

# Deployment of Intelligent Transportation Systems: A Summary Of the 2013 National Survey Results

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<b>16. Abstract</b> <p>This report presents summary results of the 2013 ITS Deployment Tracking survey, the most recent survey conducted by the ITS Deployment Tracking Project. The U.S. Department of Transportation and the ITS Joint Program Office have pursued a research and development agenda, the Intelligent Transportation System (ITS) Program, designed to integrate the latest in information technologies to improve the safety, mobility, and reliability of surface transportation modes. Within metropolitan areas, implementation of these advanced technologies has been carried out by a variety of state and local transportation agencies. In order to measure the rate of ITS deployment within the nation's largest metropolitan areas, the ITS Deployment Tracking Project has conducted a nationwide survey of state and local transportation and emergency management agencies nearly every year since 1997.</p> <p>The results presented in this report are a summary of the database from the 2013 survey. Access to the complete survey results and results from previous national surveys is available on-line at <a href="http://www.itsdeployment.its.dot.gov">http://www.itsdeployment.its.dot.gov</a>. The website also provides access to survey results in the form of downloadable reports, including a survey summary for each survey type and fact sheets. Nearly 2100 surveys were distributed to state and local transportation agencies in 2013. A total of seven (7) survey types were distributed including: Freeway Management, Arterial Management, Transit Management, Transportation Management Center (TMC), Electronic Toll Collection (ETC), Public Safety – Law Enforcement, and Public Safety – Fire/Rescue.</p>					
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The conclusions expressed in this document reflect solely the opinions of the authors and do not represent the opinions of the U.S. Department of Transportation.



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# Executive Summary

Continuing advancement in communications, electronics, and computing offers the opportunity to revolutionize the management and operation of the surface transportation system. The U.S. Department of Transportation and its member agencies have pursued a research and development agenda, the Intelligent Transportation System (ITS) Program, designed to integrate the latest in information technologies to improve the safety, mobility, and reliability of surface transportation. Within metropolitan areas, implementation of these technologies has been carried out by a variety of state and local transportation management agencies. In order to measure the deployment of ITS technology nationally, the ITS Deployment Tracking Project surveys transportation agencies in the largest U.S. cities on a regular basis. The Deployment Tracking Project has conducted national surveys on a regular basis since 1997, with the most recent previous survey conducted in 2010. This report presents results of the 2013 National ITS Deployment Tracking survey.

This report provides an overview of the key findings from the 2013 national survey. Access to the complete database of the survey results is available through the ITS Deployment Tracking Website at: <http://www.itsdeployment.its.dot.gov/>. The website supports searches of the database and access to a variety of downloadable reports. In addition, the site supports download of the survey results database in a variety of formats.

As summarized in Table ES1 nearly 2,100 surveys were distributed to state and local transportation agencies in 2013. A total of seven survey types were distributed, targeting the key agencies within a metropolitan transportation infrastructure: freeway management, arterial management, transit management, transportation management center (TMC), electronic toll collection (ETC), public safety – law enforcement, and public safety – fire/rescue.

**Table ES1. 2013 ITS Metropolitan Deployment Tracking Survey Response Rate by Agency Type**

Survey	Agency Type	Sent	Returned	% Returned
Freeway Management	Freeway	147	109	74%
Arterial Management	Arterial	514	310	60%
Transit Management	Transit	221	142	64%
Transportation Management Center (TMC)	TMC	252	191	76%
Electronic Toll Collection (ETC)	Toll road Operator	73	56	77%
Public Safety – Law Enforcement	Law Enforcement	516	317	61%
Public Safety – Fire/Rescue	Fire/Rescue	368	250	68%
Totals		2091	1375	66%

The overall response rate for all surveys was 66%. This response rate was somewhat lower than that of the 2010 survey, which was 85% overall. The main reason for this difference appears to be the impact of staff reductions at state and local agencies as the result of reductions in funding from 2010

to 2013. The project team received feedback from numerous agencies that due to staff reductions, workloads had increased to the point that respondents could not take the time to complete the survey. This problem was exacerbated by the increased length and complexity of the survey when compared to 2010. The 2013 survey covered new ground in a number of areas, including maintenance of ITS technologies, road weather management, ITS standards, Integrated Corridor Management, and planning for operations. The trade-off for targeting such a rich variety of data was an increase in the effort required of respondents. However, the impact of the lower response rate on the quality of the data turns out to be slight. More agencies were surveyed in 2013 than in 2010 and even with the lower overall response rate, the number of completed surveys in 2013 was actually higher than in 2010. While the rate of response was lower, the amount of data collected was very similar to the 2010 survey.

This report has four chapters. The first chapter covers data gathered on the opinions of respondents in a number of areas, including factors involved with the decision to purchase ITS, benefits of ITS technologies, and future deployment plans. The second chapter covers deployment data for key ITS technologies by each agency type. The third chapter covers new topic areas included in the 2013 survey that are cross-cutting and for which the survey data for each topic are combined in a single section rather than separately for each agency type. Chapter 4 repeats the summary findings emerging from the survey data.

## **Agency Opinions and Deployment Planning**

### **Future Deployment Plans**

Four of the seven surveys, targeting freeway, arterial, toll collection, and transit agencies, included questions about future ITS deployment plans, specifically whether the agency plans to expand current ITS coverage or to make investments in new technologies in the next three years. The results showed that more than half of the agencies are planning to expand their current coverage. Freeway agencies were in the lead, with more than 70% of freeway agencies planning to expand coverage or make new investments in the next three years. Additionally, interest in making future investments in ITS technology is growing--in every case the percentage of agencies planning new ITS investments in 2013 was higher than in 2010.

### **ITS Investment Decision Factors**

Freeway, arterial, transit, and toll collection agencies were asked to rank the importance of the following ten factors in making a decision to purchase ITS technology:

- Funding/grant availability,
- Integration with currently deployed technologies,
- Integration with other agencies,
- Mobility benefits,
- Cost of initial deployment,
- Cost to maintain and repair,
- Public/constituents involvement,
- Safety benefits,
- Technology already in use by another agency, and
- Environmental benefits.

Of these factors, cost was generally listed among the most important factors in making a deployment decision. Also typically included among the most important factors were safety benefits and integration with existing technologies, the latter indicating widespread appreciation for the technical issues involved with adding new systems to an existing infrastructure. Mobility was also important, but was ranked lower than safety in every case. Environmental benefits, public involvement, and use by other agencies were factors typically rated less important.

## Benefits of ITS

Another effort to assess agency opinions targeted the perception of benefits of major ITS technologies, based on a ranking by agency staff from their experience with the devices. Freeway and arterial agencies ranked cameras, traveler information, and sensors highest. Interestingly, ramp metering, lane control and traffic adaptive signals received high benefit ratings, even though they are currently not widely deployed. Transit agencies ranked the benefits of communications technologies very high, followed by automatic vehicle location (AVL), security cameras, and computer aided dispatch (CAD). Both freeway and transit agencies generally had higher ranking scores for individual technologies than arterial agencies.

## Planned Future Deployments

In order to assess future deployment plans more accurately, respondents were asked to specify the types of technologies they intend to purchase over the next three years. The results show that ITS deployment plans are focused on real-time transportation management and the collection and dissemination of traveler information. The future deployment plans of freeway agencies--dynamic message signs (DMS), closed circuit television (CCTV) cameras, detection systems, and Bluetooth probe readers—reflect this focus. Arterial agencies similarly plan to deploy DMS and cameras, but, in a major change from previous responses, they also plan to invest in traffic adaptive signals, additional detection, and traffic management software systems. Transit agencies most often reported planning to deploy CAD/AVL, real-time information dissemination, automated fare boxes, and scheduling software systems, all of which will provide better service to customers.

## Deployment Status and Trends

As in years past, the 2013 national survey gathered a wide variety of statistical data on the deployment of ITS technologies in metropolitan areas by transportation agencies. Deployment data are reported as *coverage*, expressed as the percentage of signalized intersections, miles of road or vehicles equipped; and *adoption*, expressed as the percentage of agencies that report having deployed the technology.

## Freeway Management

Freeway management deployments showed a substantial expansion of freeway miles covered by real-time traffic data collection technologies (up from an average of 56% in 2010 to 63% by 2013) and CCTV (increasing from 46% to 57% from 2010 to 2013). Also expanding significantly is the total number of DMS, which increased by nearly 10% from 2010 to 2013. The number of freeway agencies reporting the use of ITS technologies continued to expand in 2013 for CCTV cameras, DMS, and highway advisory radio (HAR). Freeway agencies are moving beyond traditional loop detectors to advanced technologies for data gathering--agencies using radar increased from 54% to 61% and probe readers from 24% to 36% (the adoption of Bluetooth probe readers was reported by 20% of freeway agencies compared to only 4% in 2010). The use of social media to distribute traveler

information expanded rapidly with the use of email and Twitter almost doubling and the use of Facebook and apps for mobile devices reported by over 40% of agencies. Nearly half of the freeway agencies reported disseminating traveler information gathered by deployed sensors, including travel time by segments and routes and road weather observations.

## **Arterial Management**

The coverage trends for arterial management deployment indicators, perhaps reflecting the concern expressed on funding issues in making deployment decisions are generally flat. The coverage of signalized intersections with transit priority, and miles of arterial roads covered by service patrols, CCTV, and HAR all showed little growth. The only outlier was a continuation of the expansion of the number of signalized intersections covered by electronic surveillance, increasing substantially to more than 60% of the intersections. While the growth in coverage of many well-established technologies was generally slow, the percentage of agencies adopting technologies that are relatively new for arterial agencies showed substantial expansion from 2010 to 2013. The percentage of agencies reporting the use of loop detectors grew to 88% and the use of video imaging detectors was reported by 75% of arterial agencies. The percentage of agencies deploying traffic adaptive signals increased from 9% to 18%, radar sensors from 13% to 31%, and Bluetooth readers from 2% to 10% from 2010 to 2013. Arterial agencies have followed the practice of freeway agencies in adopting the use of Twitter and other social media and mobile devices to distribute traveler information.

## **Incident Management**

Incident management deployment trends vary widely between freeway and arterial agencies. The coverage of CCTV and service patrols on freeways expanded to cover nearly 60% of the freeway mileage. However, both of these technologies showed a decline on arterials. Incident detection algorithms are less widely deployed for both agency types, likely reflecting the alternatives for incident detection from the expansion of CCTV and cellular phone reporting.

## **Transit management**

The trends for deployment of key technologies by transit agencies are positive. The use of CAD to control demand responsive buses expanded from 87% of the fleet in 2010 to virtual universal deployment in 2013. AVL is now in nearly 90% of fixed route buses, up from 66% in 2010. The use of real-time monitoring of vehicle systems now covers nearly 50% of the fixed route bus fleet, up from 36% in 2010. The percentage of agencies with AVL on fixed route busses increased from 54% in 2010 to 63% in 2013. Agencies using technology to improve fare payment also increased, from 40% to 48% for magnetic stripe readers, and 24% to 30% for smart card readers. Transit agencies have made a strong commitment to providing real-time information, with 38% of the agencies distributing dynamic information on schedule adherence through websites, 27% through DMS in stations, 25% through a mobile device app, and 21% through DMS at bus stops.

## **Transportation Management Centers**

The TMCs provide the focal point for management of transportation operations covering a wide variety of combinations of freeway, arterial, transit, and public safety agencies. Most commonly reported are TMCs supporting both freeway and arterial management (31%), while 20% are arterial only and 10% are freeway only. TMCs reported performing up to 15 different functions on freeways, all of which are supported by ITS technology. The use of technology is particularly important in supporting surveillance of incidents, network performance, and environment, as well as disseminating traveler information. Many functions performed by TMCs involve management of operations in response to special circumstances such as planned special events, emergency services, work zones, incidents,

maintenance dispatch, and road weather management. Freeway TMCs control traffic through lane management, integrated corridor management, and ramp management. As with freeway TMCs, surveillance is a key function of many arterial TMCs. Real time traveler information dissemination is also well-established for arterial TMCs, but reported less often than the by freeway TMCs. Arterial TMCs also manage operations in response to various special circumstances. Arterial TMCs control traffic through traffic signal control, lane management, and integrated corridor management.

## **Electronic Toll Collection**

ETC agencies use technology widely to improve traffic management and customer services as well as enforcement. The use of price managed lanes is reported by 86% of toll collection agencies and 45% have open road tolling. The use of automated enforcement is reported by 84% of responding agencies, carried out through a variety of technologies.

## **Public Safety**

Public safety agencies have widely adopted the use of technology to assist in emergency response and recovery. More than 60% of law enforcement and fire/rescue agencies have broadband connection to other dispatch centers, with the use of CAD/AVL is reported by 59% of law enforcement and 44% of fire/rescue agencies.

## **Cross-Cutting Applications**

### **Operations Performance Management**

ITS technology makes it possible for transportation agencies to collect operational data for the purpose of tracking and reporting on performance and improving service. Operational performance data are collected by 68% of freeway agencies and 30% of arterial agencies. Setting targets for performance improves the ability of agencies to diagnose and correct problems and is reported in use by 44% of freeway agencies and 15% of arterial agencies. A variety of performance measures are in use. The most widely employed measures by freeway agencies are travel time, vehicles per hour, travel time reliability, and vehicles per lane per mile. The top three measures for arterial agencies are travel time, vehicles per hour, and average queue length. Transit agencies primarily track vehicle time and location, passenger counts, incidents, and passenger information. Performance data are archived by freeway and arterial agencies and used to support a variety of functions, including operations planning, work zone design, dissemination to the public, capital planning, and real-time operations.

### **Safety and Work Zone Systems**

ITS technologies can be used to detect a variety of hazardous conditions and provide warnings to travelers. Technologies deployed on freeways at work zones include portable CCTV (46% of agencies), travel time systems (37% of agencies), and queue detection systems (21% of agencies), with from 11% to 6% of agencies reporting use of alternative route guidance, portable HAR, variable speed limit, speed enforcement, and dynamic lane merge. Arterial agencies also report the use of these technologies but less frequently (about one fifth as often as freeway agencies for most systems). A variety of automated safety warning systems are deployed. On freeways, 46% of agencies have deployed weather safety warning systems, 37% of agencies use over-height warning systems, and 21% of agencies have deployed dynamic curve warning systems. Arterial agencies deploy the same safety systems about one third as frequently, while also deploying pedestrian and

bicycle warning systems. Transit agencies deploy surveillance cameras to enhance security on most fixed route buses, and about 40% of transfer stations and bus depots.

## **Road Weather Systems**

The main source of road weather information for freeway, arterial and public safety agencies is the national weather service, followed by agency field personnel. A high percentage of freeway agencies also use field sensors, which are reported much less frequently for the other agency types. Freeway and arterial agencies also use private providers as a source for weather information. Environmental sensor stations (ESS) are deployed by 62% of freeway agencies and 16% of arterial agencies. These sensors detect a wide variety of weather data, most frequently temperature, wind speed, humidity, pavement temperature, and precipitation (rain). Weather safety warning systems deployed by 46% of freeway and 16% of arterial agencies, and the hazards most frequently detected by these systems are icy roads, high wind, and fog.

## **Integrated Corridor Management**

Integrated Corridor Management (ICM) is an integrated concept of transportation management made possible by the use of ITS technology. Corridors offer an opportunity to operate and optimize the entire system as opposed to the individual networks. From 25% to 30% of TMCs, freeway and arterial agencies and 16% of transit agencies identified themselves as being part of an integrated corridor. The ICM concept envisions freeway, arterial and transit agencies coordinating operations within a corridor. The data show that while integration between TMCs, freeway agencies and arterial agencies operating in a corridor is well established, if less than complete, integration of transit agencies lags substantially. Operational data sharing shows a similar pattern, with data being sent and received by one-third to one-half of the freeway and arterial agencies, but by less than 10% of transit agencies. The structure for interagency coordination is in an early stage of development and is basically informal, consisting of ad hoc meetings or working groups with very few agencies involved with funded staff or legal agreements.

## **Planning for Operations**

Planning for Operations is a joint effort between operations and planning that encompasses the institutional underpinnings needed for effective regional transportation operations collaboration. Coordination for planning and operations is widespread, with more than 90% of freeway agencies and 60% of arterial agencies report being part of a regional ITS architecture, using systems engineering when procuring ITS, having a long range plan for ITS deployment, and being included in a regional transportation concept for operations. More than half of freeway agencies and one quarter of arterial agencies report participation in operations and planning coordination meetings with about half as many being part of formal agreements to integrate planning and operations.

## **Maintenance of ITS Technology**

System maintenance for ITS technology refers to a series of methodical, ongoing activities designed to minimize the occurrence of systemic failures and to mitigate their impacts when failures do occur. Tracking the operational health of ITS devices is performed by ETC and freeway agencies mainly by real-time monitoring and inspections, while arterial agencies mainly use inspections and complaint calls. Once operational health of devices is determined the three main factors used in deciding to take maintenance action for ETC and freeway agencies are reaction to failure, inspections, and planned program of preventive maintenance; while for arterials the main factors are reaction to failure, inspection, and obsolescence. More than 80% of freeway and ETC agencies and half of arterial agencies follow a preventive maintenance program. The inspection and re-calibration schedule most



often results in inspections being conducted more than once annually, with a small number of agencies employing less frequent inspections (annual or more).

## **Dedicated Short Range Communications Standard**

Dedicated Short Range Communications (DSRC) is a two-way short- to medium-range wireless communications capability that permits very high data transmission critical in communications-based active safety applications. A high proportion of freeway agencies (63% of the agencies) and toll collection agencies (84%) report being familiar with DSRC and 17% of freeway agencies and 36% of ETC agencies are currently using the standard. A much smaller percentage of arterial and transit agencies report familiarity and use of DSRC. Of the current and planned applications using DSRC, most involve safety and mobility, followed by tolling operations and commercial vehicle operations.

## **Summary Findings**

- ITS technology has attained a central role in operations and planning of transportation agencies. A high percentage of agencies have plans to expand ITS deployments and to invest in new technologies in the near future. Agencies see very high benefits from the deployment of ITS technology, generally seeing the highest benefit from systems supporting collection and dissemination of real-time information.
- While support for safety and mobility are two key factors cited by agencies in deciding to invest in ITS technology, agencies generally report cost as the most important factor.
- The focus of future deployments is the collection and use of real-time information. Freeway and arterial agencies plan to deploy DMS, cameras, and traffic sensors. These agencies will use these resources to distribute real-time traveler information as well as to improve traffic management through the use of managed lanes, ramp metering, traffic adaptive signals and traffic control software systems.
- The deployment of traffic sensors on freeways and at signalized intersections is continuing to expand rapidly and agencies are upgrading traffic sensors to systems that are easier to deploy and are more reliable. Freeway agencies are moving from loop detector sensors to radar and probe readers, particularly Bluetooth systems. Similarly, arterial agencies are rapidly expanding the use of Bluetooth readers and radar sensors.
- The widespread deployment of traffic sensor systems by arterial agencies has been accompanied by a significant increase in arterial agencies planning to deploy traffic adaptive signaling. Increased familiarity with adaptive signaling by arterial agencies appears to be overcoming objections to its deployment. In 2013 the percentage of arterial agencies citing reasons for not deploying adaptive signaling is half what it was in 2010.
- Several new media for dissemination of traveler information emerged in 2013, particularly the use of social media, including Twitter, Facebook, and apps for smart phones or tablets.
- The widespread deployment of technologies to track and dispatch transit vehicles has allowed agencies to improve customer service by providing travelers with real-time information on schedule adherence, as well as supporting demand responsive operations and improved route planning.
- Almost all toll collection agencies reported participating in traffic management through the use of price managed lanes.

- Public safety agencies are expanding the use of ITS technology to support response and recovery through the use of integrated communications to coordinate with traffic management as well as the use of AVL/CAD to assist in locating, assigning, and routing responders.
- Freeway and arterial agencies are expanding the collection of operational performance data and comparing observed performance to established goals to evaluate status of customer service and diagnose areas for future improvement. Measures such as travel time, vehicles per hour and travel time reliability are becoming widely adopted.
- ITS technology is widely used to improve safety. Work zone safety is enhanced through the use of technology to monitor status, detect queues, enforce speed limits, and merge lanes. Outside work zones, ITS technology provides automated warnings about weather conditions, over-height conflicts, and dangerous curves. Pedestrian and bicyclist warning systems are widely deployed by arterial agencies. Nearly three-fourths of buses are equipped with audio or video surveillance to enhance security.
- The capability of ITS technology to support real-time data sharing and communications is supporting efforts to improve operational collaboration between agencies. A significant number of agencies report being part of an integrated corridor in which the different transportation agencies manage the transportation corridor as a single system, rather than managing individual assets. Outside of integrated corridors, agencies are working to improve coordination through activities like participating in a regional ITS architecture, being part of a regional concept for transportation operations, and developing formal agreements to coordinate data sharing and integrate operations.

# Chapter 1 Agency Opinions and Deployment Plans

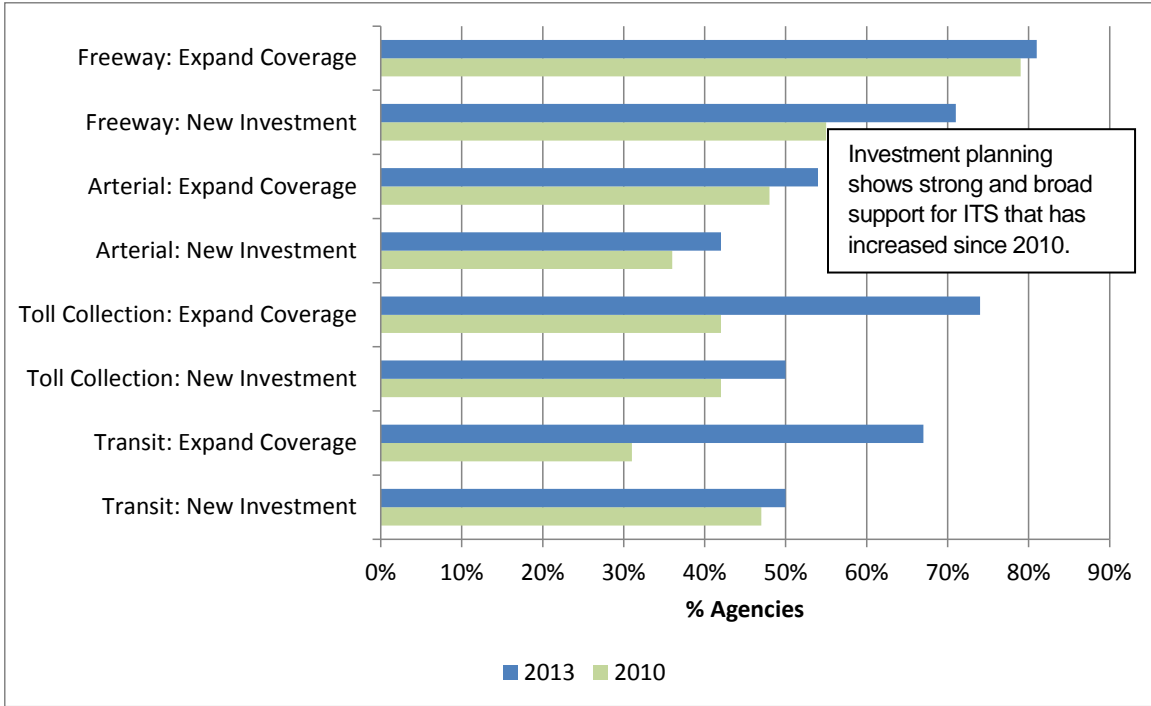
New for the 2010 Intelligent Transportation Systems (ITS) deployment tracking survey, and continued in 2013, was inclusion of a number of questions to gather information about opinions and future deployment plans concerning ITS. These new questions were included to provide the types of information that previously could only be inferred from the pattern of deployments and trends. Four areas were covered: (1) general plans to invest in ITS in the next three years; (2) factors influencing decisions to invest in ITS; (3) benefits of ITS technologies; and (4) plans to deploy specific technologies in the near future.

## Plans to Invest in ITS

One measure of the health of the national ITS program is the extent that agencies are planning to make new investments in ITS technologies. Questions concerning plans to make investments in ITS technologies were included in four of the seven surveys, targeting agencies managing freeways, arterials, transit, and electronic toll collection (ETC). Agencies were asked to report on their general future investment plans (covering the period from 2013 – 2016) in two areas: expansion of the coverage of existing ITS technologies, and deployment of new types of technologies.

Figure 1-1 shows the percentage of the four agency types with plans to expand current coverage of ITS technologies and/or to invest in new technologies, with results from the 2010 survey to the same question included for comparison. Overall, there is a strong commitment to continued growth in deployment of ITS technologies, with results ranging from about one-half to more than three-fourths of the agencies planning to expand current deployments or deploy new technologies. The strength of this commitment is growing; in every case, the percentage of agencies planning to expand current deployments and to make investments in new technologies increased from 2010 to 2013.

There is a clear distinction between freeway and arterial agencies. More than 80% of freeway agencies plan to expand coverage and more than 70% plan to invest in new technologies in the next three years. Arterial agencies show a similar pattern, but to a lower extent: 54% of agencies are planning to expand, and 42% of agencies are planning to make new investments. Transit and toll collection agencies, on the other hand, split the difference with more than two-thirds planning to expand deployment and half of the agencies planning to make new investments. While more agencies are planning to make new investments for in 2013 than in 2010, some results stand out. The percentage of transit agencies planning to expand existing coverage more than doubled in 2013 and increased by three fourths for ETC agencies. The percentage of freeway agencies planning to make new investments increased from 55% to more than 70%.



