus Rapid Transit (BRT) applies rail transit concepts to automated buses to deliver fast and efficient service. These concepts focus on eliminating causes of delay that typically slow regular bus services and may include dedicated lanes, busways, traffic signal priority, off-board fare collection, platforms, and enhanced stations.

Automated Passenger Fixed Route service provides rides along a single route with pre-defined stops and a set schedule. The route may be limited to closed environments, such as parking lots, busways, campuses, and retirement communities, or it may operate in mixed traffic on public roads in areas, such as business parks or downtown districts.

Automated Passenger On-Demand provides on-demand service between any two addresses within a defined service area. The concept is similar to the automated passenger fixed route service; however, it is not restricted to predefined routes or schedules - users can request pick-ups and drop-offs on demand (e.g., using an application on a smartphone, tablet, or kiosk).

Automated Maintenance and Bus Yard Operations is the deployment of automated driving systems (ADS) on transit vehicles for use within the domain of the bus yard. Use cases may include precision movement for fueling/recharging, maintenance, disinfection/bus wash, or automated parking and recall.

Automated Delivery Device (e.g., sidewalk delivery robot) testing/deployment includes automated delivery devices (i.e., robots) that navigate using GPS, sensors and cameras, allowing them to operate on sidewalks or other pedestrian areas, making deliveries in limited-service areas.

Automated Last Mile Delivery (e.g., light duty vehicle) uses automation to deliver goods over short distances on local roadways from business to consumer.

Automated Regional or Long-Haul Trucking applies automation to trucking. Automated trucking generally refers to SAE Level 3-5 automation, where the automated driving system is primarily responsible for monitoring the driving environment.

Truck Platooning incorporates on-board computers, vehicle sensors, and automated driving technology, allowing equipped long-haul trucks to communicate with each other and travel closely together on the highway (40 to 50 feet apart) to improve fuel efficiency and reduce vehicle emissions.

Automated Logistics Yard Operation is the deployment of automation (e.g., robots, yard trucks with automated driving systems) to perform logistics tasks in the yard. For example, this may include moving trailers from one part of the yard to another.

Construction or Maintenance Operations (e.g., automated truck mounted attenuator) is the deployment of automated driving systems (ADS) on commercial vehicles for the purpose of performing construction and maintenance activities on the road.

Automated light duty passenger vehicle test/deployment: Use this category for any light-duty passenger vehicle test/deployment not covered in other categories.

41. (+) **For your** [Q41 = AUTOMATED BUS RAPID TRANSIT/ AUTOMATED PASSENGER FIXED ROUTE/AUTOMATED PASSENGER ON DEMAND/AUTOMATED MAINTENANCE AND BUS YARD OPERATIONS] **test or deployment, which type of vehicle is being used?** *Please select all that apply.*

- ❑ Full-sized transit bus
- ❑ Articulated bus
- ❑ Motorcoach (over the road bus)
- ❑ Cutaway bus or minibus
- ❑ Novel-design low-speed shuttle
- ❑ Light-duty passenger vehicle (e.g., car, van, SUV)
- ❑ Other (please specify): ______________________
- ❑ Don’t know

Telecommunications

42. [ASK ALL] **What type of telecommunications technologies does your agency use to enable Intelligent Transportation Systems (ITS) on arterial roadways?** *Please select all that apply.*

Wired:

- ❑ Coaxial – OMIT FROM Q43
- ❑ Fiber-optic cable – OMIT FROM Q43
- ❑ 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)
- ❑ Dedicated short range communications (DSRC)
- ❑ Wi-Fi
- ❑ Mobile or Fixed service satellite (FSS) – OMIT FROM Q43
- ❑ Ultra-wideband (UWB)
- ❑ Microwave – OMIT FROM Q43
- ❑ Other telecommunications (wired and/or wireless) (please specify): _______ – OMIT FROM Q43
- ❑ Don't know – SKIP TO Q44
- ❑ No telecommunications used to enable ITS on arterials – SKIP TO Q44
- ❑ No ITS infrastructure or devices are deployed – SKIP TO Q44

DEFINITIONS SHOWN IN HOVER BOXES

Coaxial cable is mainly used to provide communications between field controllers and a central controller. Coaxial cables have an inner conductor, insulating layer, conductive shielding, and protective outer jacket.

Fiber-optic cables transmit large amounts of information over long distances (e.g., camera images) through use of many super-thin strands of optical glass fiber.

Twisted copper pair/Twisted wire pair is composed of two insulated copper wires twisted around one another. This is mainly used to provide basic telephone services and ethernet over short distance.

Digital subscriber line (DSL) is a wireline transmission technology that uses existing infrastructure to provide integrated traffic video and field device communications. This includes all forms of DSL (e.g., ADSL, RADSL, HDSL, SDSL).