**Figure 1-1. Agency Plans to Invest in New ITS Technology or Expand Current Coverage, 2013-2016**

## Factors Influencing Decisions to Invest in ITS

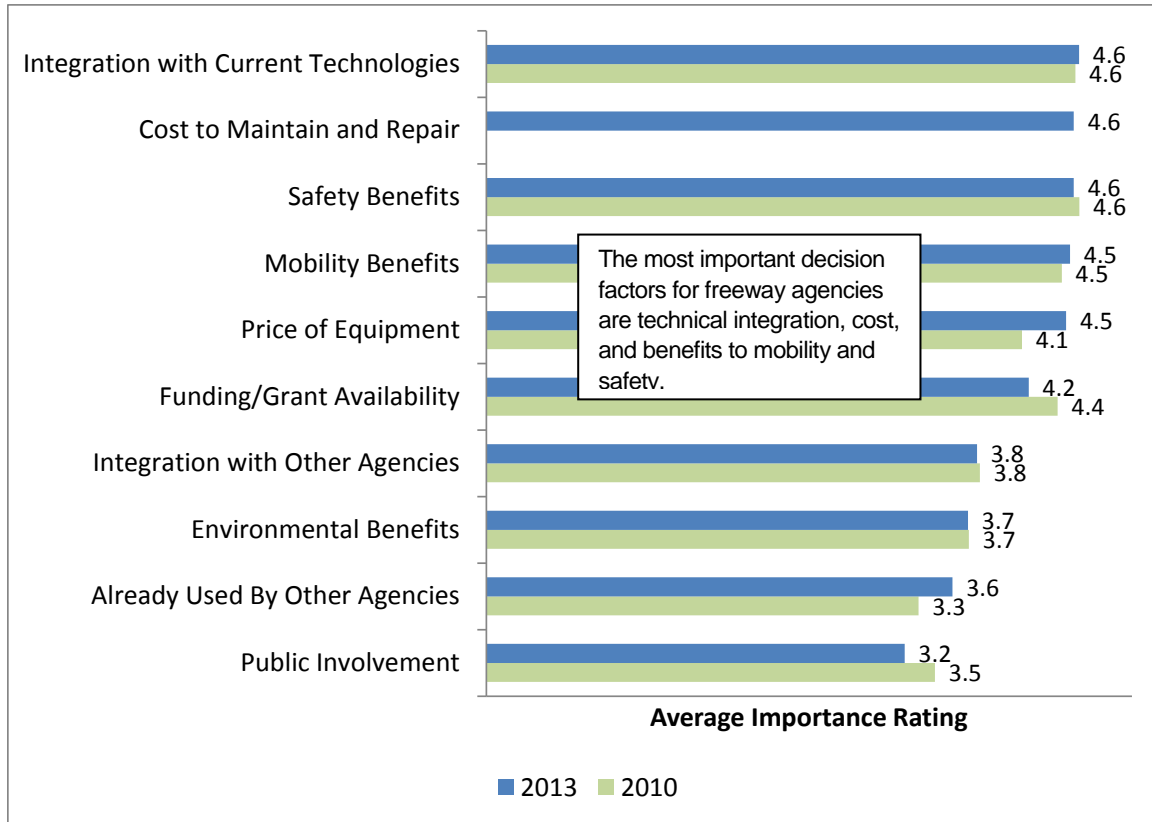
The issue of what factors impact decisions by state and local transportation agencies to invest in ITS technology has been an important research topic for U.S. Department of Transportation since the start of the national ITS program. The 2013 national ITS deployment tracking survey provided the opportunity to gather information from more than a thousand agencies concerning this issue. These questions were included in freeway management, arterial management, toll collection, and transit management surveys. Respondents were asked to rank the factors on a scale of 1 to 5, from (1) not at all Important to (5) very Important. Ten factors were assessed by the four agency types targeted:

- Environmental benefits,
- Funding/grant availability,
- Integration with currently deployed technologies,
- Integration with other agencies,
- Mobility benefits,
- Cost of initial deployment,
- Cost to maintain and repair,
- Public/constituents involvement,
- Safety benefits, and
- Technology already used by another agency.

Each agency type had a unique pattern of responses, but generally, cost, safety benefits and mobility benefits were the most important factors in deciding to deploy ITS. Environmental benefits, public involvement, and the fact that other agencies had adopted ITS technologies were generally ranked

lower in importance. The following four figures show the specific results for the different agency types, comparing the 2013 results to those of 2010. One difference between the two surveys involves cost; in 2013, cost was broken into two factors--cost of initial deployment and cost to maintain and repair, while in 2010, only price of equipment was included. In the figures, the 2010 price of equipment is compared directly to the 2013 cost of initial deployment, with the 2013 cost to maintain and repair reported separately.

Figure 1-2 shows the average importance rating assigned by freeway agencies to factors influencing decisions to deploy ITS technology. The results are in order of the average of the (1 to 5) ranking scores of all the respondents.

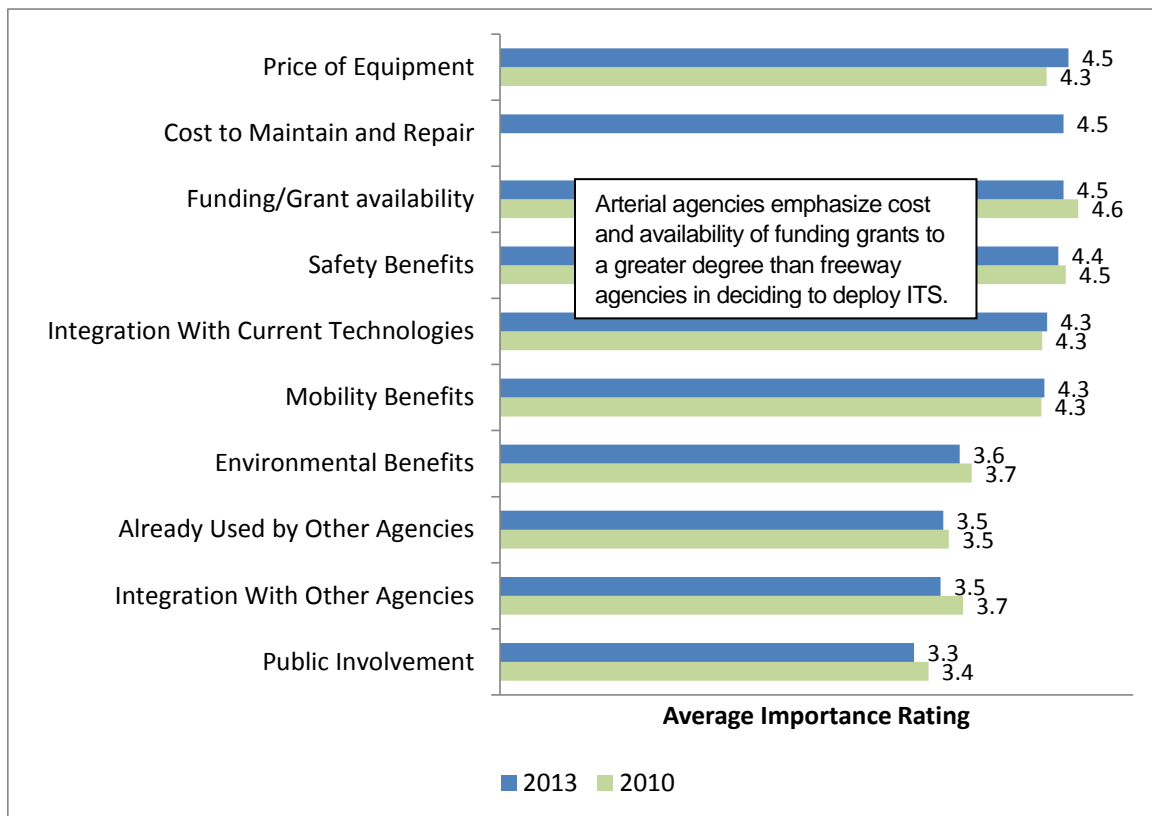


**Figure 1-2. Importance of Factors in Deciding to Purchase ITS Technology - Freeway Agencies, 2010 – 2013**

As Figure 1-2 shows, the average of the rankings ranged from 4.6 to 3.2 in 2013, indicating that all factors were ranked above neutral in making a purchase decision. The top five factors have an average score around 4.5 and include integration with current technologies, price, mobility benefits and safety benefits, with the major difference between 2010 and 2013 being an increased concern about cost in 2013. The high ranking assigned to integration with current technologies reflects an appreciation on the part of freeway agencies for the technical issues involved with creating and maintaining an integrated system. Slightly behind these first five factors is the availability of grant money. All of these factors were significantly more important than the last four. Three factors are similarly ranked: integration with other agencies (3.8), environmental benefits (3.7) and the fact that the systems were already used by other agencies (3.6, an increase over 2010). Finally, public/constituents involvement (3.2, somewhat less than in 2010) was last in importance. The

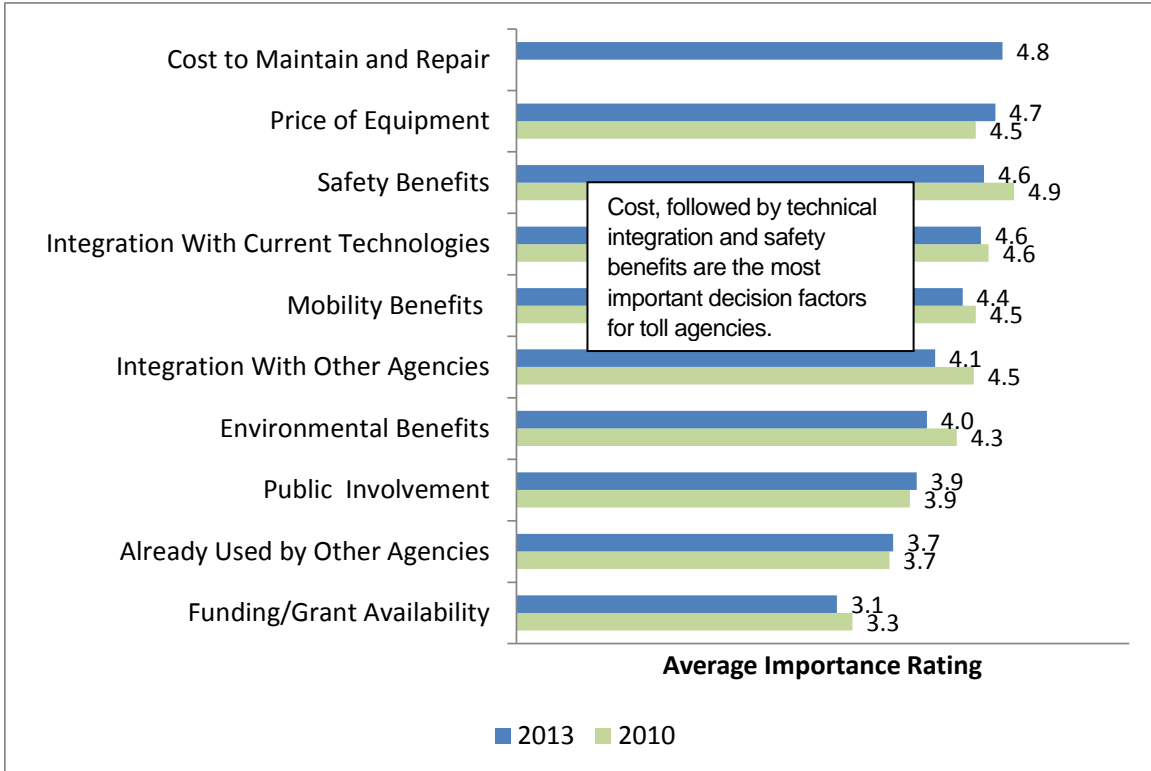
rankings reflect strong opinions and the importance assigned to mobility and safety benefits shows the value of ITS technologies to local agencies.

Figure 1-3 shows the ranking of factors impacting deployment decisions for arterial agencies. Cost and the availability of grant money are at the top of the list of factors influencing deployment decisions, followed closely by safety benefits, with an increase in concern over cost shown in 2013. Integration with other technologies (4.3) and mobility benefits (4.3) are in the next group. Factors ranking lower in importance were environmental benefits (3.6), integration with other agencies (3.5), already used by other agencies (3.5), with public/constituent’s involvement (3.3) again last in importance. These results indicate that arterial agencies perceive ITS technology to have an important role in supporting safety and mobility, but may be constrained by the cost in making decisions to deploy, apparently to a greater degree than freeway agencies. This emphasis on cost is more pronounced than in the 2010 survey results, and seems to reflect changes to the fiscal environment since that time.



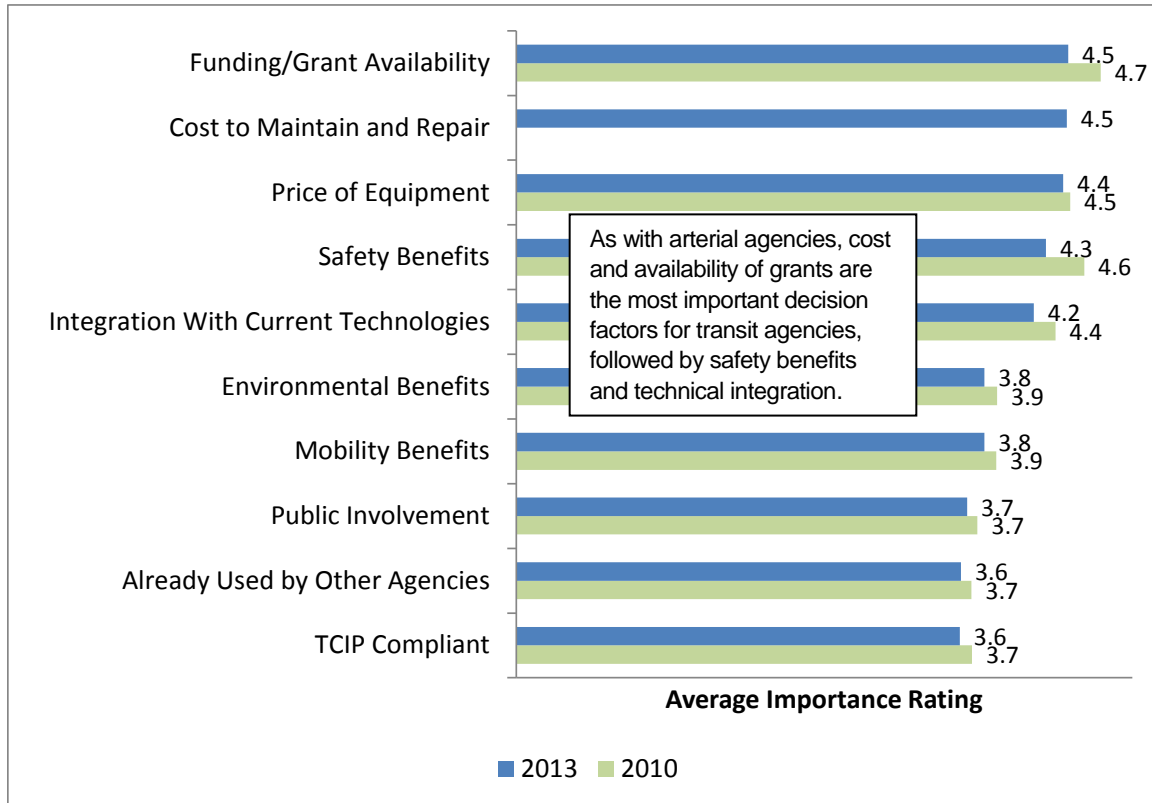
**Figure 1-3. Importance of Factors in Deciding to Purchase ITS Technology - Arterial Agencies, 2010 – 2013**

As with arterial agencies, cost is a critical factor in making deployment decisions by ETC agencies, shown in Figure 1-4. Cost to maintain and repair and price of the equipment are the most important factors. Safety benefits and integration with current technologies are slightly behind with a ranking of 4.6, followed by mobility benefits at 4.4. The major change from 2010 for toll collection agencies is that the importance of cost has increased and moved up to be the top factor, while the rating of the other top factors is slightly reduced in 2013.



**Figure 1-4. Importance of Factors in Deciding to Purchase ITS Technology - Toll Collection Agencies, 2010 – 2013**

The responses by transit agencies, shown in Figure 1-5 follow the pattern of the responses by arterial agencies, with funding/grant availability (4.5), cost to maintain and repair (4.5) and price (4.4) grouped at the top of the factors influencing deployment decisions. Safety benefits (4.3) and integration with current technologies (4.2) follow closely, with the remaining factors in a group with a score below 4. The grouping of these factors is consistent with 2010 results, but the 2013 ratings are slightly lower in every case.



**Figure 1-5. Importance of Factors in Deciding to Purchase ITS Technology - Transit Agencies, 2010 - 2013**

Overall, the results show that in 2013 cost was the factor most often included in the group of primary factors. Next in importance are safety benefits and integration with current technologies. Mobility benefit, which might be expected to be the main reason for deployment, is ranked below safety in every case.

## Benefits of ITS Technologies

The ITS Joint Program Office has an extensive effort in place aimed at gathering empirical data on the benefits of particular ITS technologies, typically expressed in terms of improvement of specific performance measures. The deployment tracking survey provides the opportunity to examine the perception of benefits of ITS technologies from personnel having experience with the systems. These assessments can provide a number of useful insights. For example, situations in which technologies are ranked high for benefits but have a relatively low level of deployment may point to opportunities for research into issues such as operational constraints, cost, or other factors that impact deployment decision-making.



Freeway, arterial, and transit agencies were asked to judge the benefits of ITS technologies. In each case, only those agencies actually deploying a technology were asked to provide a ranking, and the ranking was to be based on individual operational experience with the technology. As with the questions previously discussed, respondents were asked to rate the technologies on a scale of (1) no benefit to (5) significant benefits. The 2013 results are shown along with the results from the 2010 survey.

Figure 1-6 shows the three systems with the highest benefit to freeway agencies reflect the use of ITS technology to support real-time traffic management. Cameras (5.0) are almost universally rated very high, while traveler information systems (4.7) and sensors (4.6) also gathered very high benefit scores. Toll tags (4.4), another technology used to track traffic conditions was ranked slightly lower. Two traffic control systems, ramp control (4.3), and lane management (4.3) also averaged well above a ranking of 4 out of a possible 5, and both are examples of technologies being highly ranked but not widely deployed. Systems ranked lower for benefits include automated enforcement (4.1) archived data (4.0), and vehicle probes (4.0). In almost every case, the 2013 benefit rating is higher than the 2010 rating, and all technologies are rated 4 or more out of a possible 5. This may reflect an increased appreciation of the benefits of ITS technology as the result of having more experience with the systems.

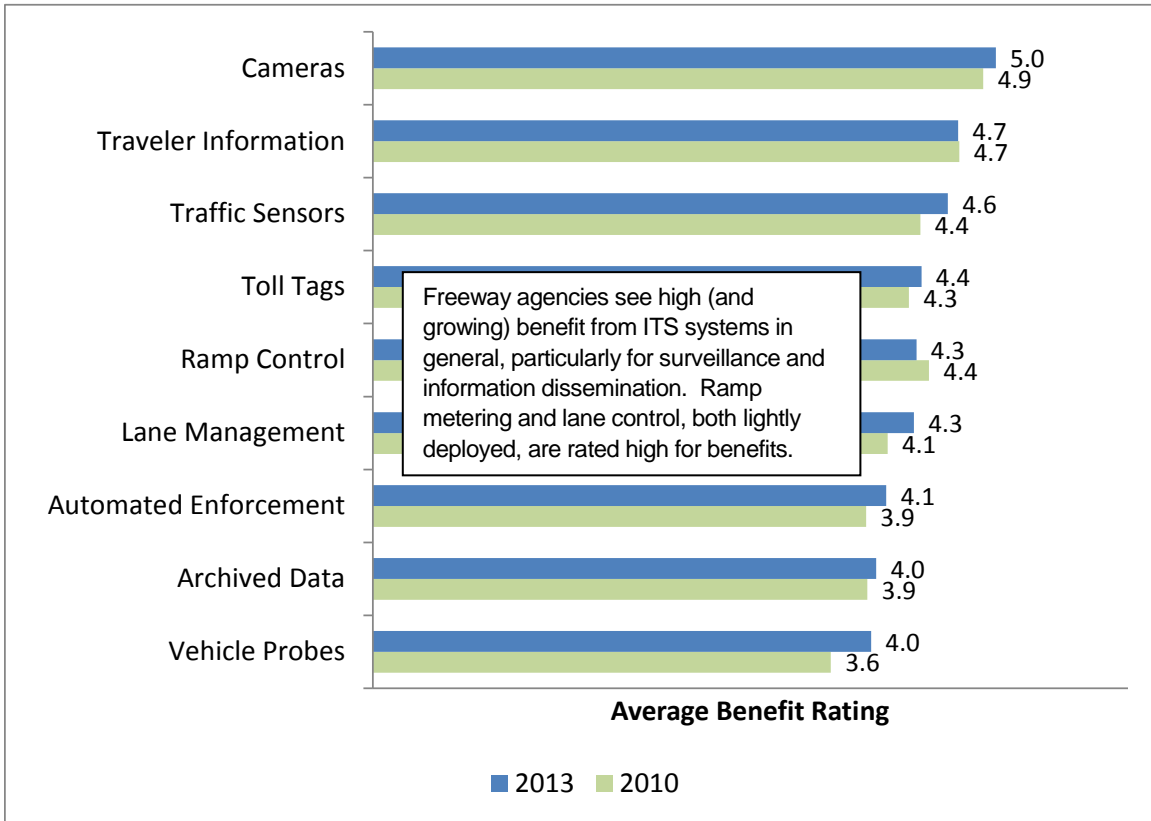
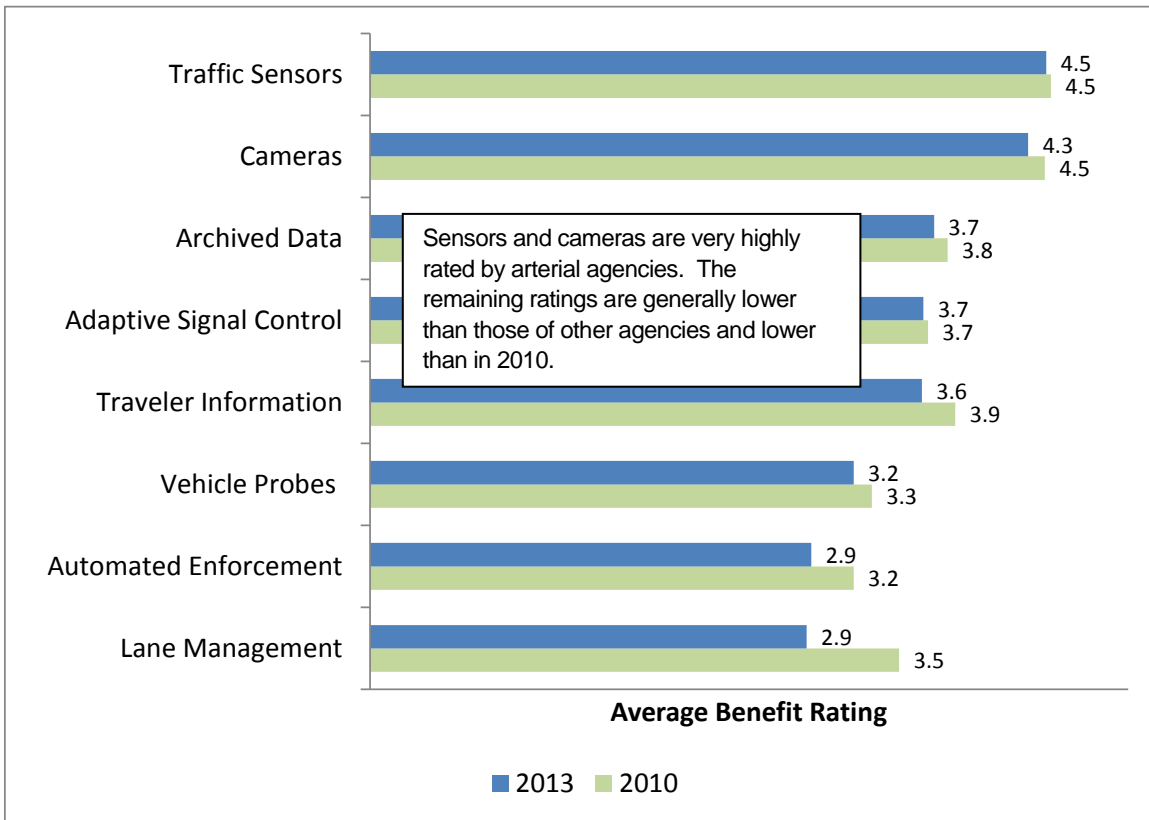


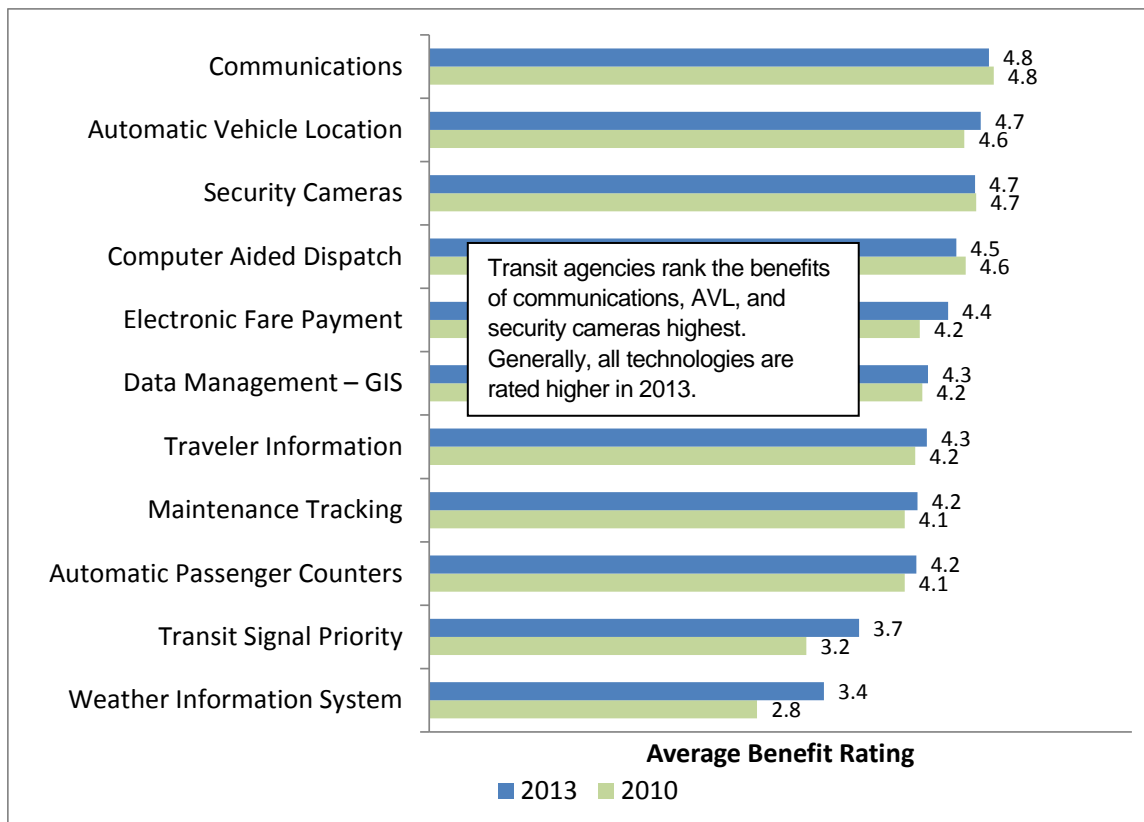
Figure 1-6. Benefit Ratings Assigned to ITS Technologies by Freeway Agencies, 2010 – 2013

Figure 1-7 shows the assessments of benefits of technologies supporting arterial agencies. Two technologies dominate the ratings by a wide margin, traffic sensors (4.5) and cameras (4.3), and no other technology received a ranking above 4. Archived data (3.7), adaptive signal control (3.7), and traveler information (3.6) are in a group behind the first two technologies, followed by vehicle probes (3.2). Finally, automated enforcement (2.9) and lane management (2.9) were not rated above having a moderate benefit by arterial agencies. The ratings in general are lower than the 2010 results, with the greatest drop for automated enforcement and lane management. These results appear to indicate an overall difference in the assessment of benefits of ITS technologies by arterial agencies compared to freeway agencies, with freeway agencies appearing in general to value ITS technologies significantly higher. Arterial agencies assigned a rank of 4 or higher to only 2 out of the 8 technologies. Freeway agencies, on the other hand, ranked 9 out of 9 technologies 4 or higher.



**Figure 1-7. Benefit Ratings Assigned to ITS Technologies by Arterial Agencies, 2010 – 2013**

For transit agencies, as shown in Figure 1-8, the benefit rankings for nine of the eleven technologies are uniformly high and fall in a narrow range (4.2 – 4.8). Communications (4.8) is the most highly rated technology followed closely by automatic vehicle location (4.7) and security cameras (4.7). These top three are followed by computer aided dispatch (4.5) and electronic fare payment systems (4.4). Next in priority are data management – GIS (4.3) and traveler information (4.3), followed by maintenance tracking (4.2) and automatic passenger counters (4.2). Lower ranked for benefits by transit agencies were transit signal priority (3.7) and environmental sensor stations (3.4). The benefit ratings are generally higher compared to the 2010 results. Nine of the eleven technologies have a rating above 4 out of a possible 5, showing that transit agencies are similar to freeway agencies in valuing ITS technology highly.



**Figure 1-8. Benefit Ratings Assigned to ITS Technologies by Transit Agencies, 2010 – 2013**

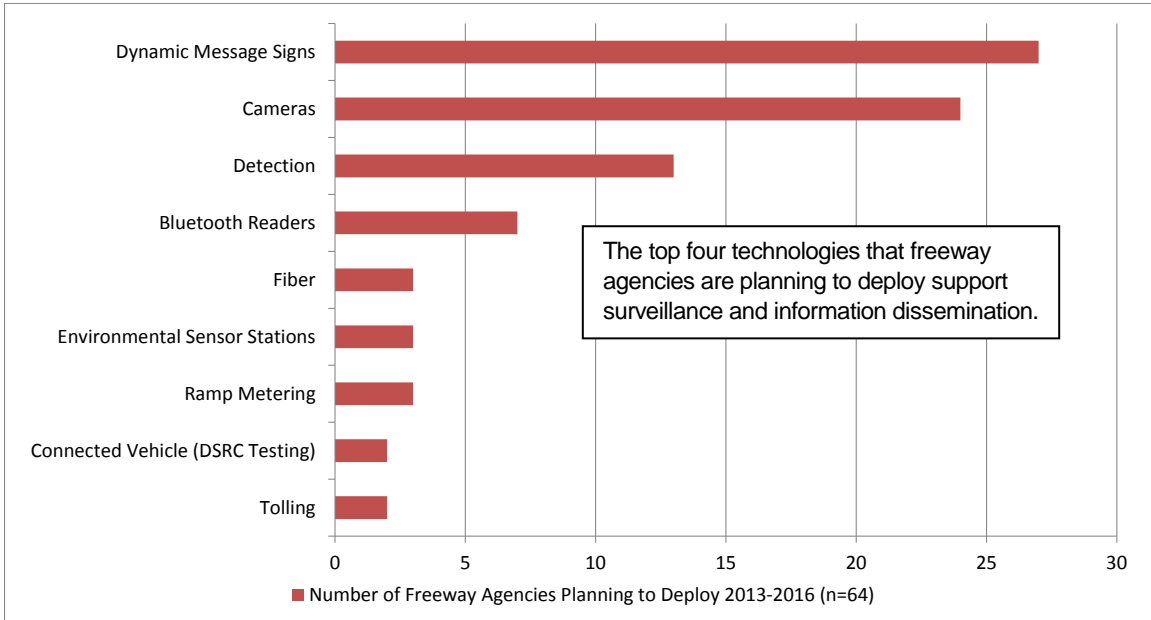
Overall, the results for the three types of agencies show a strong positive impression of the benefits of ITS technologies, with the majority of the technologies ranked above 4 out of a possible 5. The 2013 data track closely to the 2010, with differences likely reflecting the greater experience agencies have with the technologies in 2013.

## Future Deployment Plans for Specific Technologies

The agencies that reported they are planning to invest in ITS technologies were asked to comment on the particular technologies to be purchased. This section summarizes comments from freeway, arterial, and transit agencies. Not all agencies that could have provided comments chose to do so, and as a result, the number of agencies included is less than the number indicating plans to make

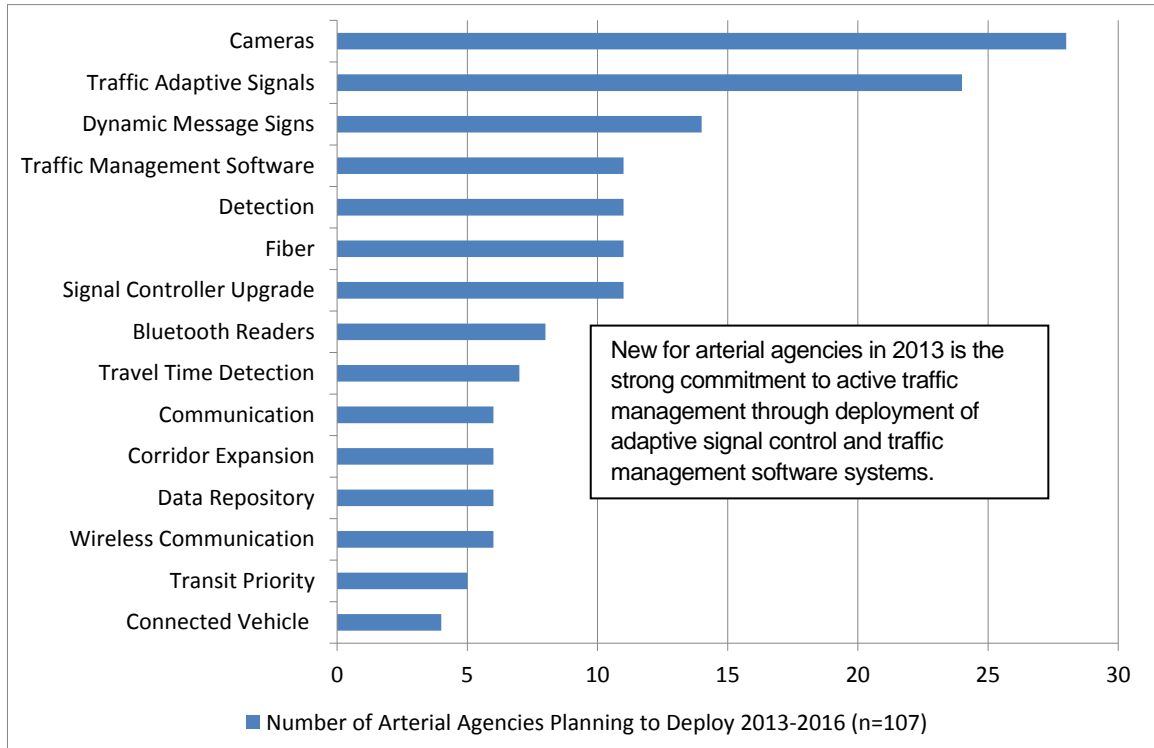
future investments. However, the results provide a picture of the relative importance of the different technologies to the different agency types when considering future deployment.

Figure 1-9 shows the planned deployments for freeway agencies. By far, the two technologies most highly ranked for benefits in the preceding section, cameras and dynamic message signs (DMS) were listed most often by freeway agencies as planned future deployments. Next in importance are two related technologies, detection (in general) and Bluetooth readers. These results indicate that in the next three years freeway agencies are focusing on expanding their ability to collect and disseminate real-time traffic data.



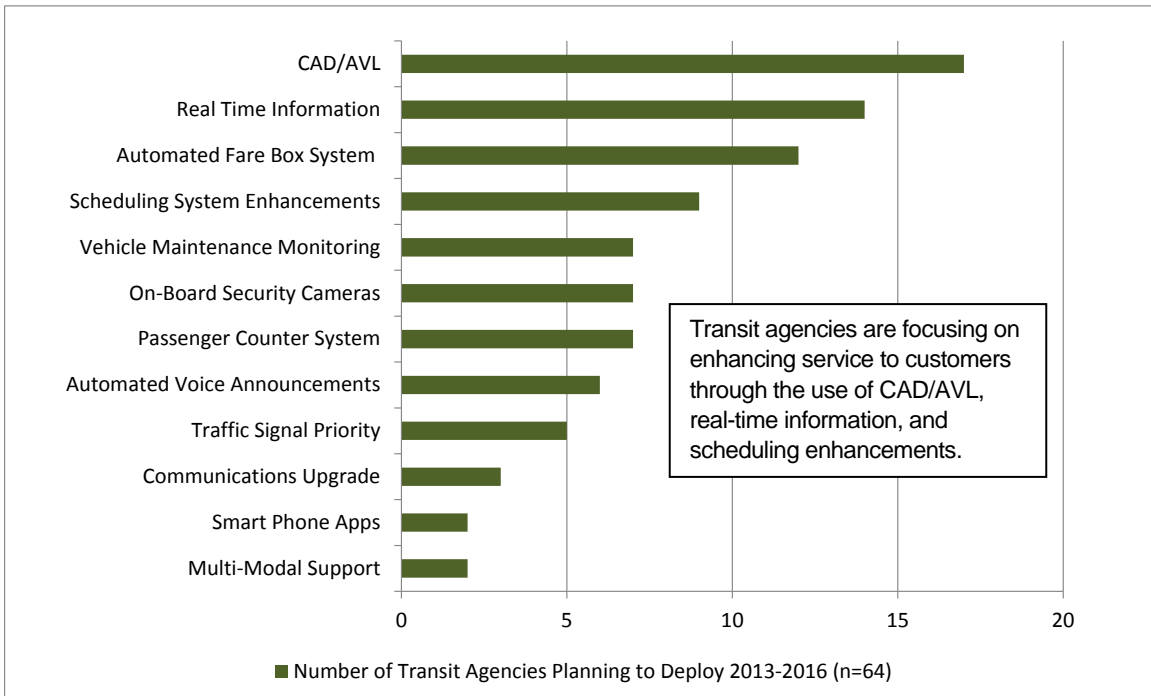
**Figure 1-9. Planned Future Deployments for Freeway Agencies 2013 – 2016**

Figure 1-10 shows the specific deployment plans for arterial agencies. As with freeway agencies, the major focus of planned deployments is to improve data collection and dissemination, with cameras and DMS mentioned frequently, as is the use of probe data gathered through Bluetooth readers. However, the real-time data on traffic being gathered by arterial agencies will be used to improve operations as well as informing travelers, as seen in the significant interest in deployment of traffic adaptive signaling, traffic management software systems, and signal controller upgrades.



**Figure 1-10. Planned Future Deployments for Arterial Agencies 2013 – 2016**

Figure 1-11 shows the plans for future deployments by transit agencies over the next three years. The four most often mentioned technologies are all directly related to improving service to transit passengers. Most frequently cited is computer aided dispatch (CAD)/automatic vehicle location (AVL), followed by real-time information. The use of AVL in association with CAD supports improved dynamic scheduling capability, and agencies are planning to deploy scheduling system enhancements in the form of scheduling software as systems a result. Also included near the top of planned deployments is making improvements to fare payment through smart cards or other electronic enhancements. After these top four technologies, vehicle maintenance monitoring, security cameras, automatic passenger counters, and traffic signal priority follow closely.



**Figure 1-11. Planned Future Deployments for Transit Agencies 2013 – 2016**

These planned future deployments indicate that agencies have advanced from using ITS technology to simply monitor the transportation system to using the systems to manage operations. The use of real-time data collection and dissemination allows traffic managers to detect problems and provide travelers with timely advisories and diversion information. Ramp metering and lane control on freeways, traffic adaptive signalling and expanded use of traffic management software systems on arterials, as well as the use of CAD/AVL and improved scheduling systems by transit agencies all reflect a more active role in managing operations made possible by ITS technology.

## Chapter 2 Deployment Status and Trends

As in previous surveys, the 2013 ITS deployment tracking survey continued to gather a consistent set of data elements designed to track progress in major cities. In this chapter deployment data are presented in two varieties: *coverage*, measuring how much has been deployed, expressed as the percentage of signalized intersections, miles of road or vehicles equipped; and *adoption*, which establishes whether or not a particular technology has been deployed, expressed as the percentage of agencies that report having deployed the technology. Coverage and adoption data are shown for different years to explore trends and, where appropriate, data for freeway and arterial agencies are shown together for comparison. The coverage data are based on a set of deployment indicators developed early in the project and tracked in every survey. As a result, the technologies covered may not include many of the newer systems, which are covered in the results for adoption of technologies. This chapter breaks out the data for the different agency types covered in the survey: freeway management, arterial management, incident management, transit management, transportation management centers (TMC), ETC, and public safety (law enforcement and fire/rescue).

## Freeway Management

Figure 2-1 shows the coverage trends for key ITS technologies deployed on freeways. The data show that the ITS technologies supporting real-time data collection and traveler information dissemination on freeways experienced growth in coverage from the 2010 survey; and this growth is consistent with long term trends. The number of DMS deployed (read on the right hand scale) nearly tripled between 2000 and 2013, greatly expanding the capability to communicate directly with freeway travelers. There has been nearly a fourfold increase in the capability of agencies to visually monitor travel conditions through the use of CCTV with coverage increasing from 15% of freeway miles in 2000 to 57% in 2013. The percent of freeway miles under electronic surveillance has also experienced continuous and rapid growth, expanding from 18% in 2000 to 63% in 2013.

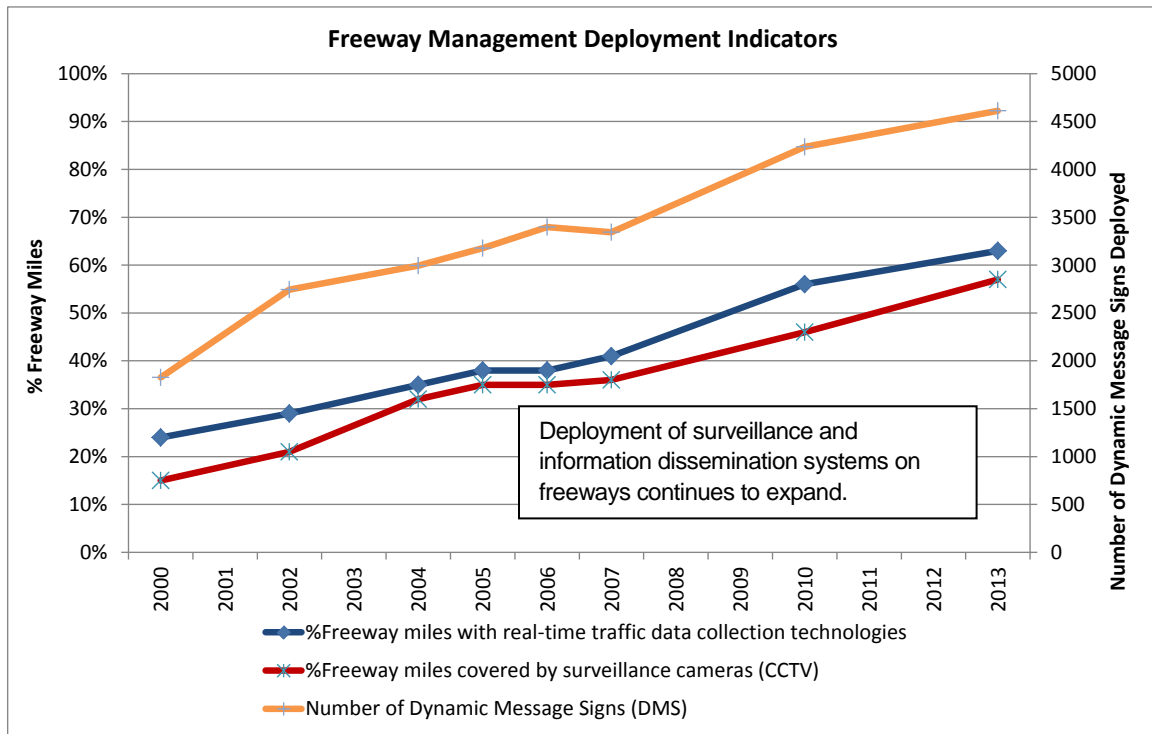
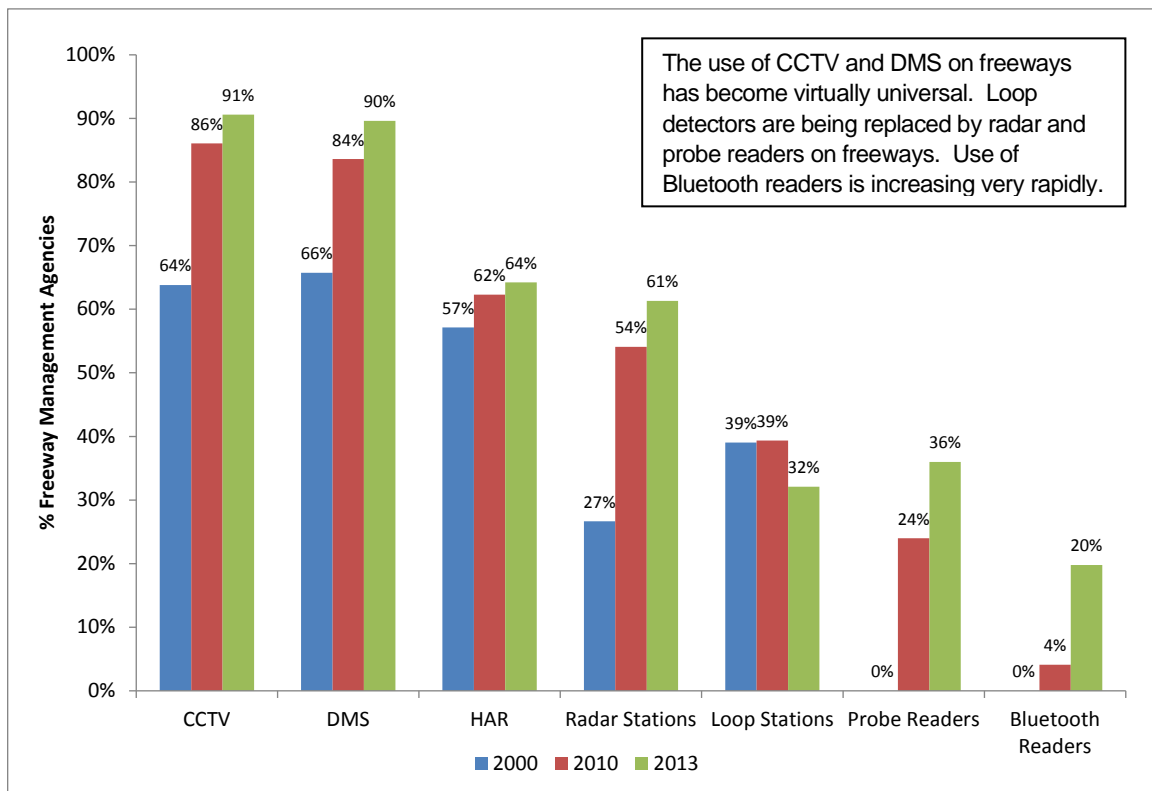


Figure 2-1. Freeway Management Deployment Trends, 2000 – 2013



Figure 2-2 shows the trends in the adoption of key ITS technologies by freeway agencies, comparing the 2013 data to 2000 and 2010 results. Adoption of CCTV and DMS expanded in lockstep over this period from 64% and 66% of freeway agencies in 2000 to 86% and 84% in 2010 to 91% and 90% of agencies by 2013. Adoption of highway advisory radio (HAR) has increased more gradually, from 57% of freeway agencies in 2000 to 64% of agencies in 2013. The data on adoption of sensor technologies show a movement away from loop stations to other alternatives. The percentage of freeway agencies using radar has more than doubled, increasing from 27% of agencies in 2000 to 61% in 2013, and the adoption of probe readers has increased even faster, from 0% of agencies in 2000, to 24% of freeway agencies in 2010 and 36% in 2013. During that time, adoption of loop stations flattened out at 39% of agencies in 2010 and actually went down in 2013 to 32% of agencies. The increase in use of probe readers may be due mainly to one specific type of probe reader, Bluetooth, the adoption of which ballooned from 4% of freeway agencies in 2010 to 20% just three years later.



**Figure 2-2. Technologies Adopted by Freeway Agencies, 2000, 2010 and 2013**

In light of the rapid increase in the use of probe readers, it is useful to consider what other types of readers are being deployed. Figure 2-3 shows the types of probe readers in use by freeway agencies and compares that to arterial agencies. Adoption of Bluetooth readers is relatively high for freeway agencies at 20% as well as for arterial agencies at 10% of agencies surveyed. Adoption of other types of probe readers is also fairly widespread on freeways: toll tag (17% of agencies), GPS (11% of agencies) and cellular phone (10%), with license plate recognition systems (5% of agencies) less widely adopted. Arterial adoption of the probe readers outside of Bluetooth is limited to 1% to 3% of agencies.