Data cable over modem service enables operators to provide broadband using standard cable lines (e.g., 56 kilobits/second).

5G New Radio and 5G small cell infrastructure (which communicates over very short distances) represents the newest generation of cellular data communication. The 5G New Radios can operate within and share existing 4G LTE infrastructure in non-standalone (NSA) mode (e.g., cell towers). The other critical component of 5G, small cell infrastructure, consists of small antennae placed in the public right-of-way to act as a high-speed intermediary between a field device and the larger cell tower.

Cellular (LTE-4G) is the fourth generation of cellular data communication. LTE (Long Term Evolution) is standard to 4G and is both forward and backward compatible. Cellular LTE 4G operates in 600 MHz, 700 MHz, 850 MHz, 1.7 GHz, 1.9 GHz, 2.3 GHz, 2.5 GHz spectrum.

Cellular GPRS – 2G or 3G are the older generations of cellular data communications and are being phased out. These generations of cellular rely on radio signals in a digital format and operate in the 470-690 MHz, 690-805 MHz, 1.850-1.995 GHz spectrum.

LTE-Cellular V2X (LTE-CV2X) operates in the reduced 5.895-5.925 GHz spectrum, known as the Safety Band (dedicated for safety-of-life and public benefit transportation purposes). LTE-CV2X is intended to service connected vehicle technology.

Dedicated short range communications (DSRC) is two-way radio communication operating in the reduced 5.895-5.925 GHz spectrum, currently known as the Safety Band (dedicated for safety-of-life and public benefit transportation purposes). The Federal Communications Commission (FCC) is planning to phase out DSRC in the future.

Wi-Fi provides wireless high-speed internet access or communications between devices (point-to-point or point-to-multipoint). It includes agency-installed Wi-Fi access points and client devices, or subscription-based Wi-Fi in the 2.4 GHz, 5.8 GHz, and (recently) 6 GHz spectrum.

Mobile or Fixed service satellite (FSS) provides radio communication between two or more fixed or mobile receivers. MSS or FSS allows uploading/downloading data across a wide range (137 MHz-51.4 GHz) of spectrum in the form of space-to-earth, earth-to-space, or broadcast communications.

Ultra-wideband (UWB) is a short-range communication technology ideal for transmitting data at high speeds between devices 10 to 30 meters apart, using any spectrum as unlicensed communications (similar to radar).

Microwave (also known as Ultra High Frequency (UHF) or Extremely High Frequency (EHF)) communicates as fixed point-to-point backhaul or as very short-range, line-of-sight radar/Lidar communications, typically between 300 MHz and 300 GHz spectrum.

43. (+) [IF Q42 = EACH TELECOM TECH CHECKED EXCEPT FOR COAXIAL, FIBER OPTIC CABLE, FSS, and MICROWAVE; **Please indicate how your agency is using the telecommunication technology(ies) shown below to enable ITS on arterials.**

Each of the use cases listed is based on the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) service packages. Click this link for more information: https://www.arc-it.net/html/servicepackages/servicepackages-areaspsort.html. *Please select all that apply in each column.*

- ❑ Commercial Vehicle Operations
- ❑ Data Management
- ❑ Maintenance and Construction
- ❑ Parking Management
- ❑ Public Safety
- ❑ Public Transportation
- ❑ Support
- ❑ Sustainable Travel
- ❑ Traffic Management

- ❑ Traveler Information
- ❑ Vehicle Safety
- ❑ Weather
- ❑ Other (please specify):____________________
- ❑ Don't know

EXAMPLES SHOWN IN HOVER BOXES:

Commercial Vehicle Operations: Examples include commercial vehicle parking, smart roadside and weigh in motion, roadside commercial vehicle operator safety, freight-specific dynamic travel planning, HAZMAT management, etc.

Data Management: The two relevant service packages are ITS data warehouse and performance monitoring.

Maintenance and Construction: Examples include maintenance and construction vehicle maintenance, winter maintenance, roadway maintenance and construction, work zone management, maintenance and construction signal priority, asset tracking, etc.

Parking Management: Examples include parking space management, smart park and ride system, parking electronic payment, regional parking management, etc.

Public Safety: Examples include emergency response, mayday notification, incident scene safety monitoring, disaster response and recovery, disaster traveler information, etc.

Public Transportation: Examples include dynamic transit operations, transit fare collection management, transit security, transit fleet management, transit signal priority, intermittent bus lanes, etc.

Support: Examples include connected vehicle system monitoring and management, map management, ITS communications, location and time, security and credentials management, field equipment maintenance, etc.

Sustainable Travel: Examples include emissions monitoring, eco-traffic signal timing, roadside lighting, electric charging stations management, etc.