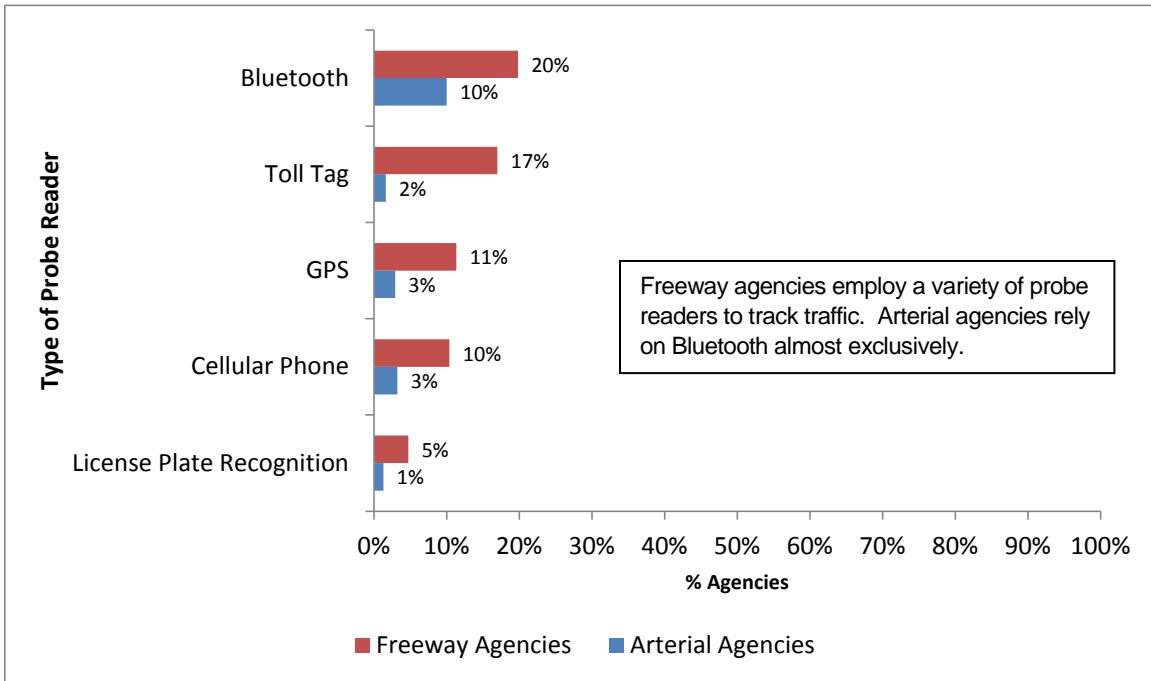
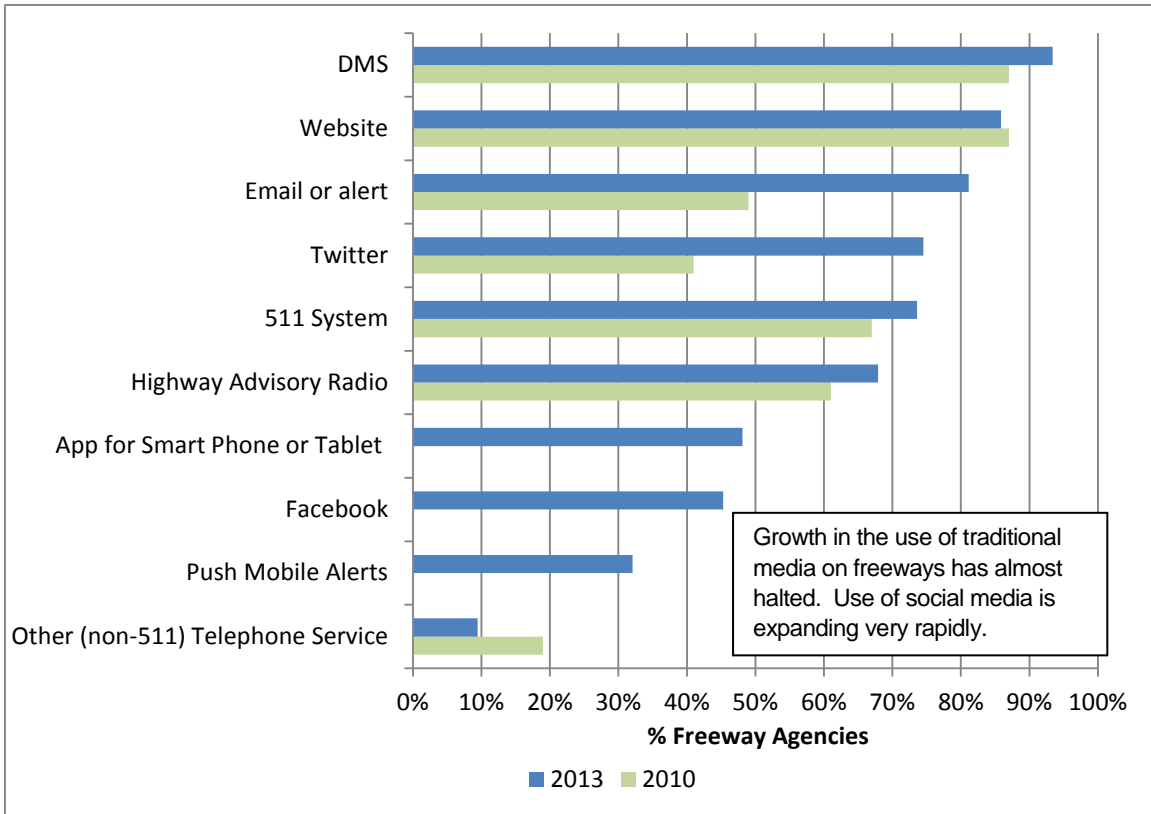


Figure 2-3. Adoption of Probe Readers by Freeway and Arterial Agencies

The media employed by freeway agencies to distribute traveler information are changing rapidly, which is clear when the data on media use in 2013 are compared to those of 2010 as shown in Figure 2-4. The growth in adoption by freeway agencies of the more traditional media, DMS, websites, 511, and HAR slowed or even stopped between 2010 and 2013. These broadcast methodologies are rapidly being supplanted by social media. The percentage of agencies using Twitter and email alerts almost doubled between 2010 and 2013. The use of other social media, including Facebook, smart phone apps, or pushed alerts to mobile devices, are well-established and are used by a third to nearly half of the freeway agencies. These media are essentially new developments and were so rare they were not even included in the previous survey. Social media enable agencies to provide a new level of service to travelers, including messaging targeted to specific travelers.



**Figure 2-4. Methods Used to Distribute Traveler Information on Freeways, 2010 – 2013**

Freeway and arterial agencies use the same types of media to distribute traveler information, but with major differences in the percentage of agencies employing each media. Figure 2-5 shows the use of various media reported by freeway and arterial agencies in 2013. For freeway agencies, the use of DMS, reported by 93% of the agencies responding, is approaching universal adoption. This is followed closely in adoption by websites (86%), email (81%), Twitter (75%), 511 (74%), and HAR (68% of agencies) as the major media in use on freeways. Arterial agencies report the use of websites (45% of agencies) most frequently, followed by DMS and Twitter, both at 29%. Next in importance for arterial agencies are Facebook (21%), 511 (19%), and email (17%). The difference between the two agency types for most media is that the percentage of adoption by freeway agencies is two to three times that of arterial agencies. However, the difference is greater for email (81% of freeway agencies to 17% of arterial agencies), HAR (68% to 9%), and in the use of mobile media, including apps for smart phones (48% to 8%) and push alerts (32% to 1%).

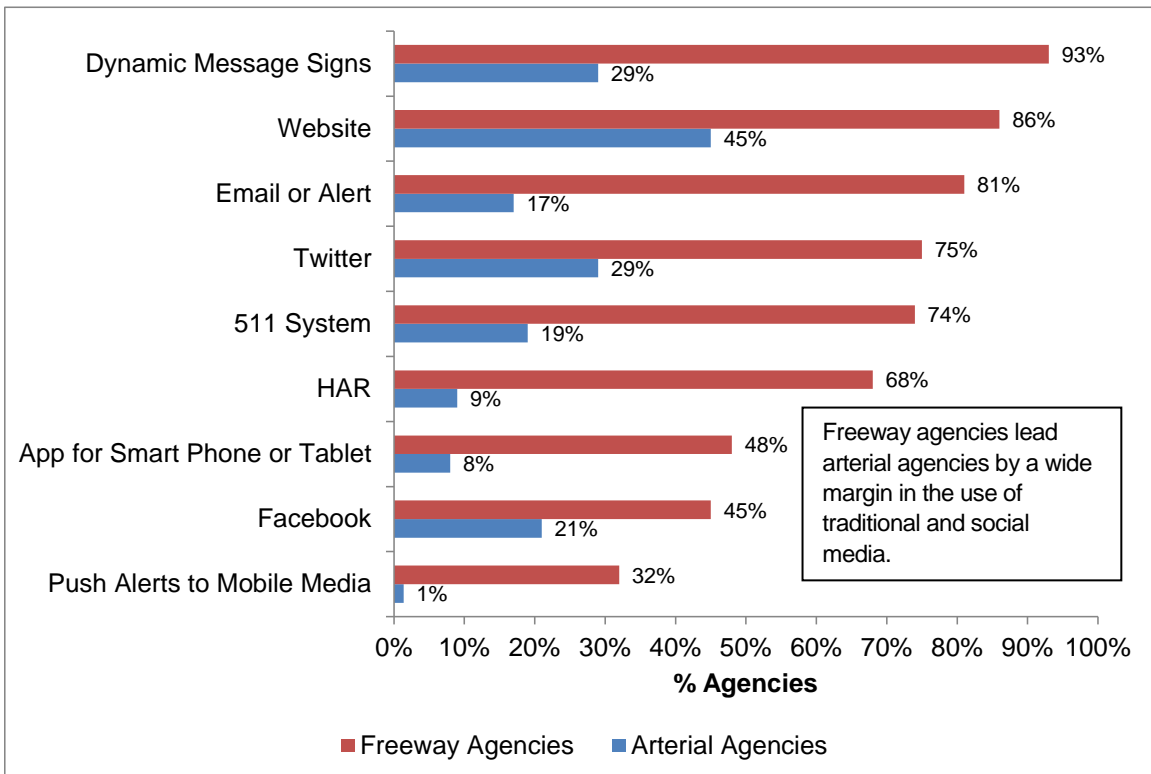
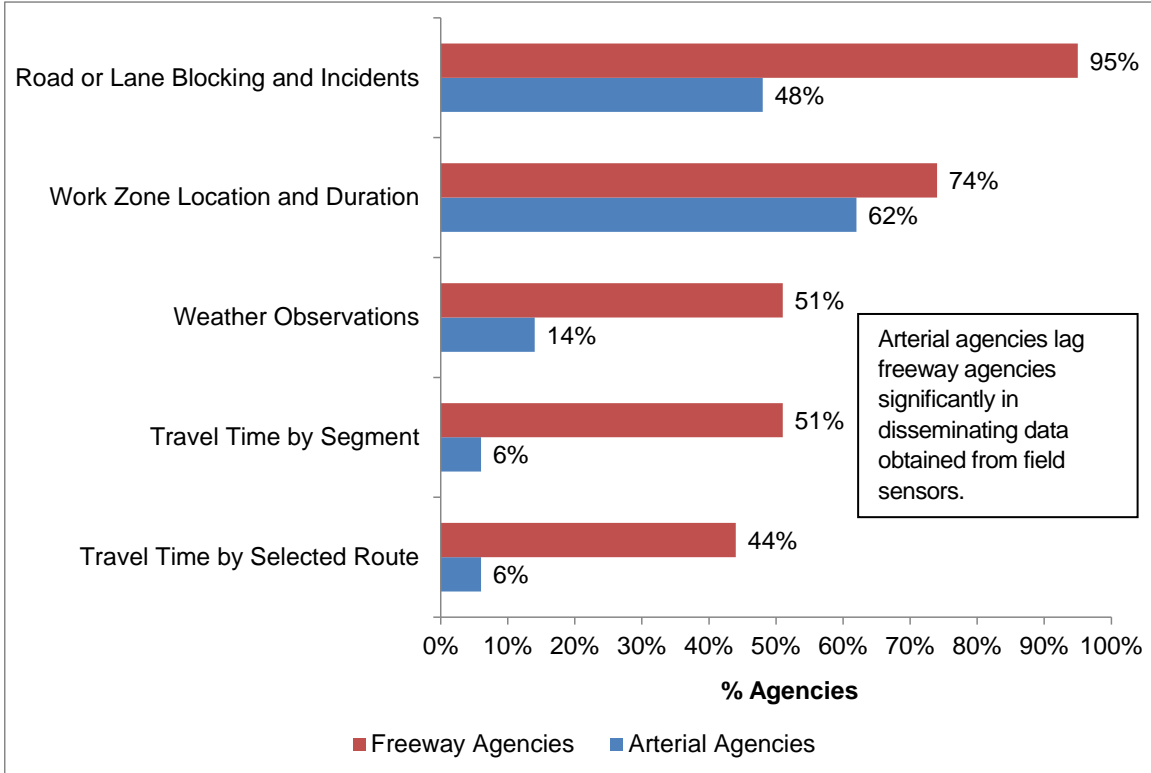


Figure 2-5. Methods Used to Distribute Traveler Information by Freeway and Arterial Agencies

Freeway and arterial agencies also differ significantly in dissemination of different types of information to travelers. Figure 2-6 shows that the major difference between freeway and arterial agencies emerges in the categories of information dependent on deployment of sensors. While about half of the freeway agencies disseminate travel time and weather advisories, the percentage of arterial agencies disseminating weather data (14%) and travel time advisories (6%) is much lower. The two agencies are much more similar for data categories that do not rely on deployed sensors. The distribution of information on work zones location and duration is carried out by about the same percentage of freeway agencies (74%) as arterial agencies (62%) and about twice as often by freeway agencies (95% to 48%) for information on road or lane blockages.



**Figure 2-6. Types of Information Distributed by Freeway and Arterial Agencies**

## Arterial Management

Arterial management deployment trends are summarized in Figure 2-7. Since 2000, the percentage of signalized intersections covered by electronic surveillance has continued to expand from 20% in 2000 to 48% in 2010 and 64% in 2013. Coverage of other technologies on arterials has grown more slowly. The coverage of signalized intersections equipped emergency vehicle preemption increased from 22% to 25% between 2010 and 2013. The coverage of HAR and signalized intersections with transit priority both increased from 3% to 4% over the same interval. The percentage of signalized intersections under centralized or closed loop control has been basically steady at about 50% throughout the whole period.

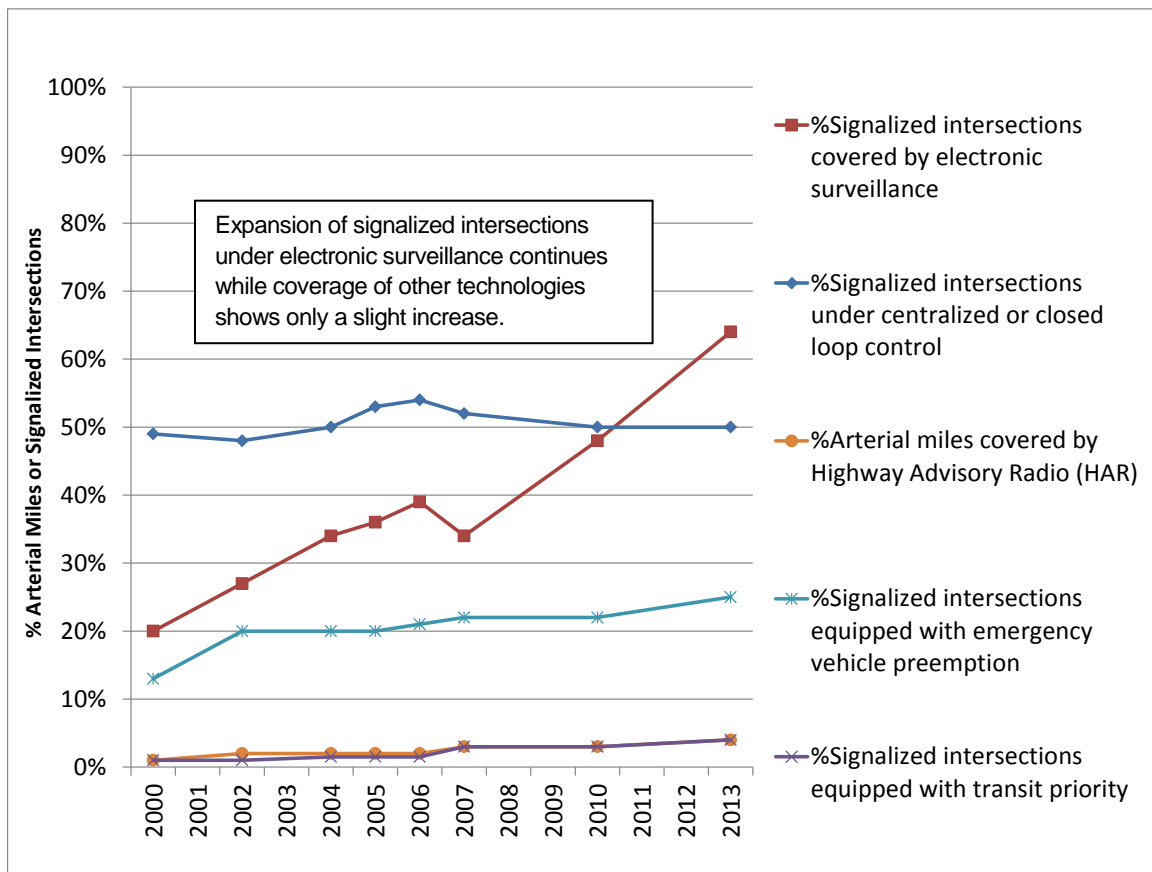


Figure 2-7. Arterial Management Deployment Trends, 2000 – 2013

The trends for adoption of ITS technologies by arterial agencies are shown in Figure 2-8. The percentage of agencies adopting in-pavement loop stations increased from 51% of arterial agencies in 2000 to 68% of agencies in 2010 and 88% of agencies in 2013. Video Imaging Detectors (VIDS) adoption has increased from only 26% of arterial agencies in 2000 and 58% in 2010 to 75% in 2013. The trends for these sensors vary significantly from that observed for freeway agencies, which reported no growth for adoption of loop stations and a slight reduction for VIDS over the same period, with the difference being the result of expanded deployment of electronic surveillance at arterial intersections shown in Figure 2-7 above. Starting from no deployment in 2000, adoption of Bluetooth readers jumped from only 2% of arterial agencies in 2010 to 10% in 2013 and that of radar stations from 13% of arterial agencies to 31% in the same interval. CCTV is being adopted by arterial agencies at an increasing rate and rose from 21% of arterial agencies in 2010 to 28% in 2013, while having increased only by 4% (from 17% to 21% of arterial agencies) between 2000 and 2010. The adoption of parking management systems continued to increase slightly in 2013. Some trends were negative--automated enforcement technologies have become controversial, and adoption of red light running cameras was actually lower in 2013. Adoption of DMS was mostly flat after a rise from 2000 to 2010. Finally, the adoption of traffic adaptive signals is accelerating, doubling (9% to 18% of agencies) between 2010 and 2013, while only increasing slightly (5% to 9%) between 2000 and 2010.

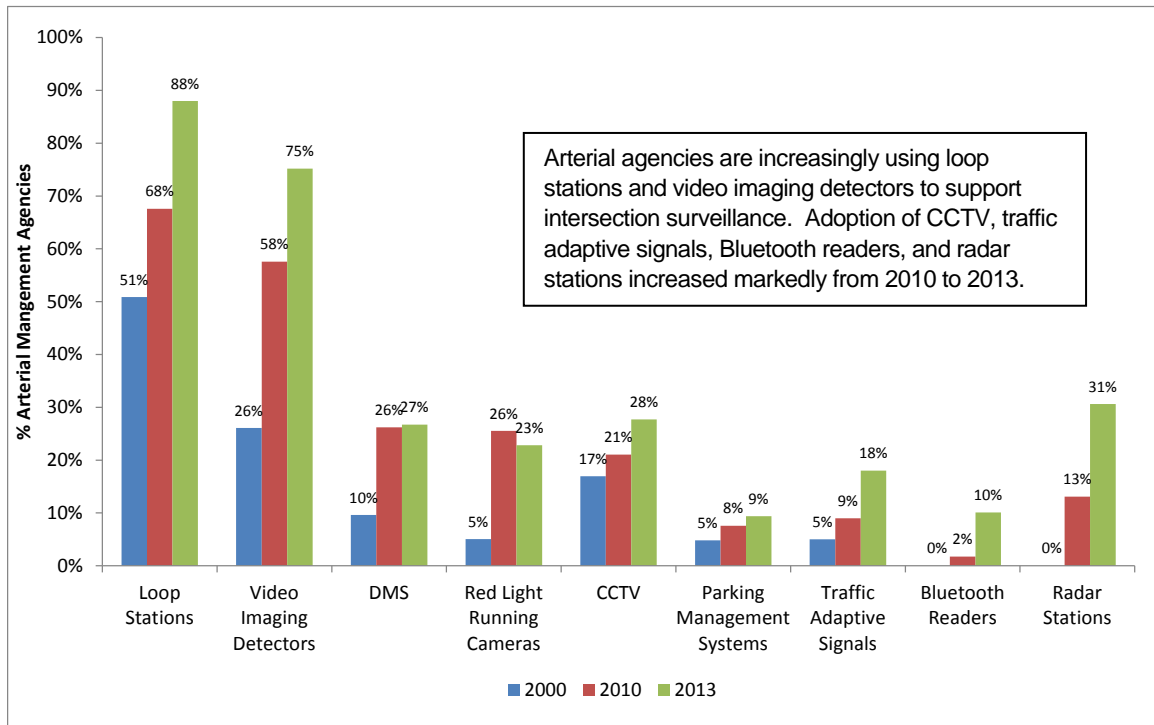


Figure 2-8. Technologies Adopted by Arterial Agencies, 2000 - 2013

Traffic adaptive signal timing provides a capability to implement strategies to optimize traffic signal operations. However, as shown in Figure 2-8, prior to 2013 the adoption of traffic adaptive signal timing was growing slowly, increasing only from 5% of arterial agencies to 9% between 2000 and 2010. In the 2010 survey, questions were included to determine why agencies were not deploying traffic adaptive signals to a greater extent. These questions were repeated in the 2013 survey, providing an opportunity to see if attitudes had changed over three years. Figure 2-9 summarizes the results from both years. The most common reasons cited in both surveys were cost to deploy followed by uncertainty about benefits and cost to operate and maintain. While the 2013 results follow the 2010 pattern of responses generally, the percentage of agencies reporting each reason was reduced by one third to one half in 2013. These results appear to indicate the community is less concerned about problems associated with deploying traffic adaptive signaling. This conclusion is borne out by the results seen in Figure 2-8 above, showing a two fold increase in the adoption of traffic adaptive signaling between 2010 and 2013.

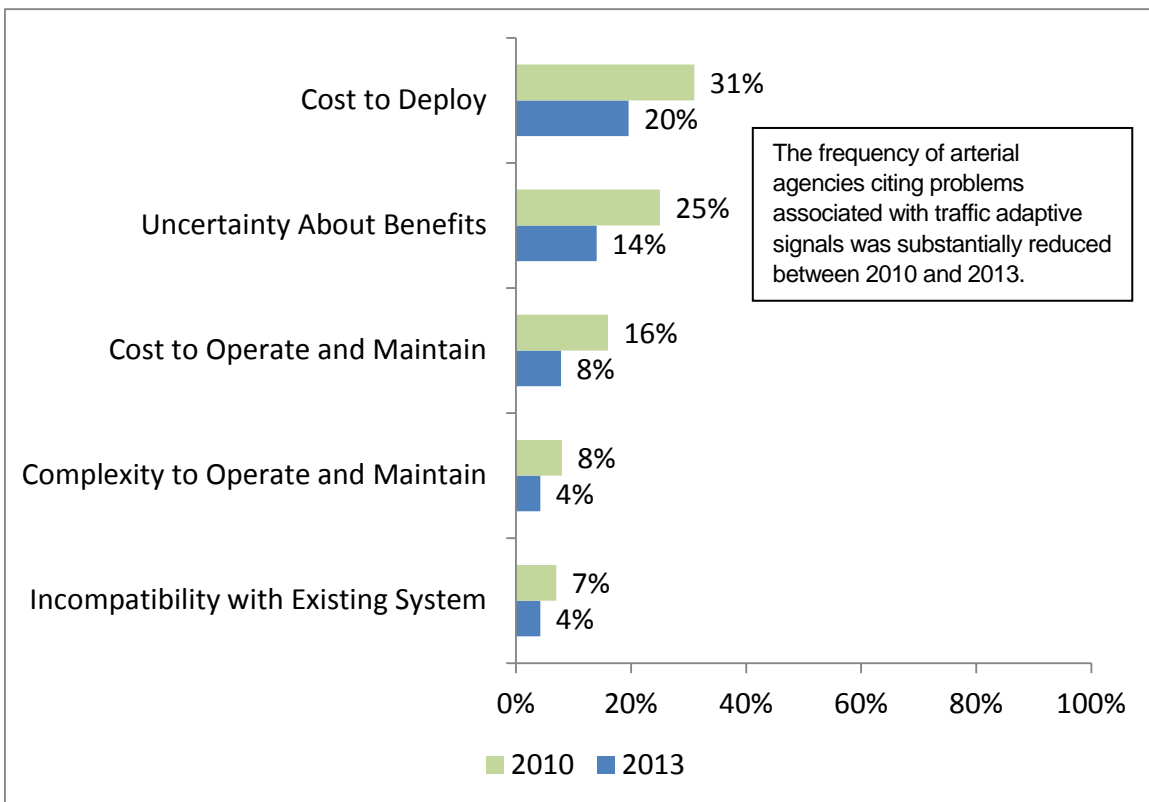


Figure 2-9. Reasons for not Using Traffic Adaptive Signal Systems, 2010 - 2013



Arterial agencies use a variety of media to distribute traveler information as shown in Figure 2-10. Figure 2-10 compares the 2013 data to 2010 and shows that there has been a significant increase in the use of all media types by arterial agencies to distribute traveler information from 2010 to 2013. The use of websites increased from 40% of agencies to 45%, DMS from 22% to 29%, and 511 from 14% to 19% of agencies. The expansion of use of the internet and social media has been particularly rapid in this period. The use of Twitter is reported by three times as many agencies in 2013, and the use of email has doubled. Some media that were not included in the last survey are already well established. Facebook is used by 21% of arterial agencies, and smart phone apps by 8%.

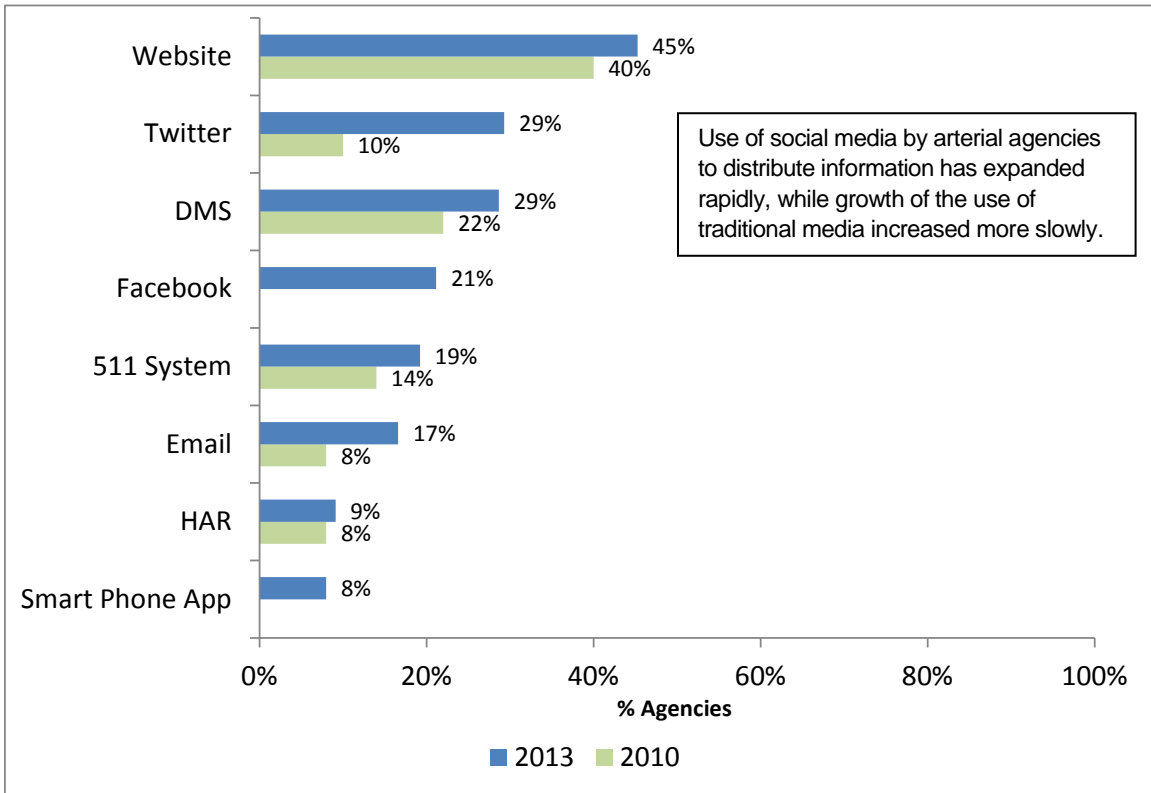
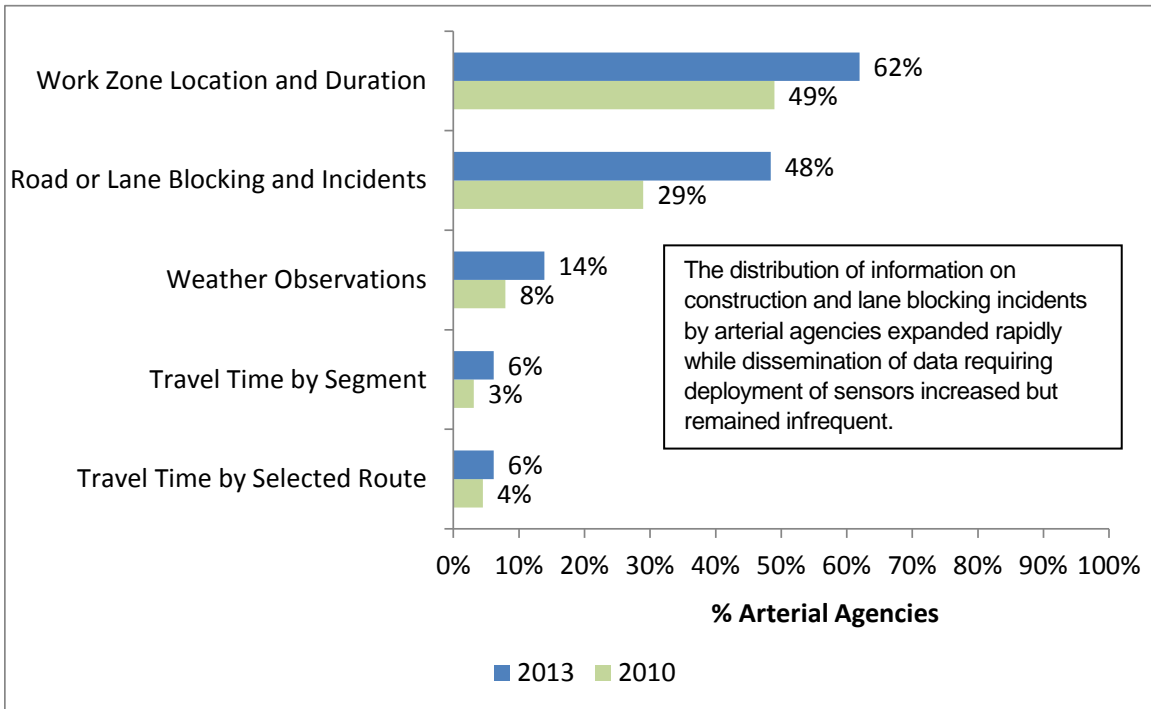


Figure 2-10. Media Used to Distribute Traveler Information by Arterial Agencies, 2010 - 2013

Figure 2-11 shows the change in the percentage of arterial agencies distributing different types of traveler information from 2010 to 2013. The results show a broad and rapid expansion in the distribution of traveler information. Agencies distributing work zone information increased from 49% to 62%, and road or lane blocking incidents from 29% to 48%. Distribution of data from field sensors increased as well, although remaining relatively rare. Agencies distributing weather observations nearly doubled from 8% to 14%. The distribution of travel time by segment increased from 3% to 6% and for selected routes from 4% to 6%.



**Figure 2-11. Types of Traveler Information Distributed by Arterial Agencies, 2010-2013**

## Incident Management

Incident management is designed to quickly identify and respond to a variety of non-recurring events, including crashes that can impede the flow of traffic on the freeway and arterial street systems. Agencies rely upon CCTV and incident detection algorithms to identify incident occurrence. In response, agencies use dedicated service patrols or highway helper services to clear incidents. Very often, motorists who observe incidents provide reports directly to police, emergency response, and traffic management officials.

Data on incident management deployments for freeway and arterial agencies are summarized in Figure 2-12, covering deployment data from 2000 to 2013. Over that time, the coverage of freeway miles by service patrols increased from 40% of freeway miles in 2000, to 48% in 2010 and to 55% in 2013. The CCTV coverage has increased more rapidly than freeway service patrols, growing from 16% of freeway centerline miles in 2000 to 46% 2010 and 57% by 2013. The use of computer algorithms to detect incidents is not growing and apparently has been displaced by the combination of CCTV and traveler cell phone calls. The incident management indicators for arterials (use of detection algorithms, CCTV and service patrols) were unchanged from 2010.

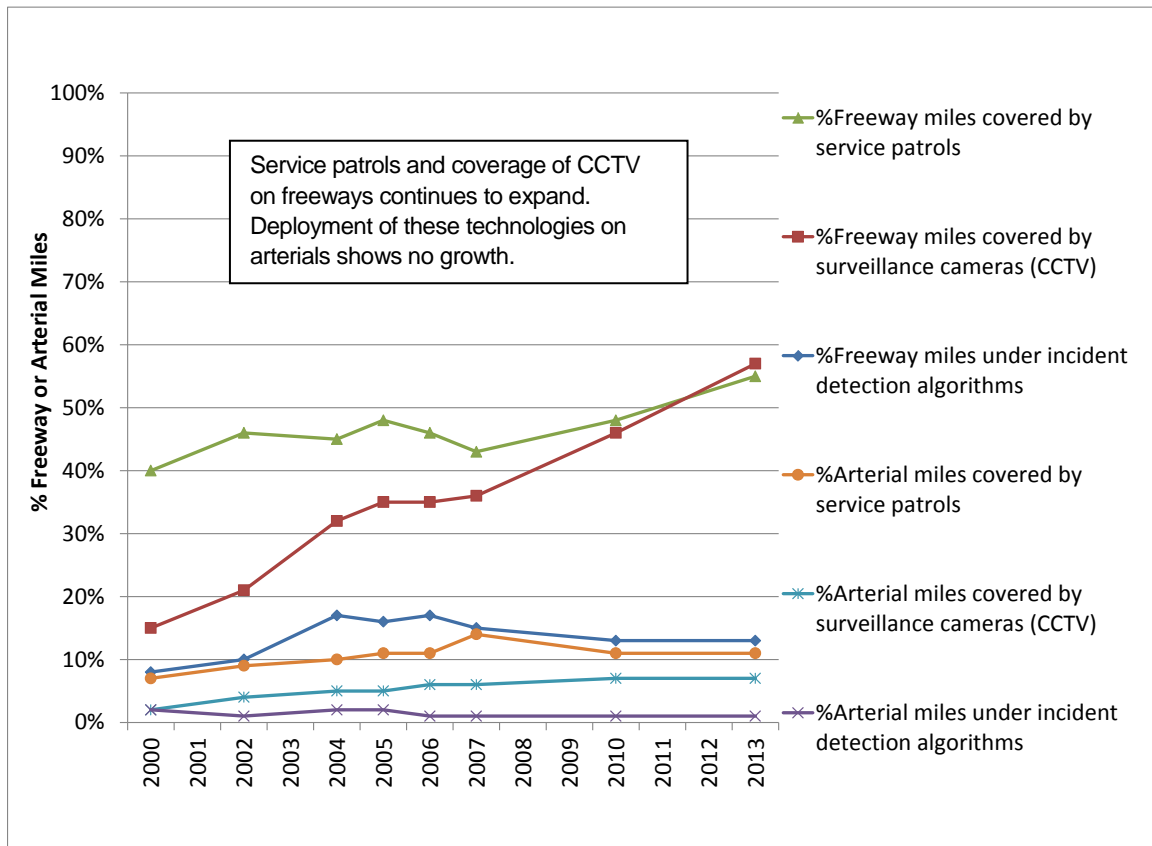


Figure 2-12. Incident Management Deployment Indicators, 2000 - 2013

## Transit Management

Transit management consists of a broad range of strategies and technologies designed to improve the operations of transit vehicles and services. Operating buses and paratransit vehicles are a primary focus of many transit agencies, however agencies also operate light rail, heavy rail, commuter rail and ferry services. Transit management deployment trends are summarized in Figure 2-13. Since 2000, there has been a significant increase in the deployment of several transit technologies. The percentage of fixed route buses equipped with AVL increased from 31% of vehicles in 2000 to 66% in 2010 and to 86% in 2013. In addition, the demand responsive vehicles operating under CAD increased from 88% of vehicles in 2010 to become virtually universal by 2013, after climbing from 28% of vehicles in 2000. Finally, the proportion of fixed route buses equipped with electronic real-time monitoring system components increased from 15% in 2000 to 35% in 2010 and 48% in 2013.

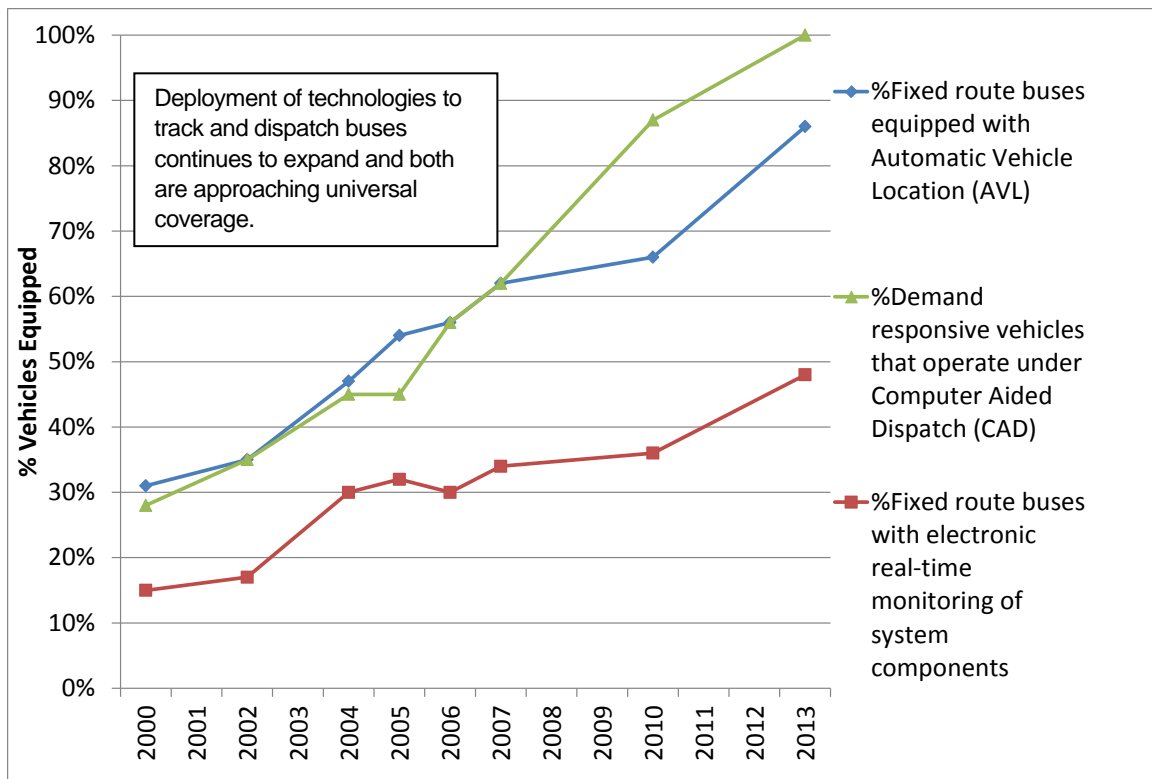


Figure 2-13. Transit Management Deployment Indicators, 2000 - 2013

Similar to the changes in deployment shown in Figure 2-13 above, the adoption of ITS technology by transit agencies is generally increasing. This can be seen in Figure 2-14 which compares the level of adoption for several field devices in 2013 to 2000 and 2010. The data show that transit agencies continued to increase the adoption of AVL and electronic fare payment technologies in 2013, and at an accelerated rate between 2010 and 2013. The proportion of agencies deploying AVL on fixed route bus has increased from 21% of transit agencies in 2000 to 54% in 2010 and to 63% in 2013. The percentage of agencies deploying magnetic strip readers on fixed route buses increased from only 5% in 2000 to 40% in 2010 and rose to 48% in 2013. Similarly, adoption of smart card readers increased from only 3% of agencies in 2000 to 24% in 2010 and 30% in 2013. Adoption of traffic signal priority systems on fixed route buses, on the other hand, continued to stagnate in 2013 at about 26% of agencies.

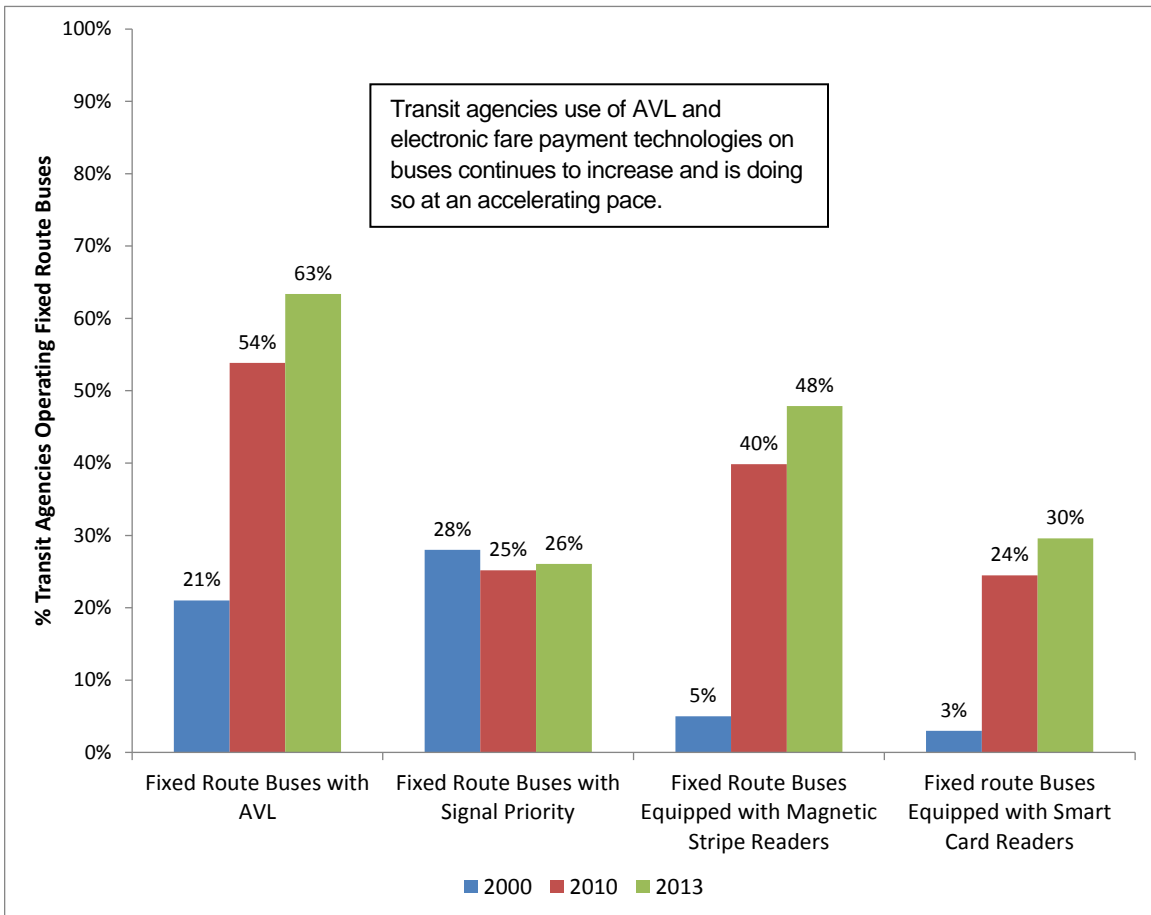
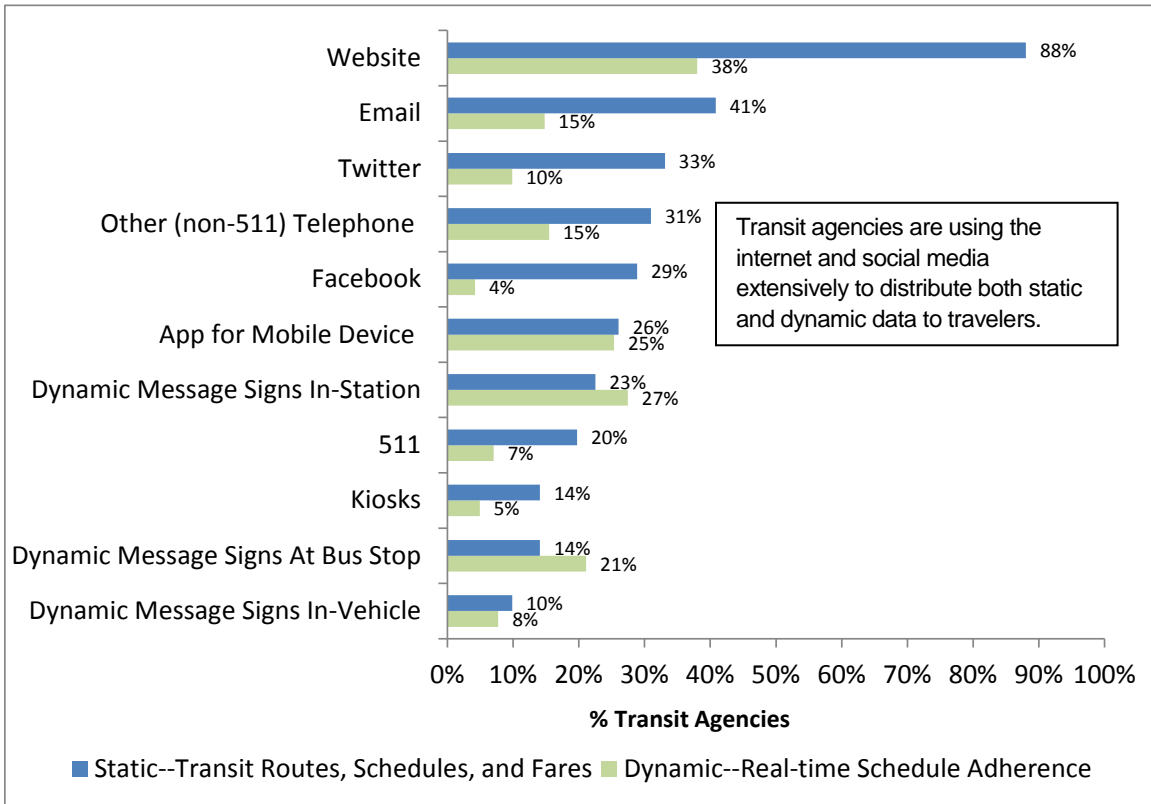


Figure 2-14. Technologies Adopted by Transit Agencies, 2000, 2010, and 2013

Transit agencies distribute two types of information: static, consisting of transit routes, schedules, and fare information; and dynamic, covering real-time transit schedule adherence. As with freeway and arterial agencies, transit agencies are making extensive use of the internet and social media to distribute traveler information. As shown in Figure 2-15, the various media are typically used more often to distribute static information than dynamic information. Websites are the most commonly used media, with 88% of transit agencies using it for static information compared to 38% for dynamic data. The next most widely used media follow a similar pattern: email (used by 41% of agencies for static information, 15% for dynamic information), Twitter (33% of agencies for static, 10% for dynamic), telephone (31% of agencies for static, 15% for dynamic) and Facebook (29% static, 4% dynamic). However, some media are used nearly as much or more to share dynamic data as static, including apps for mobile devices (in use by 26% of agencies for static information and 25% for dynamic), DMS in stations (23% static, 27% dynamic), and DMS at bus stops (14% static, 21% dynamic).



**Figure 2-15. Media used by Transit Agencies to Distribute Dynamic and Static Traveler Information**

## Transportation Management Centers (TMCs)

TMCs provide the focal point for management of transportation operations covering a wide variety of combinations of freeway, arterial, transit, and public safety agencies. Figure 2-16 summarizes the distribution of agencies being supported by TMCs. Most commonly reported are TMCs supporting both freeway and arterial agencies (31% of TMCs), which are supported separately by 20% of TMCs (arterial agencies) and 10% of TMCs (freeway agencies). Also widely reported are TMCs supporting freeway, arterial, and public safety (16%) with a smaller number of TMCs adding transit management (7%) to cover four modes. Other binary TMCs are also reported, covering arterial management and public safety (5%) and arterial management and transit management (4%), as well as other combinations reported by a small number of TMCs.