Traffic Management: Examples include infrastructure-based traffic surveillance, vehicle based traffic surveillance, connected vehicle traffic signal system, traffic incident management system, variable speed limits, speed harmonization, etc.

Traveler Information: Examples include broadcast traveler information, dynamic route guidance, infrastructure-provided trip planning and route guidance, dynamic ridesharing, and shared use transportation, etc.

Vehicle Safety: Examples include autonomous vehicle safety systems, V2V basic safety, situational awareness, curve speed warning, pedestrian and cyclist safety, stop sign gap assist, automated vehicle operations, etc.

Weather: Examples include weather data collection, weather information processing and distribution, spot weather impact warning, etc.

44. [ASK ALL] **If your agency has any notes or additional information about its use of telecommunications, please provide below.**

Maintenance of Arterial ITS Technology

45. [ASK ALL] **Does your agency utilize an <u>asset management system</u> to track Intelligent Transportation Systems (ITS) inventory and/or ITS maintenance and operations activity on arterials?** *Please select all that apply.*

- ❑ Yes, system tracks inventory of ITS field devices
- ❑ Yes, system tracks inventory of ITS central systems / software
- ❑ Yes, system tracks maintenance and operations of ITS field devices
- ❑ Yes, system tracks maintenance and operations of ITS central systems / software
- ❑ No, my agency does not have an ITS asset management system
- ❑ Not applicable, my agency has not deployed ITS – SKIP TO Q47

DEFINITION SHOWN IN HOVER BOX: An ITS **asset management system** is a software system, procedure, or tool that assists an agency in managing and maintaining data on ITS assets across the entire lifecycle of these assets, from acquisition to disposal. For more information see: https://ops.fhwa.dot.gov/publications/fhwahop20047/chap4.htm.

46. (+) [EXCLUDE IF Q45 = OPTION 6 NO ITS] **What is your agency's primary approach for conducting maintenance activities on arterial ITS assets?** *Please select one.*

- o My agency primarily schedules maintenance based on the regularly monitored condition of arterial ITS assets.
- o My agency primarily schedules maintenance of arterial ITS assets based on regular intervals.
- o My agency primarily conducts maintenance in response to reported arterial ITS asset failures or events, such as a vehicle collision or component failure.
- o Other (please specify): _______________
- o Don't know

Transportation Systems Management and Operations (TSMO) Plan

47. [ASK ALL] **Does your agency have a Transportation Systems Management and Operations (TSMO) Plan?** *Please select one.*

- o Yes
- o No, but my agency plans to develop a TSMO Plan
- o No current plans to develop a TSMO Plan

Cybersecurity

48. [ASK ALL] **Does your agency have a documented cybersecurity policy that explicitly addresses Intelligent Transportation Systems (ITS) technologies/equipment?** *Please select one.*

- ○ My agency has a cybersecurity policy which explicitly addresses ITS. – SKIP TO Q50
- ○ My agency's general cybersecurity policy (i.e., for information technology (IT)) is applied to ITS.
- ○ My agency's ITS is not covered by a cybersecurity policy.
- ○ My agency has not deployed ITS technologies/equipment. – SKIP TO Q51
- ○ Don't know – SKIP TO Q50

49. [IF Q48 = OPTIONS 2 or 3] **Is your agency planning to develop a cybersecurity policy that explicitly addresses ITS technologies/equipment?** *Please select one*

- ○ Yes
- ○ No
- ○ Don't know

50. (+) [EXCLUDE IF Q 48 = OPTION 4 NO ITS] **In the last five years, has your agency conducted <u>incident response exercises</u> that include ITS equipment/technologies to prepare for ITS cybersecurity events?** *Please select one.*

- ○ Yes, my agency's incident response exercises have included ITS equipment/technologies
- ○ No, my agency's incident response exercises have not included ITS equipment/technologies
- ○ No, my agency has not conducted incident response exercises in the last five years
- ○ Don't know

DEFINITION SHOWN IN HOVER BOX: **Incident response exercises** are agency-run tests of protocols that mitigate violations of security policies and recommended practices.

51. a. [EXCLUDE IF Q 48= OPTION 4 NO ITS] **In the last three years, has your agency had any cybersecurity events or attacks (e.g., ransomware, data breach) that affected its <u>information technology (IT) system</u> and/or ITS technologies/equipment on arterials?** *Please select all that apply.*

If your agency has experienced multiple events or attacks, please respond based on all experiences.

- ❑ Yes, affecting IT system
- ❑ Yes, affecting ITS technologies/equipment
- ❑ No – SKIP TO Q54
- ❑ Don't know – SKIP TO Q54

51. b. [ASK IF Q 48 = OPTION 4 NO ITS] **In the last three years, has your agency had any cybersecurity events or attacks (e.g., ransomware, data breach) that affected its information technology (IT) system?**

If your agency has experienced multiple events or attacks, please respond based on all experiences.