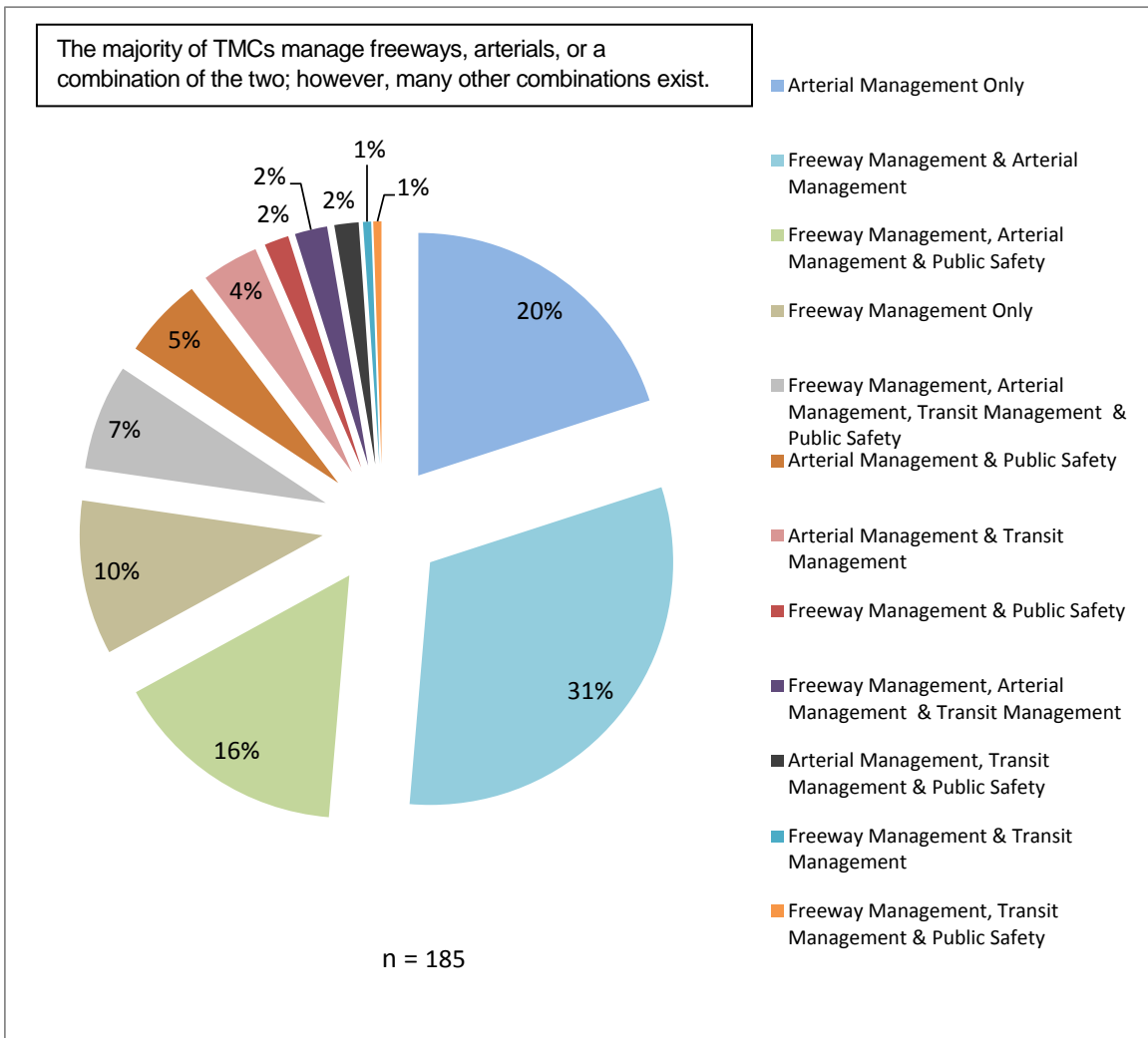
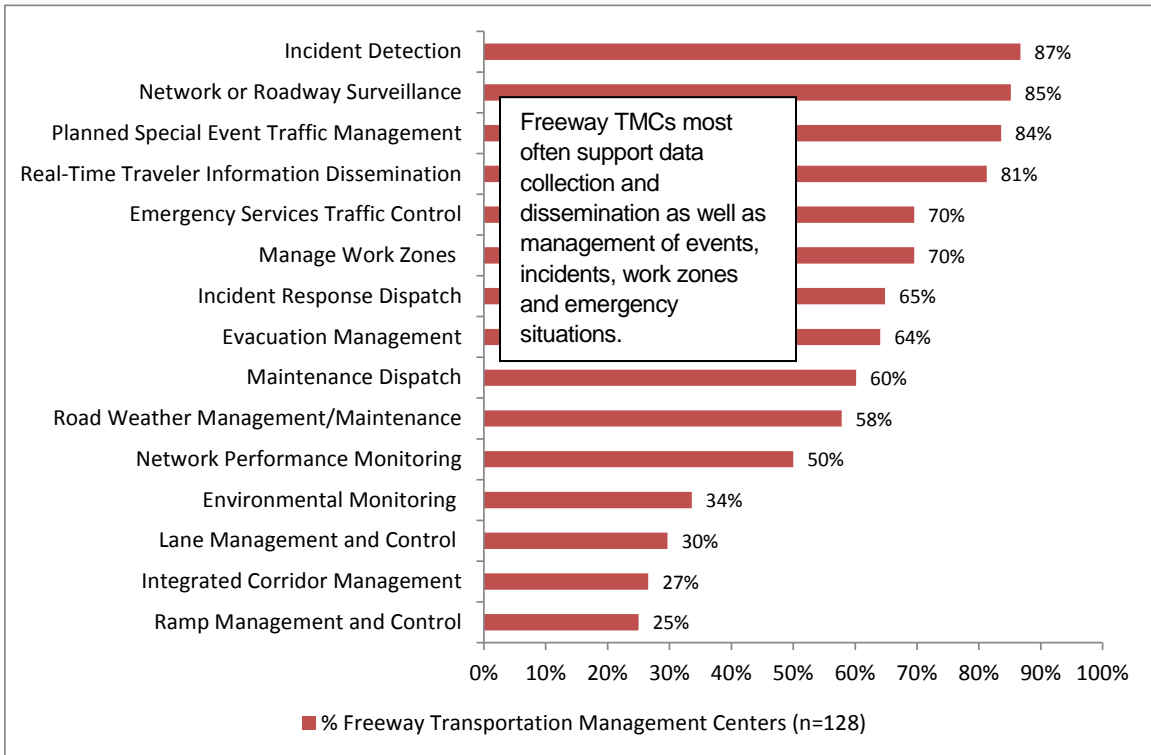


Figure 2-16. Types of Transportation Management Centers

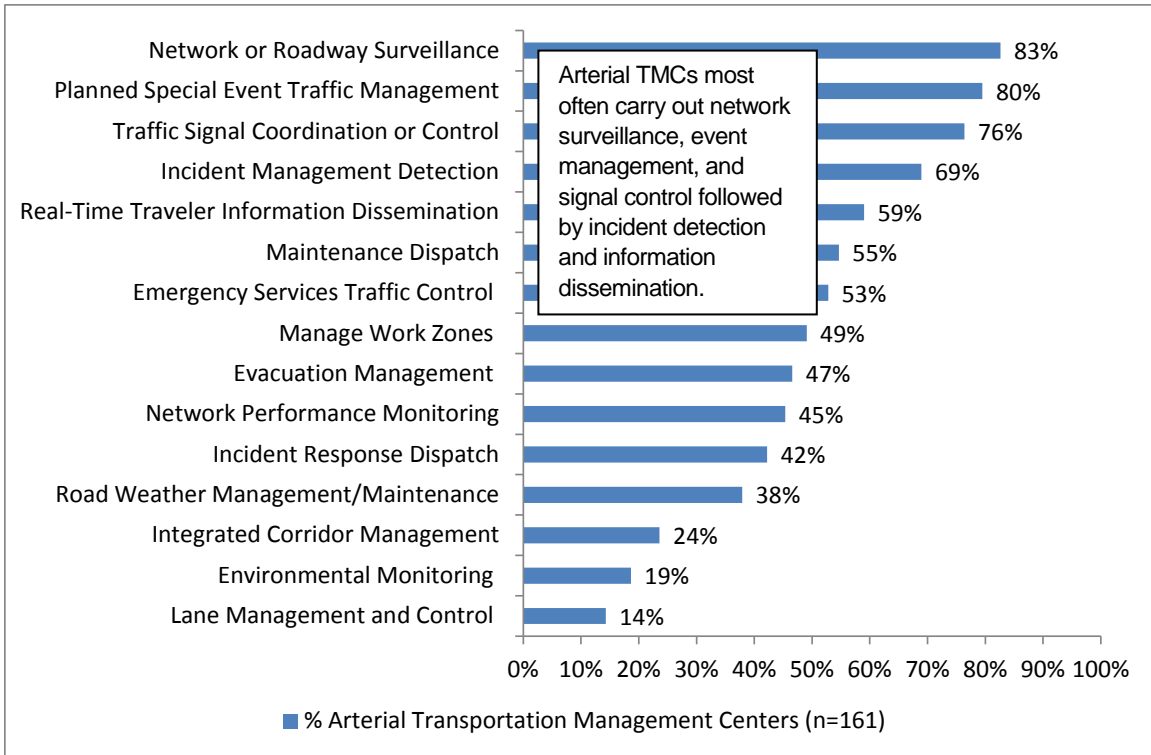
Figure 2-17 summarizes the frequency with which functions are performed on freeways by TMCs. In all, 15 different functions are supported by at least 25% of TMCs on freeways, all of which are supported by ITS technology. The use of technology is particularly important in supporting various types of surveillance--incident detection (87% of freeway TMCs), network surveillance (85%), network performance monitoring (50%), and environmental monitoring (34%)—as well as disseminating the data gathered through real-time traveler information (81%). Many functions involve management of operations in response to special circumstances: planned special event management (84% of TMCs), emergency services traffic control (70%), work zone management (70%), incident response management (65%), evacuation management (64%), maintenance dispatch (60%), and road weather management (58%). Finally, some TMCs exercise active control of day to day traffic through lane management (30% of TMCs), integrated corridor management (27%), and ramp management (25%).



**Figure 2-17. Functions Performed by Transportation Management Centers on Freeways**



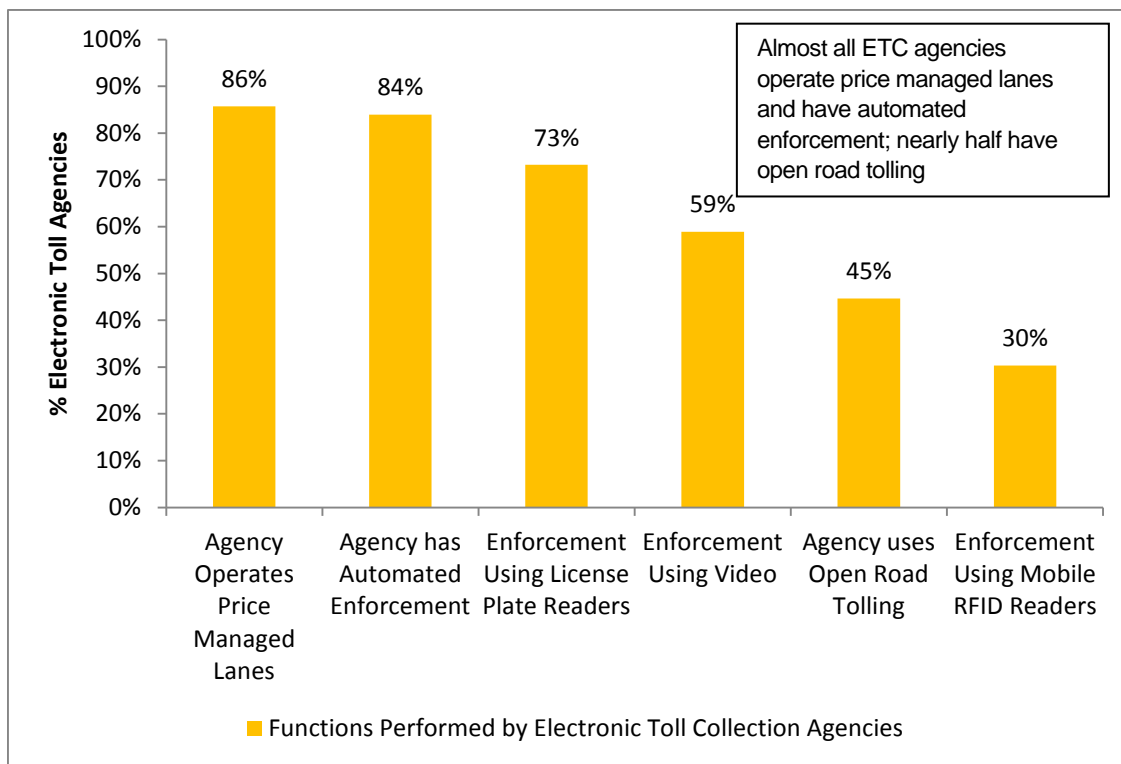
Figure 2-18 shows the range of functions performed by TMCs on arterials. In all, 15 functions are supported by at least 14% of TMCs. As with freeway TMCs, surveillance is a function of many arterial TMCs: network surveillance (83% of TMCs), incident detection (69%), network performance monitoring (45%), and environmental monitoring (19%). Real time traveler information dissemination (59%) is well-established, but lower than the 81% of agencies reported by freeway TMCs. Arterial TMCs also manage operations in response to special circumstances: planned special events (80% of arterial TMCs), maintenance dispatch (55%), emergency services traffic control (53%), work zones (49%), evacuation management (47%), incident response management (42%), and road weather maintenance (38%). Arterial agencies control traffic through traffic signal control (76%), lane management (14%) and integrated corridor management (24%).



**Figure 2-18. Functions Performed by Transportation Management Centers on Arterials**

## Electronic Toll Collection (ETC)

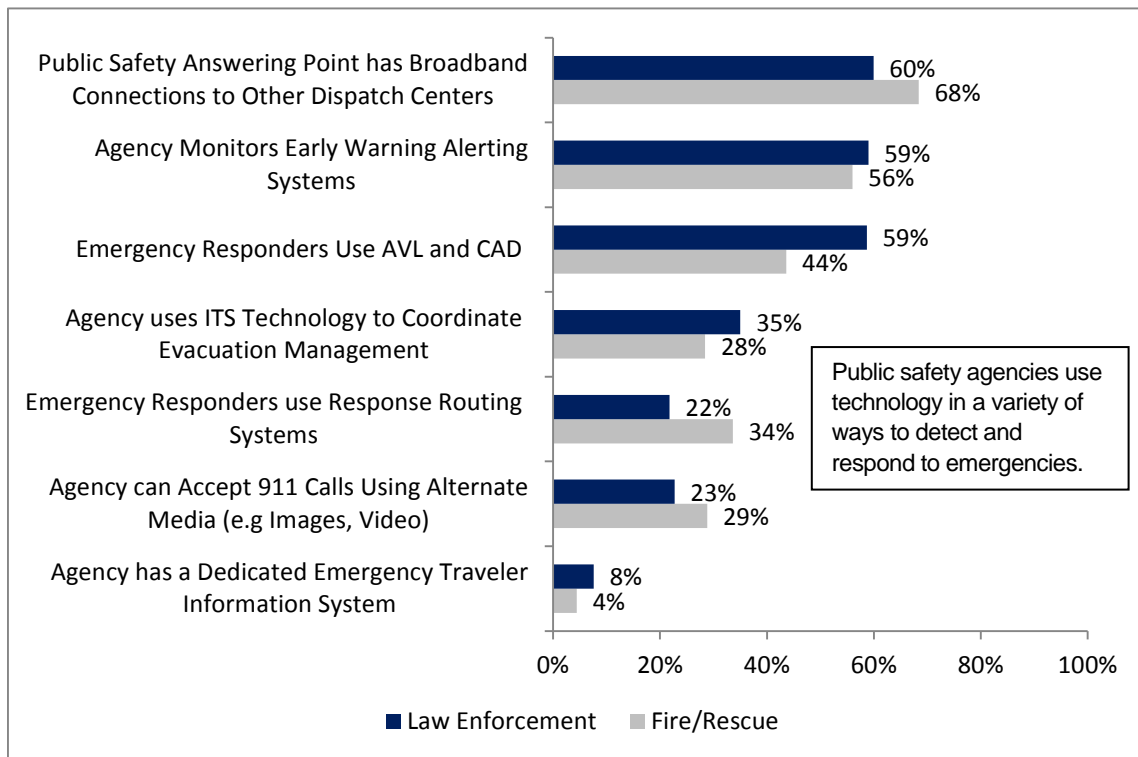
Figure 2-19 summarizes the percentage of agencies employing ITS technologies to support critical toll collection functions. A very high percentage (86%) of toll collection agencies has deployed ITS technology to improve traffic management through price managed lanes. Automated enforcement is another critical function supported by technology and is reported by 84% of the ETC agencies surveyed. Three different ITS technologies support automated enforcement with license plate readers, used by 73% of toll agencies being the most widely deployed, followed by enforcement using video cameras (59%). The third enforcement methodology, reported by 30% of the agencies, is the use of mobile RFID readers, typically located in police vehicles. In addition, nearly half of the agencies report using open road tolling to improve customer service by eliminating the need to slow down to pass through a toll booth.



**Figure 2-19. Use of ITS Technology by Toll Collection Agencies**

## Public Safety

Figure 2-20 shows how public safety agencies—law enforcement and fire/rescue—use a variety of technologies to support response and recovery. The critical first communication with public sector agencies is through the public safety answering point and 60% of law enforcement and 68% of fire/rescue agencies report having a broadband connection to other dispatch centers to support coordinated response and recovery. Another critical communication link is with early warning alerting systems, which are monitored by nearly 60% of both types of agency. The use of AVL and CAD is widespread but is higher for law enforcement agencies (59%) than fire/rescue (44%) as is the use of technology to coordinate evacuation management (35% for law enforcement to 28% for fire/rescue). On the other hand, more fire/rescue agencies report use of response routing systems to identify the best route to incidents than law enforcement (34% to 22%) and having the capability to handle 911 calls in multiple media, (29% to 23%). Finally, both agencies employ a dedicated emergency traveler information system to a limited extent.



**Figure 2-20. Use of Technology by Public Safety Agencies to Support Emergency Response and Recovery**

The safe and efficient movement of public safety vehicles responding to an incident is aided by close coordination with traffic management agencies. Figure 2-21 shows the types of interface between public safety agencies and traffic management. The most common type of interface is voice communication, reported by 46% of law enforcement and 35% of fire/rescue agencies. About a quarter of both types of agencies are co-located with traffic management. Data communication (CAD or XML) is used by 28% of law enforcement and 17% of fire/rescue agencies. Multimedia, including video, is a rarely used interface at this time, reported by 10% of law enforcement and 8% of fire rescue agencies. Overall, there is room for improvement in the interface between public safety and traffic management—35% of law enforcement and 44% of fire rescue agencies report having no interface at all with traffic management agencies.

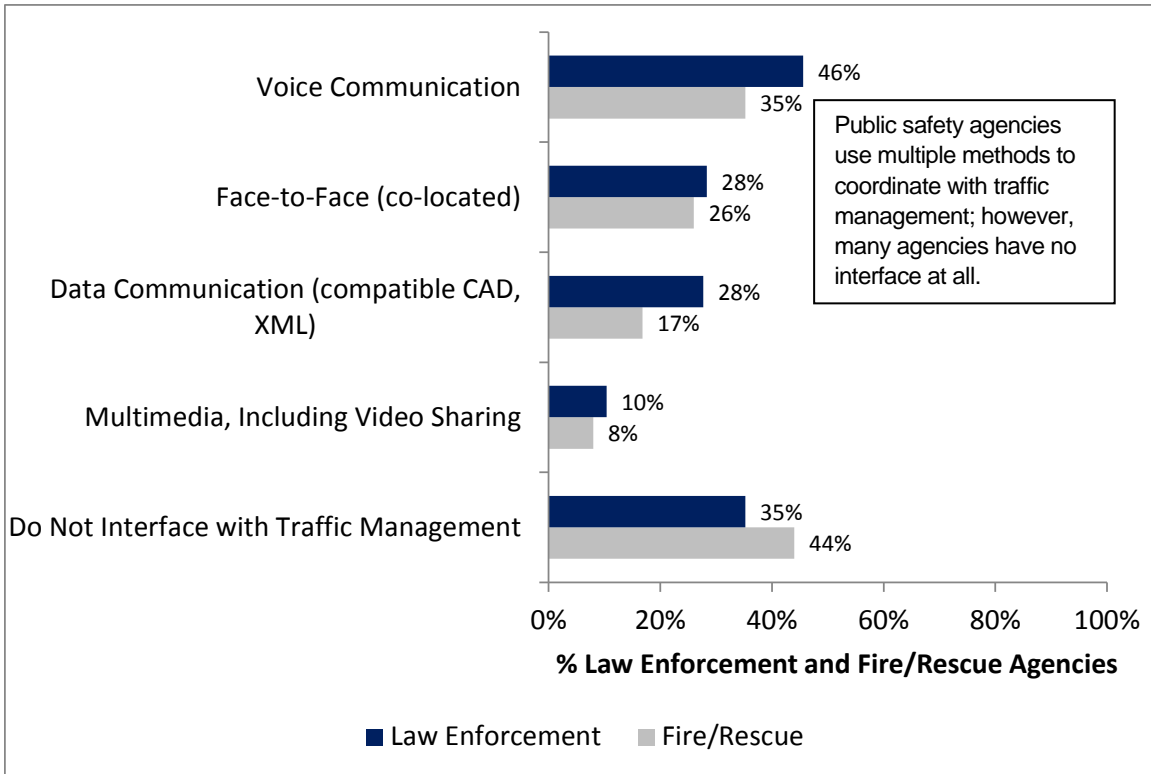


Figure 2-21. Interface between Public Safety Agencies and Traffic Management

# Chapter 3 Cross-Cutting Applications

The 2013 survey was expanded over previous versions with additional sections devoted to particular applications of ITS technology that are cross-cutting, with a similar set of questions repeated for different agency types. Since these additional topics are not strictly limited to one agency, it is more useful to report results by the application rather than separately for each agency type. Chapter 3 will cover survey results for the following cross-cutting applications:

- Operations Performance Management,
- Safety and Work Zone Systems,
- Road Weather Systems,
- Integrated Corridor Management (ICM),
- Planning for Operations,
- Maintenance of ITS Technology, and
- Dedicated Short Range Communication (DSRC) Standard.

## Operations Performance Management

It is critically important for transportation agencies to know if the highway systems are operating at the highest level of efficiency and that traffic management strategies are having their intended effect. The deployment of ITS technologies greatly enhances the ability of agencies to monitor traffic conditions using a variety of operations performance measures. A performance management approach enables agencies to not only detect problems but also to learn from successes and failures in dealing with them.

A performance management program involves the collection and use of operational data to track performance and can include the comparison of these data to specific performance goals to identify ways to improve service. Figure 3-1 shows the percentage of freeway and arterial agencies performing these functions. The first step in performance management is to collect operational data using a variety of performance measures. Performance data are collected by 68% of freeway agencies, a little more than twice the frequency of arterial agencies (30%). The performance data are archived to support analysis of system performance over time, and in 2013 52% of freeway agencies and 24% of arterial agencies reported archiving performance data for this purpose. Finally, comparing performance data to established targets provides a powerful tool to diagnose problems and develop improvements. Performance targets have been developed by 44% of freeway agencies and 15% of arterial agencies.

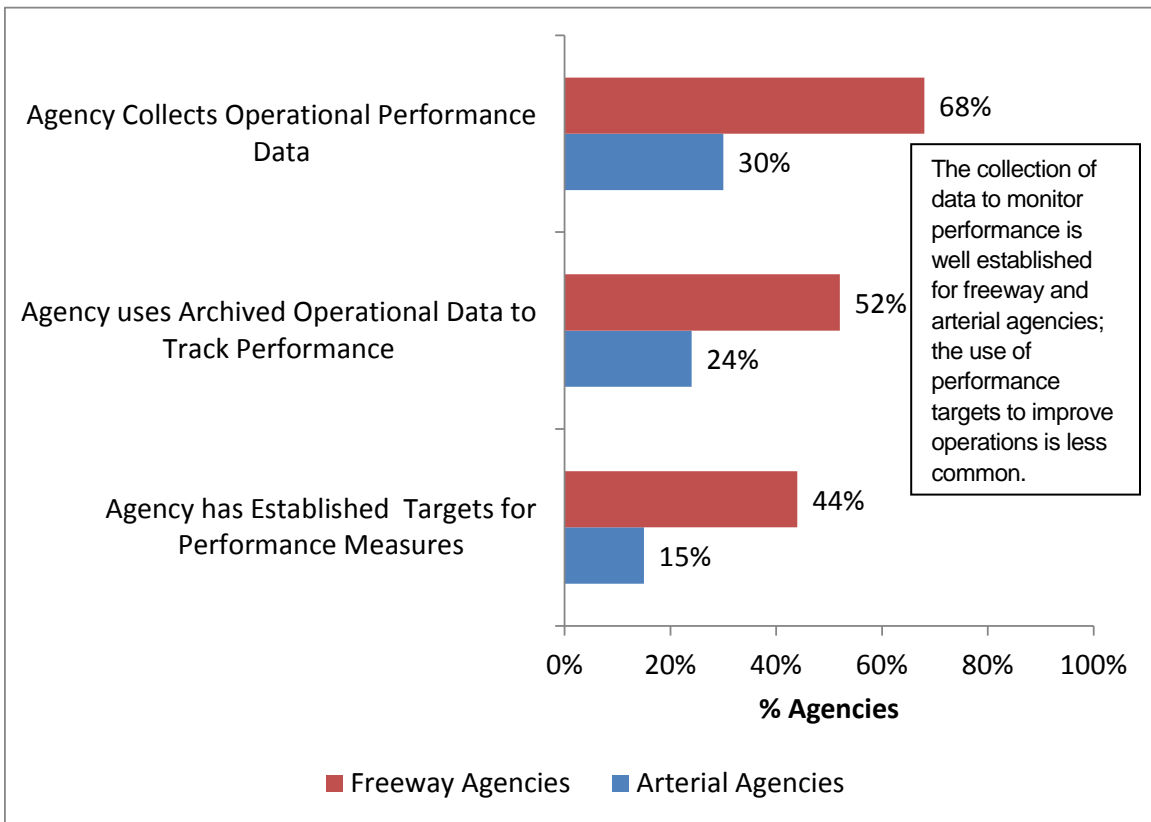
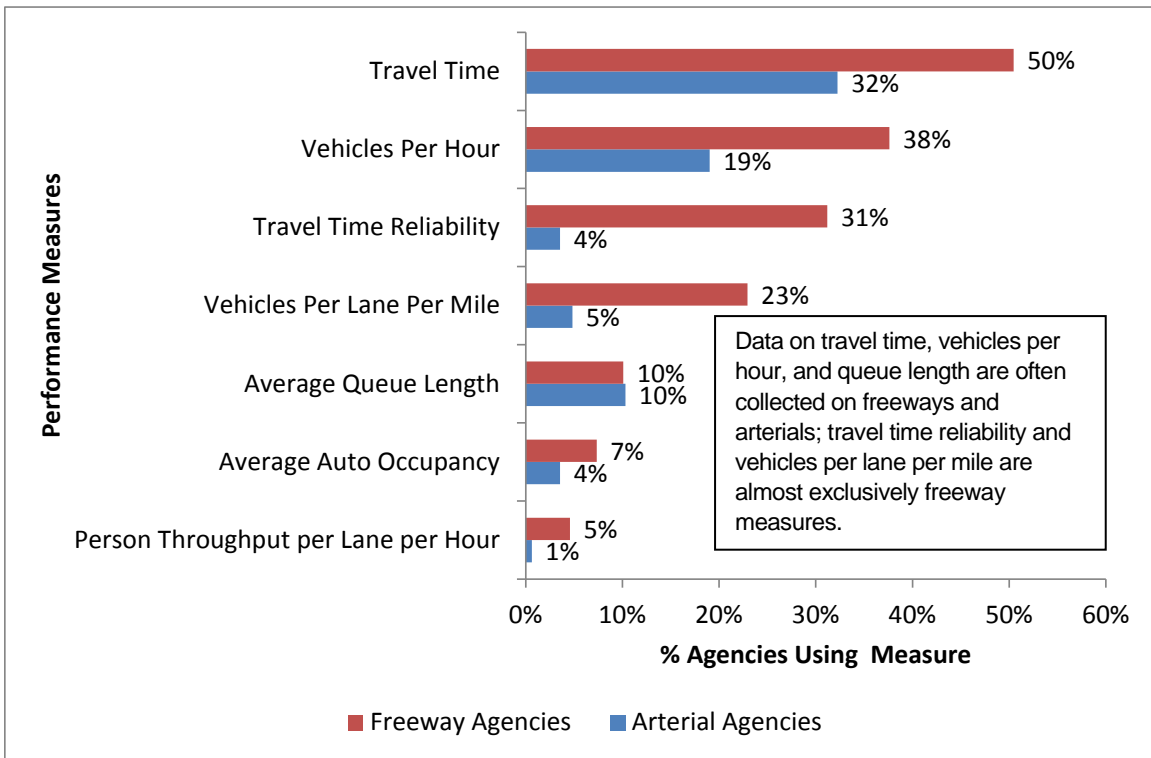


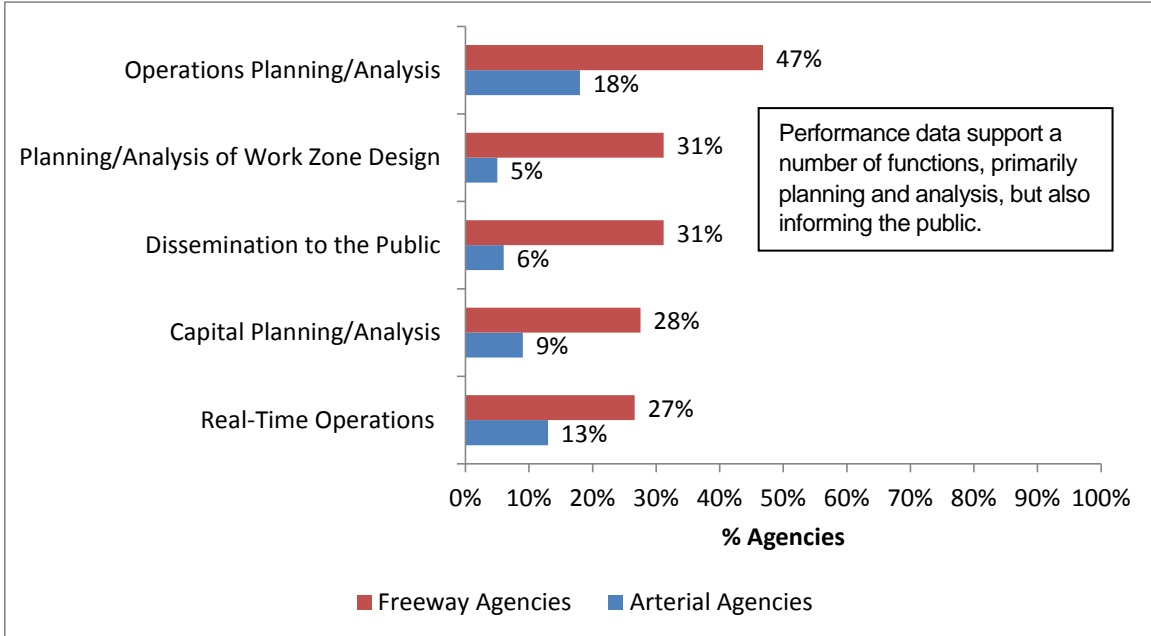
Figure 3-1. System Performance Management by Freeway and Arterial Agencies

Figure 3-2 compares the use of different performance measures by freeway and arterial agencies. Travel time is a particularly useful measure that can be used to monitor system performance and also reported to travelers. Travel time is the most often reported performance measure and is collected by 50% of freeway agencies and 32% of arterial agencies. A related measure, travel time reliability, however, is basically limited to freeway agencies (31% of agencies), with only 4% of arterial agencies using this measure. The remaining performance measures are used to track traffic management and throughput performance. Most widespread is the measurement of vehicles per hour, reported by 38% of freeway agencies and 19% of arterial agencies. Another measure, vehicles per lane per mile is more widely used by freeway agencies (23%) than arterial agencies (5%). Average queue length is an important arterial performance measure and is in use by 10% of both freeway and arterial agencies. The final two measures included in the survey are not widely used: average auto occupancy (reported by 7% of freeway agencies and 4% of arterial agencies) and person throughput per lane per hour (5% of freeway agencies and 1% of arterial agencies).



**Figure 3-2. Performance Measures Used by Freeway and Arterial Agencies**

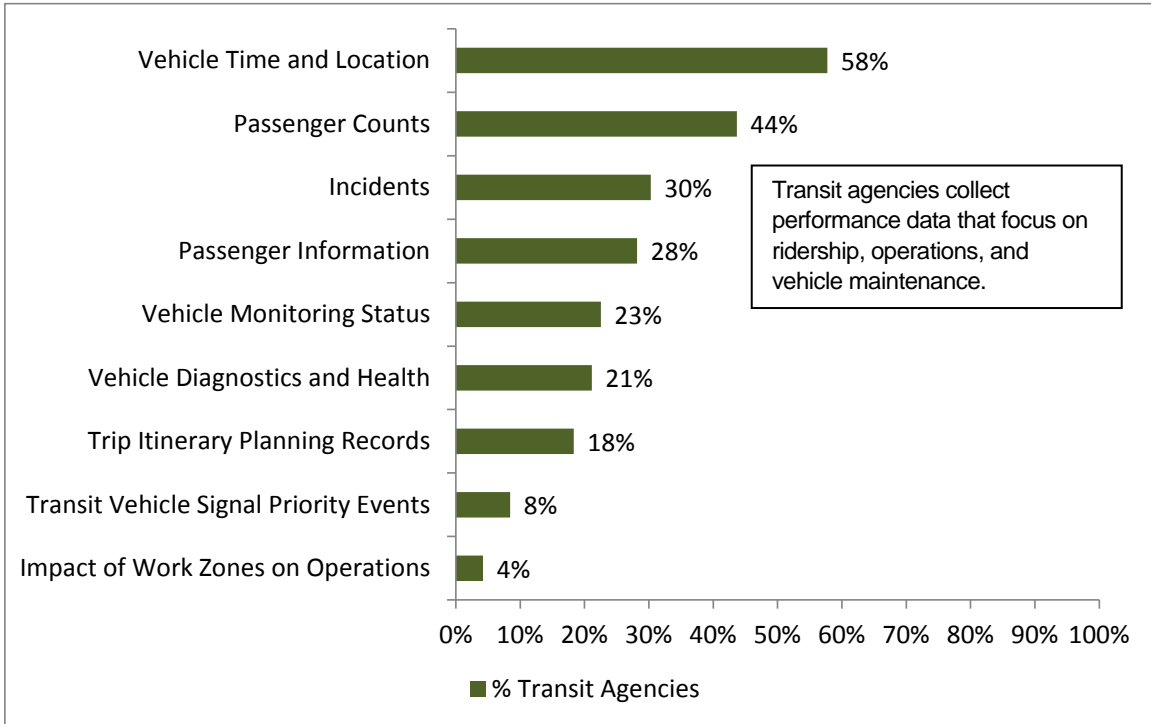
The performance data gathered through the use of ITS technology can be archived to support a variety of functions. Figure 3-3 shows the functions supported by archived performance data for freeway and arterial agencies. The function most frequently supported is operational planning and analysis, reported by 47% of freeway agencies and 18% of arterial agencies. Use of archived data for other functions by freeway agencies is fairly widespread (reported by between 27% and 31% of agencies): planning/analysis of work zone design, dissemination to the public, capital planning, and real-time operations. Arterial agencies also use archived data to support these functions but to a lesser extent: real-time operations (13% of agencies), capital planning/analysis (9%), dissemination to the public (6%) and analysis of work zones (5%).



**Figure 3-3. Functions Supported by Archived Performance Data for Freeway and Arterial Agencies**

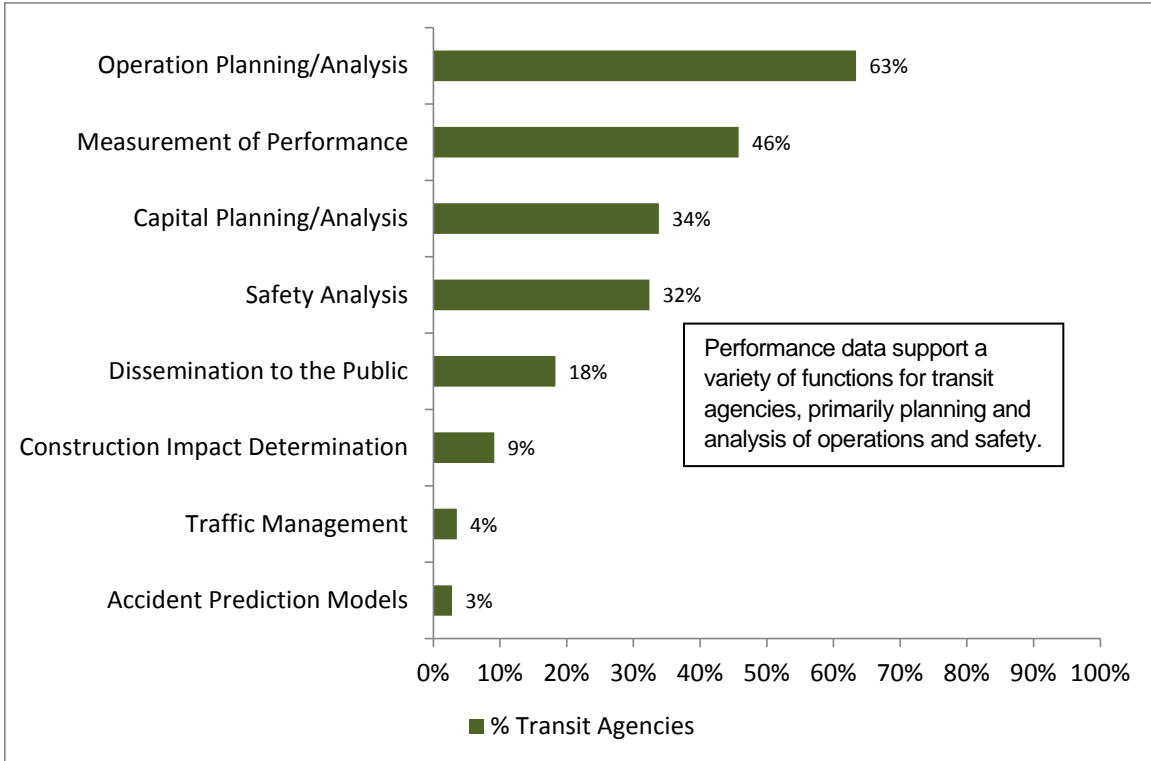


Transit agencies also use ITS technology to collect and track operational performance data. As shown in Figure 3-4, the two most commonly tracked performance measures are vehicle time and location (58% of agencies) and passenger counts (44%). Other important measures include data on incidents (30% of agencies), passenger information (28%), vehicle monitoring status (23%), vehicle diagnostics and health (21%), and trip itinerary planning records (18%). Also tracked and archived are transit vehicle signal priority events (8% of agencies) and the impact of work zones on operations (4%).



**Figure 3-4. Operational Data Collected and Archived by Transit Agencies**

Figure 3-5 shows the uses for archived performance data by transit agencies, many of them the same categories as freeway and arterial agencies. Operational planning and analysis (63% of transit agencies) and performance measurement (46%) are the two most often cited. Capital planning (34% of agencies) and safety analysis (32%) are also widely supported, followed by dissemination to the public (18%). Archived data are used for construction impact determination by 9% of transit agencies and also support traffic management and accident prediction models for some agencies.



**Figure 3-5. Functions Supported by Archived Performance Data for Transit Agencies**

## Safety and Work Zone Systems

Managing traffic during construction is necessary to minimize traffic delays, maintain motorist and worker safety, complete roadwork in a timely manner, and maintain access for businesses and residents. Transportation agencies use ITS technologies to make travel through and around work zones safer and more efficient. Outside work zones, ITS technology is used to detect a variety of hazards and provide warnings to travelers. In the 2013 survey, freeway, arterial, and transit agencies were asked about the deployment of safety systems at work zones and elsewhere.

The use of ITS technologies in work zones by freeway and arterial agencies is shown in Figure 3-6. Portable CCTV cameras are deployed in work zones by 46% of freeway agencies and 9% of arterial agencies. Travel time systems are also widely used by freeway agencies (37%) and less often by arterial agencies (5%). Systems detecting queue length are in use by 21% of freeway and 5% of arterial agencies and alternative route guidance by 16% of freeway and 5% of arterial agencies. Finally, the use of portable HAR, variable speed limits, and speed enforcement or display systems are reported by between 11% and 8% of freeway agencies and much less frequently by arterial agencies. A sophisticated safety system to dynamically merge traffic approaching work zones is in use by 6% of freeway agencies and 2% of arterial agencies.

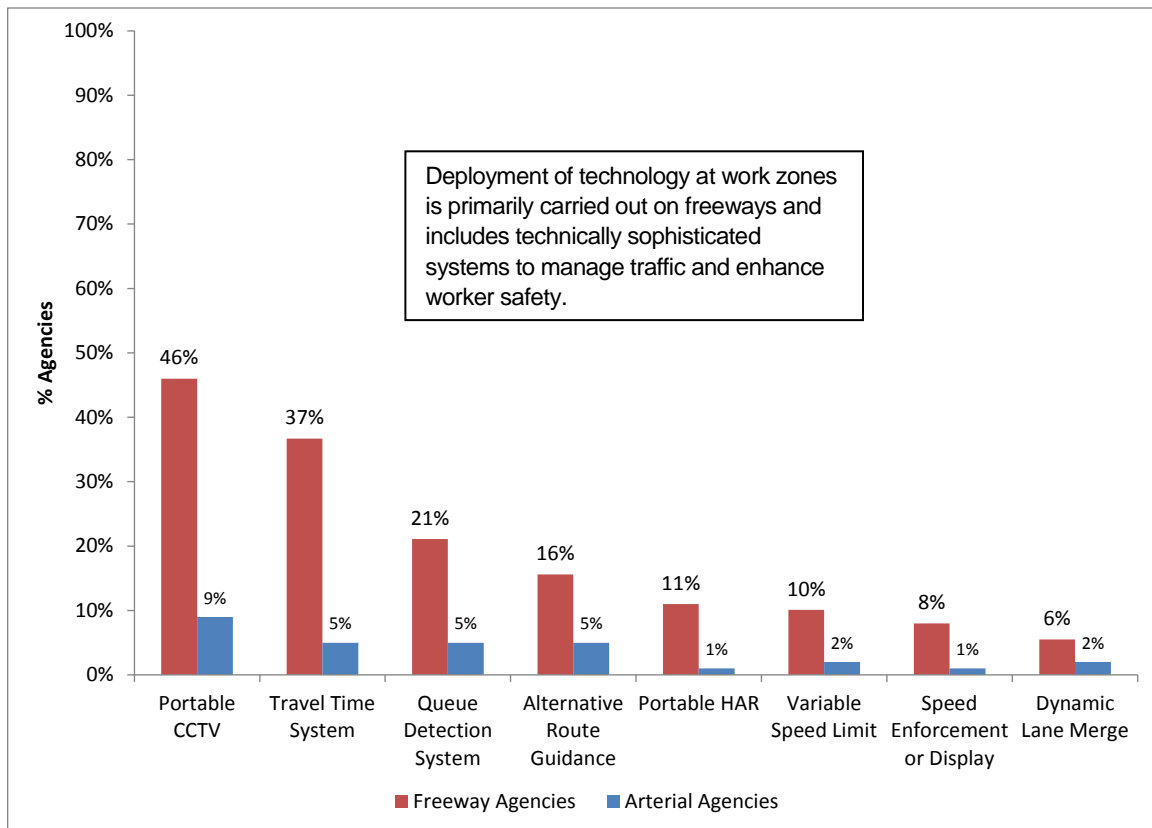
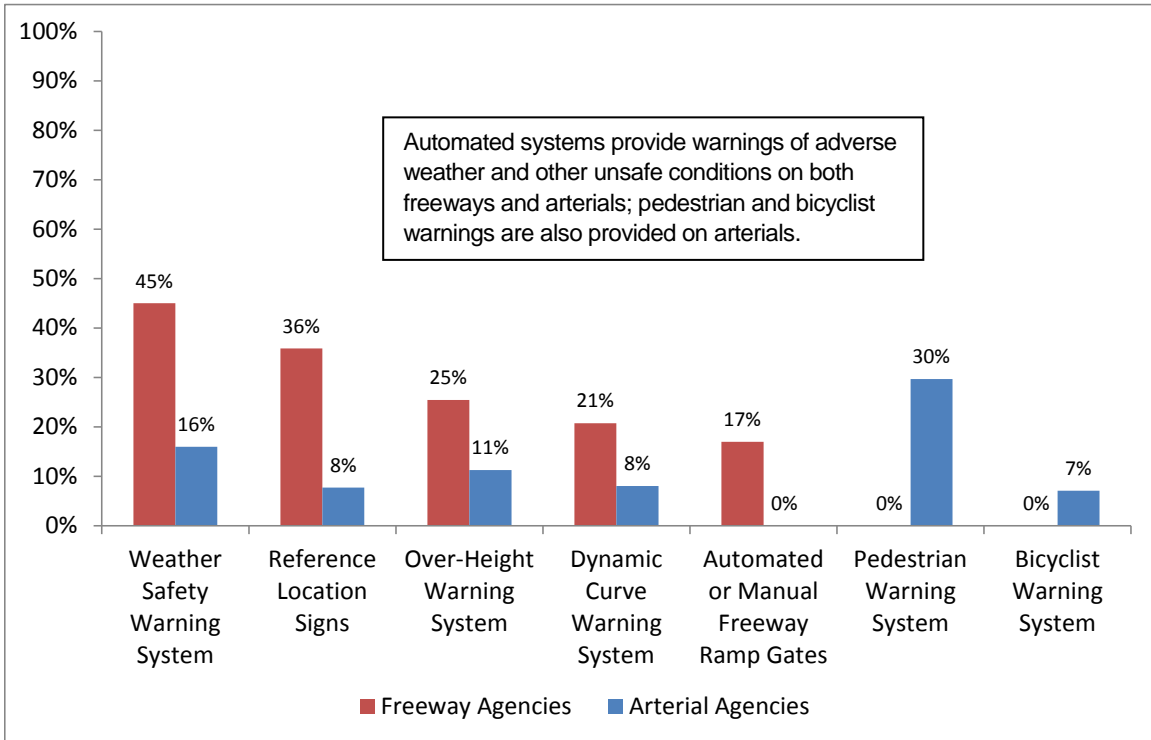


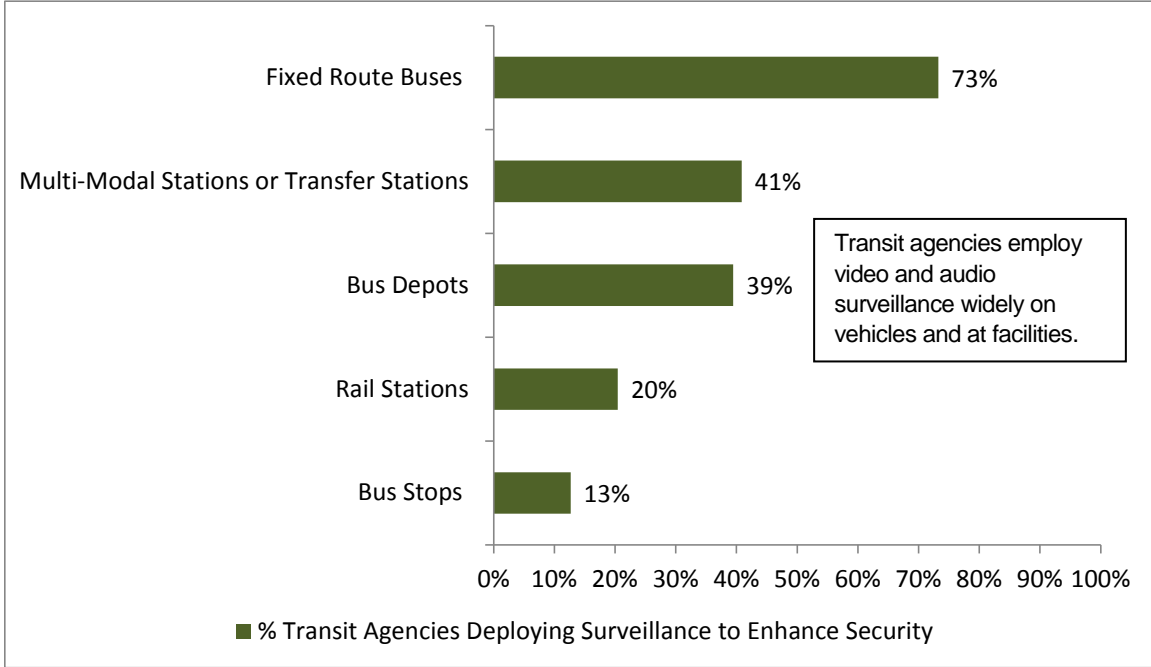
Figure 3-6. ITS Technologies Deployed in Work Zones by Freeway and Arterial Agencies

The deployment of safety systems outside work zones is shown for freeway and arterial agencies in Figure 3-7. Weather safety warning systems detect various weather hazards and provide warnings and are in use by 45% of freeway agencies and 16% of arterial agencies. The use of reference location signs, reported by 36% of freeway agencies and 8% of arterial agencies, supports accurate incident reporting by travelers. Two systems, over-height warning systems, in use by 25% of freeway and 11% of arterial agencies and dynamic curve warning systems, deployed by 21% of freeway agencies and 8% of arterial agencies, are sophisticated, stand-alone safety systems incorporating detection, threat assessment, and warning technologies. Ramp gates are limited to freeway operations and are in use by 17% of freeway agencies. Also fairly widely reported is the use of two warning systems unique to arterial agencies, automated pedestrian (30% of agencies) and bicyclist (7% of agencies).



**Figure 3-7. Deployment of Safety Systems by Freeway and Arterial Agencies**

Transit agencies deploy audio or video surveillance systems extensively to enhance security on vehicles and at facilities. Figure 3-8 shows that the most common application is on fixed route buses, reported by 73% of transit agencies. Surveillance is deployed at multi-modal stations or transfer stations (41% of agencies) and also at bus depots (39% of agencies). Deployment of surveillance equipment at rail stations is reported by 20% of transit agencies and at bus stops by 13% of agencies.