- ❑ Yes – SKIP TO Q53
- ❑ No – SKIP TO Q54
- ❑ Don't know – SKIP TO Q54

DEFINITION SHOWN IN HOVER BOX:
Information technology (IT) systems include personal computers or commercial servers along with the network equipment to connect this equipment together.

52. (+) [IF Q51 = YES (OPTIONS 1 OR 2)] **What was (or were) the initial point(s) of entry for the cybersecurity event(s) or attack(s)?** *Please select all that apply. If your agency has experienced multiple events or attacks, please respond based on all experiences.*

- ❑ IT system
- ❑ ITS equipment/technologies
- ❑ Don't know

53. (+) [IF Q51a = YES (OPTIONS 1 OR 2) OR Q51b = YES] **Did any of the cybersecurity event(s) or attack(s) affect transportation system operations on arterials?** *Please select one.*

- ○ Yes
- ○ No
- ○ Don't know

Regional ITS Architecture

54. (+) [ASK ALL] **Is your agency/region covered by a Regional (or State) Intelligent Transportation Systems (ITS) Architecture?**

- ○ Yes
- ○ No – SKIP TO Q57
- ○ Don't know – SKIP TO Q57
- ○ Not familiar or never heard of a Regional ITS Architecture – SKIP TO Q57

DEFINITION SHOWN IN HOVER BOX

A **Regional ITS Architecture** is a plan for institutional and technical integration of ITS in a region or state. A Regional ITS Architecture uses the National ITS Architecture (which provides a common framework for planning, defining, and integrating ITS deployments) as the template for its definition, including only the systems and services that are planned for implementation in the local area or state. For more information about the Regional ITS Architecture, please see: https://ops.fhwa.dot.gov/its_arch_imp/index.htm. For more information about the National ITS Architecture see: https://www.arc-it.net/.

55. (+) [IF Q54 = YES] **Is your agency using your Regional (or State) ITS Architecture to support ITS deployments on arterials?** *Please select one.*

- o Yes, for all ITS deployments – SKIP TO Q57
- o Yes, for some ITS deployments – GO TO Q56b
- o No, my agency does not use our Regional ITS Architecture – GO TO Q56a
- o Not applicable (i.e., my agency does not use federal funds for ITS deployment OR my agency has not deployed ITS) – SKIP TO Q57
- o Don't know – SKIP TO Q57

56. a. (+) [IF Q55=OPTION 3 NO DOES NOT USE]: **What are key reasons for NOT using your Regional ITS Architecture to support arterial ITS deployments?** *Please select all that apply.*

56. b. (+) [IF Q55=OPTION 2 YES FOR SOME ITS DEPLOYMENTS]: **What are key reasons for NOT using your Regional ITS Architecture to support all of your arterial ITS deployments?** *Please select all that apply.*

- ❑ Lack of experience/technical expertise with the Regional ITS Architecture
- ❑ The Regional ITS Architecture is out of date
- ❑ The scope and/or scale of my agencies' ITS projects are generally too small
- ❑ No perceived technical or operational benefit to using the Regional ITS Architecture
- ❑ Other (please specify): ______________________________

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.

57. [ASK ALL] **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*.

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

Agency Coordination

58. [ASK ALL] **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	○	○
Incident severity and type	○	○

59. [ASK ALL] **Does your agency PROVIDE 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.* SCRIPTING NOTE: It should not be required that respondents respond to yes/no to any of the options. If select no for "Other," should not be able to fill in the "Other" box.

	Arterial Traffic Information	
	Yes	*No*
Freeway management agencies	○	○
Arterial management agencies	○	○
Public transit agencies	○	○
Law enforcement public safety agencies	○	○
Fire rescue public safety agencies	○	○
Other agencies (please specify)	○	○

Future Deployment Planning

60. [ASK ALL] **Does your agency plan to expand or upgrade current ITS on arterials during the next three years (2024 through 2026)?** *Please select one.*

- ○ Yes
- ○ No
- ○ Don't know
- ○ Not applicable, my agency has not deployed ITS

61. [ASK ALL] **Does your agency plan to invest in new or emerging ITS on arterials during the next three years (2024 through 2026)?** *Please select one.*

- ○ Yes
- ○ No – SKIP TO Q63
- ○ Don't know – SKIP TO Q63

62. [IF Q61 = YES] **Please describe new or emerging ITS technologies your agency plans to invest in:**

Additional Comments

63. 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.

64. 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 Q65

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

64b. The phone number we have on file is [RESPONDENT PHONE]**. If this is not your preferred phone number, please provide your preferred phone number below:**

64c. The email address we have on file is [RESPONDENT EMAIL]**. If this is not your preferred email, please provide your preferred email address below:**

65. 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!

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