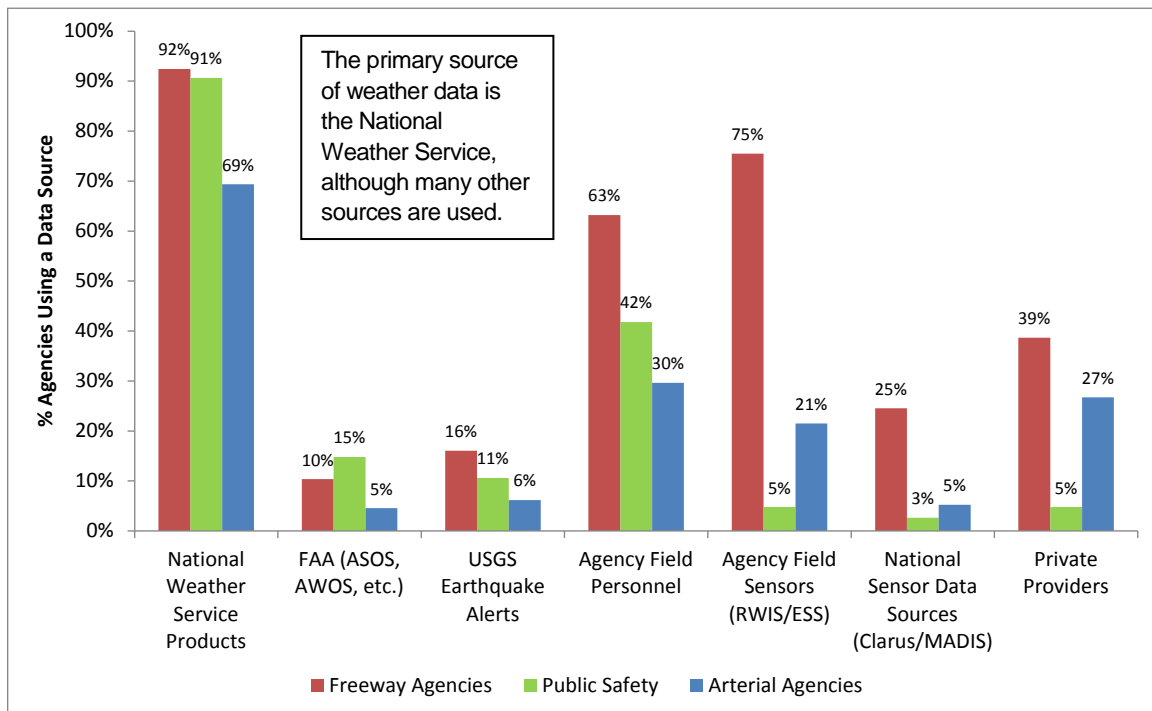


**Figure 3-8. Use of Audio or Video Surveillance to Enhance Security by Transit Agencies**

## Road Weather Systems

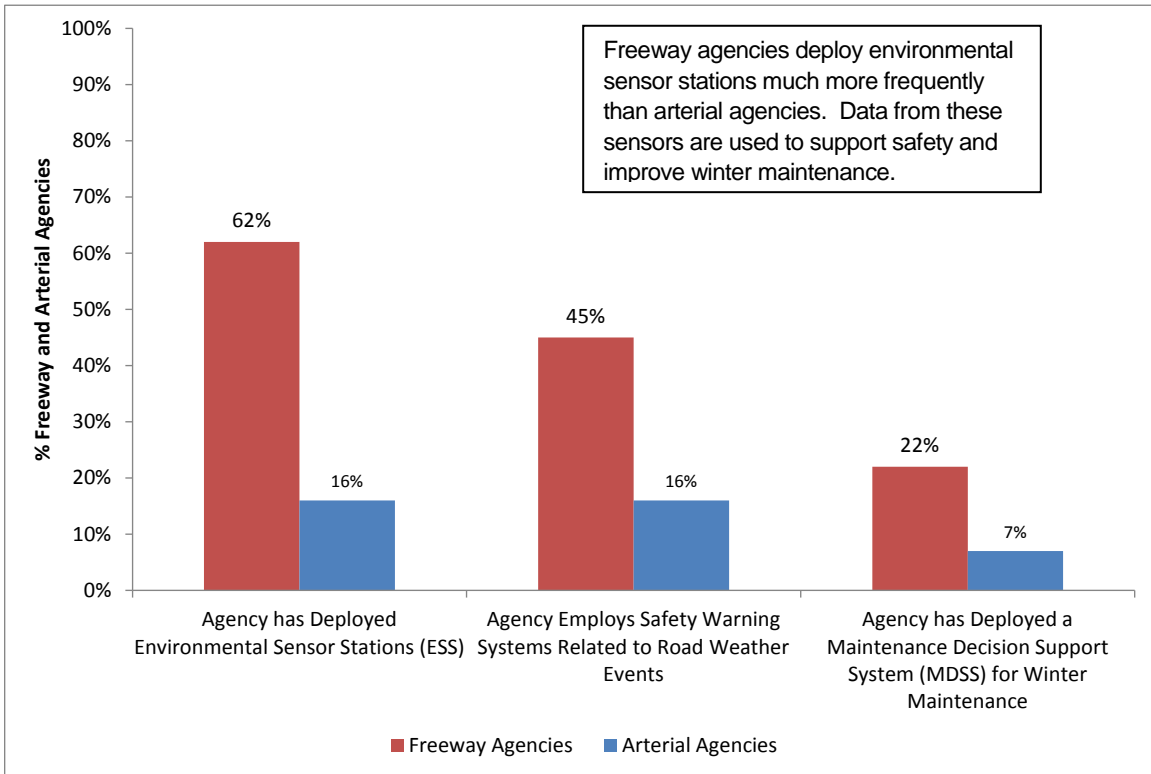
Adverse weather conditions have a major impact on transportation safety and operations. Weather affects driver behavior, vehicle performance, pavement friction, and roadway infrastructure. Weather also impacts roadway mobility by increasing travel time delay, reducing traffic volumes and speeds, increasing speed variance and decreasing roadway capacity. Transportation agencies deploy road weather systems to improve safety by reducing crash risk due to inclement weather, increase awareness among agencies and travelers of the real-time conditions, and restore safer driving conditions quicker and more efficiently.

Transportation agencies receive weather information from a variety of sources, including public sources, reports from field personnel, deployed sensors, and private providers. The use of weather data sources is shown for freeway, arterial and public safety agencies in Figure 3-9. The primary source of weather information for all three agency types is the National Weather Service, almost universally used by freeway and public safety agencies and reported by 69% of arterial agencies. Next in importance is data gathering from agency field personnel (reported by 63% of freeway agencies, 42% of public safety agencies and 30% of arterial agencies). The use of field sensors is a major source of weather data for freeways (reported by 75% of freeway agencies) and used less often (21%) by arterial agencies. Private providers are also a significant source of road weather agencies for freeway agencies (39% of agencies) and arterial agencies (27%). National sensor data sources are also used as a weather data source by 25% of freeway agencies.



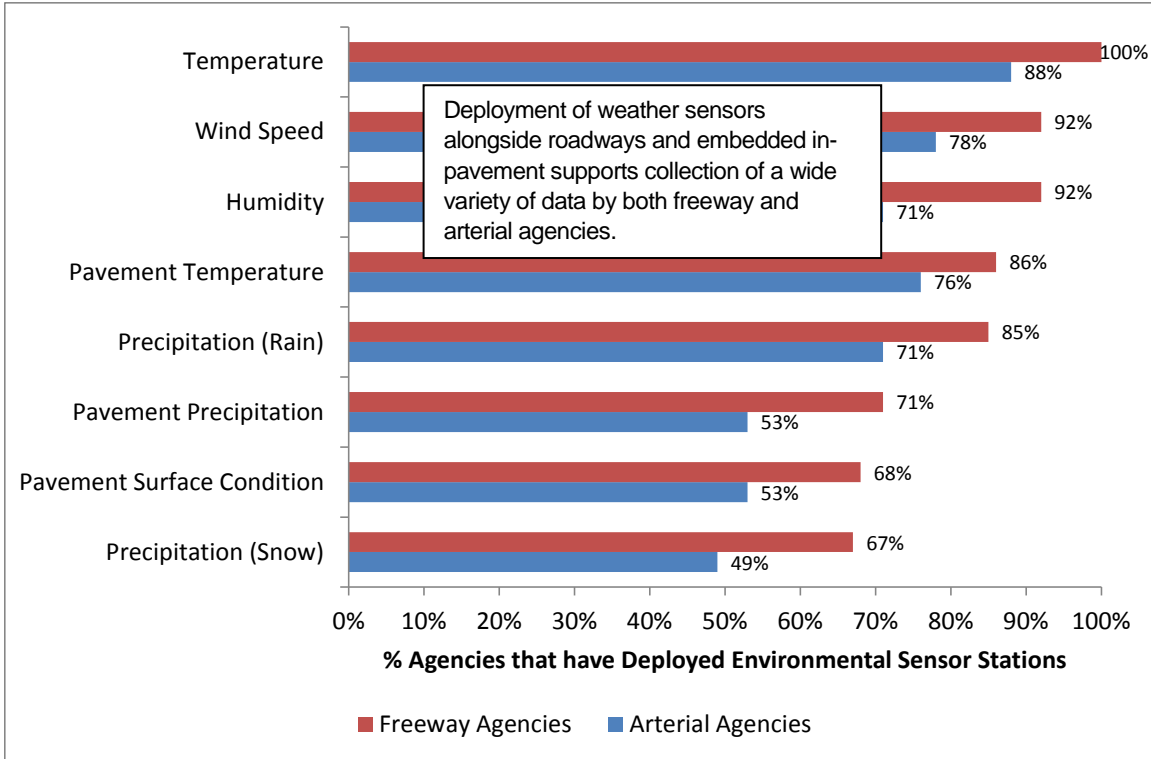
**Figure 3-9. Sources of Road Weather Information for Freeway, Arterial, and Public Safety Agencies**

Transportation agencies deploy weather sensors in order to detect unsafe conditions and to assist in managing the response to problems through winter maintenance. The types of weather-related ITS technologies employed by freeway and arterial agencies are displayed in Figure 3-10. Environmental sensor stations (ESS) are deployed to gather road weather information by 62% of freeway agencies and 16% of arterial agencies. Nearly half (45%) of freeway agencies and 16% of arterial agencies have deployed safety warning systems related to road weather events. Finally, a maintenance decision support system for winter maintenance is in use by 22% of freeway and 7% of arterial agencies.



**Figure 3-10. Deployment of Weather Technologies by Freeway and Arterial Agencies**

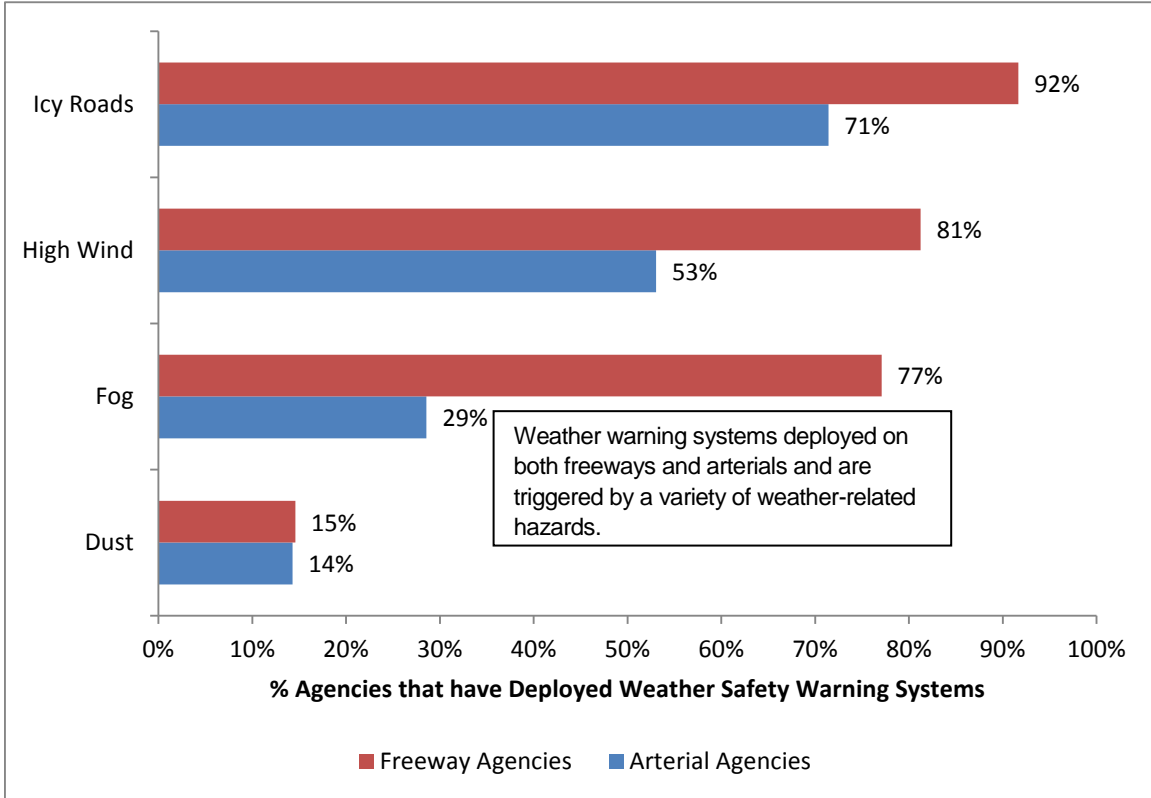
Environmental sensor systems vary in the types of weather information they collect due to differences in the sensors employed as well as whether the device is free-standing or embedded in the pavement. Figure 3-11 shows the different types of weather data collected by freeway and arterial agencies using ESS and in-pavement sensors. It can be seen that 100% of freeway agencies deploying ESS track temperature, with four other data types almost universally collected by freeway agencies as well: wind speed (92%), humidity (92%), pavement temperature (86%), and precipitation in the form of rain (85%). The collection of these data types by sensors deployed by arterial agencies is similarly high (88% to 71% of agencies deploying ESS). Collection of the final three types of weather data-- pavement precipitation, pavement surface condition, and precipitation (snow)--is reported by about two-thirds (71% to 67%) of freeway agencies and half (53% to 49%) of arterial agencies).



**Figure 3-11. Types of Data Collected by ESS and In-Pavement Sensors by Freeway and Arterial Agencies**



As with ESS, weather safety warning systems differ in the hazardous conditions they detect. Figure 3-12 shows the hazards that are handled by weather safety warning systems for freeway and arterial agencies. The results show that the most commonly covered hazard is icy roads, reported by 92% of the freeway agencies and 71% of the arterial agencies that have deployed weather safety warning systems. High winds are also covered extensively—81% of freeway and 53% of arterial agencies that have deployed weather safety warning systems. Fog is widely covered by systems deployed on freeways (77%) but much less frequently by arterial agencies (29%). Finally, detection of dust is lightly covered by the deployed weather warning systems—15% of freeway agencies and 14% of arterial agencies.



**Figure 3-12. Hazards Covered by Weather Safety Warning Systems for Freeway and Arterial Agencies**

## Integrated Corridor Management (ICM)

Integrated Corridor Management is a new concept for interagency coordination made possible by the use of ITS technology. With ICM, the different transportation agencies manage the transportation corridor as a single system, rather than the more traditional approach of managing individual assets. Close real-time coordination between agencies managing different modes is essential for ICM to succeed. The 2013 survey collected a large amount of data on ICM operations which can only be summarized in this report. Additional data, including details of specific interactions between agencies in a corridor are available through the deployment tracking website.

The ICM concept calls for coordinated transportation management of freeway, arterial, and transit agencies operating within the corridor. Where available, the coordinated management will be centered in a transportation management center. Figure 3-13 shows the participation of different agencies as part of an integrated corridor. The data shows that between 25% and 30% of TMCs, freeway agencies, and arterial agencies identified themselves as being part of a corridor, with 16% of transit agencies doing so.

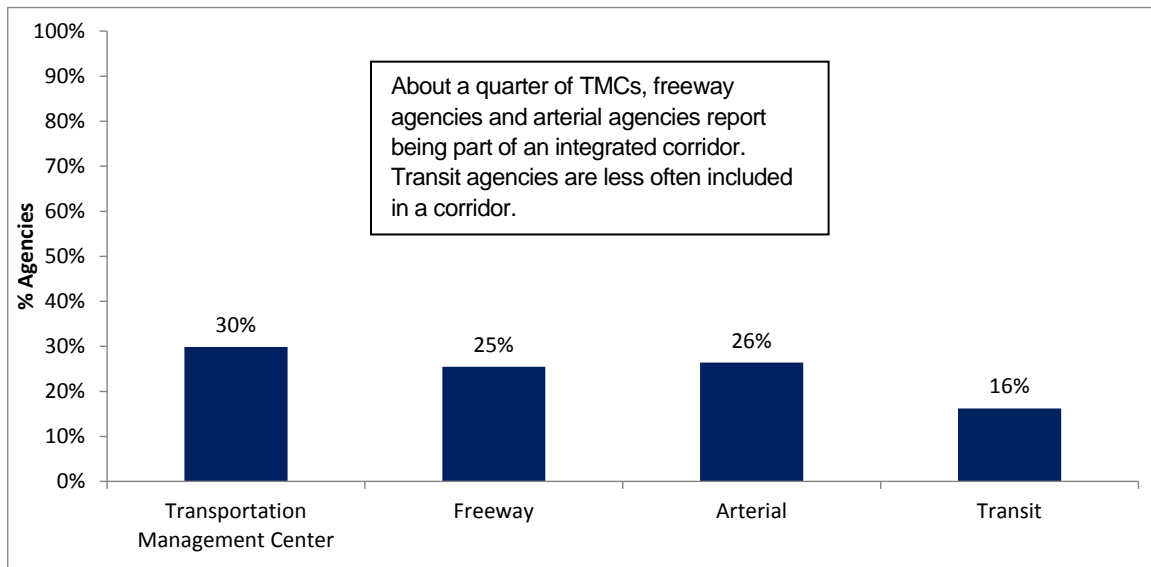
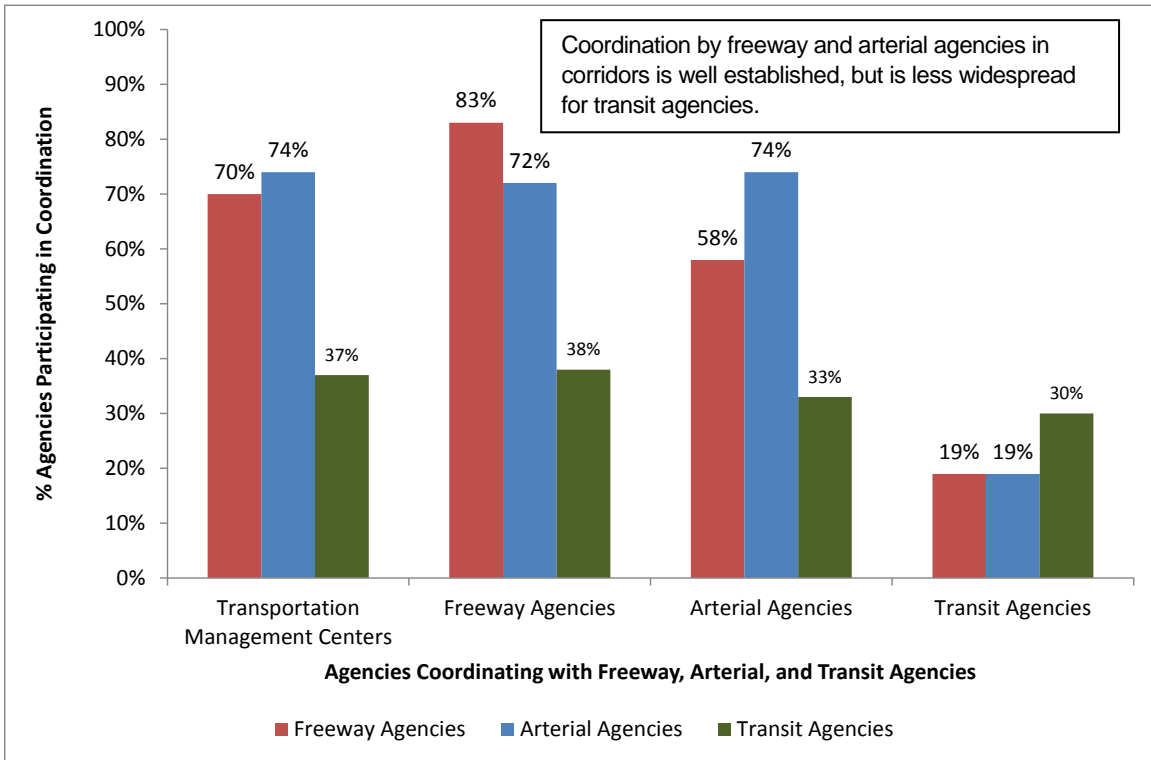


Figure 3-13. Agencies Participating in an Integrated Corridor

A fully functioning integrated corridor has the three modes of transportation, freeway, arterial and transit, coordinating with each other to jointly manage transportation. Agencies reporting that they operate in a corridor were asked to indicate with which agencies they are currently coordinating operations. The results, shown in Figure 3-14, indicate that coordination between TMCs, freeway, and arterial agencies is reported by about three fourths of the agencies, with a third of transit agencies doing so. This figure can be considered an indicator of the maturity of the existing integrated corridors, to the extent that coordination is less than complete in each case identifying the progress needed to achieve fully integrated transportation management.



**Figure 3-14. Agency-to-Agency Coordination in Existing Integrated Corridors**

The ultimate guarantor of interagency coordination is a legally binding agreement; however, in most cases the formality of interagency agreements in existing corridors is short of this goal. Figure 3-15 shows the formality of the agreements between coordinating agencies operating in a corridor. This coordination is defined in five levels, ranging from ad hoc to being part of a legal entity. The results show that in most cases, agreements fall within the first three levels: ad hoc with no regular meetings; informal working groups; and formally established working groups. Very few agencies report being involved with interagency coordination in the two highest levels: funded staff with defined responsibilities; and a legal entity with dedicated resources and a governing board. As in the previous case, transit agencies lag behind the other agency types in participation in the various types of interagency coordination.

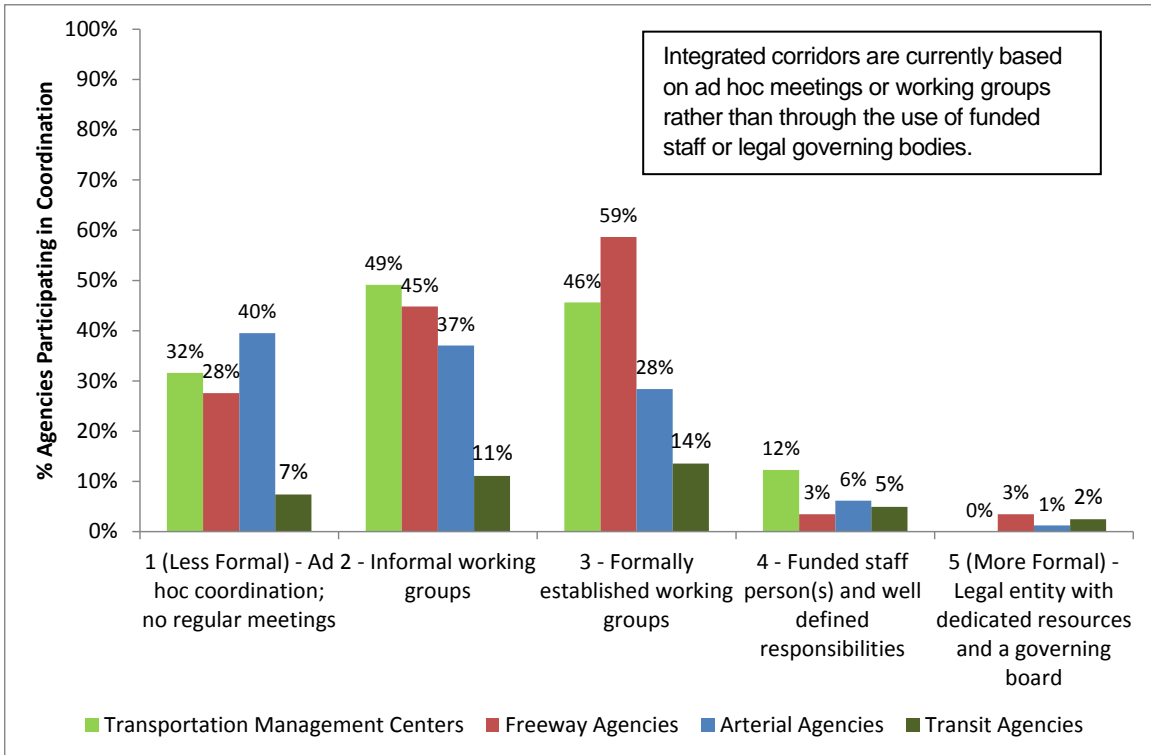
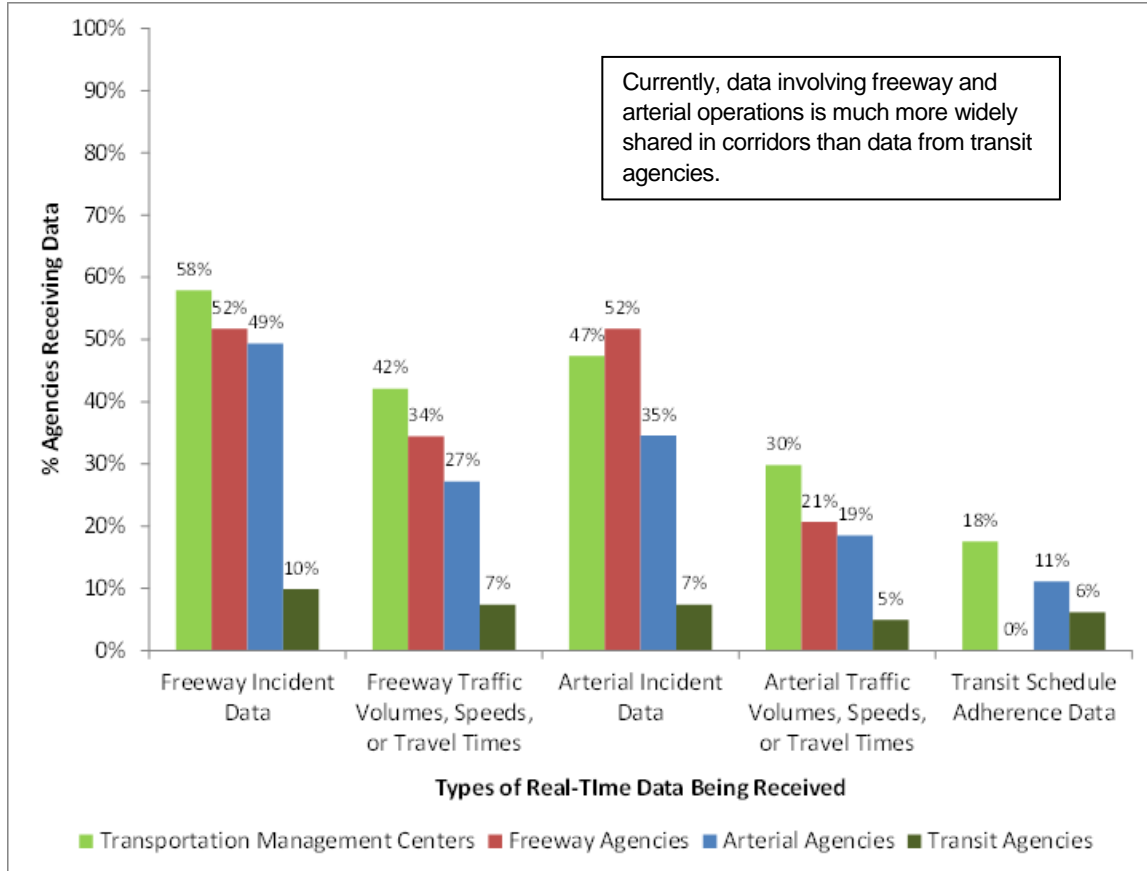


Figure 3-15. Levels of Interagency Coordination within Integrated Corridors

The cornerstone of the ICM concept is the exchange of real-time operational data between participating agencies. Figure 3-16 shows that freeway and arterial incident data are most often shared in real time, followed by freeway and arterial traffic conditions, with transit schedule adherence data being shared less frequently. These results show that while typically half to one-third of agencies receive operational data on traffic conditions and incidents, data sharing is currently short of what it could be if all corridors were fully integrated.

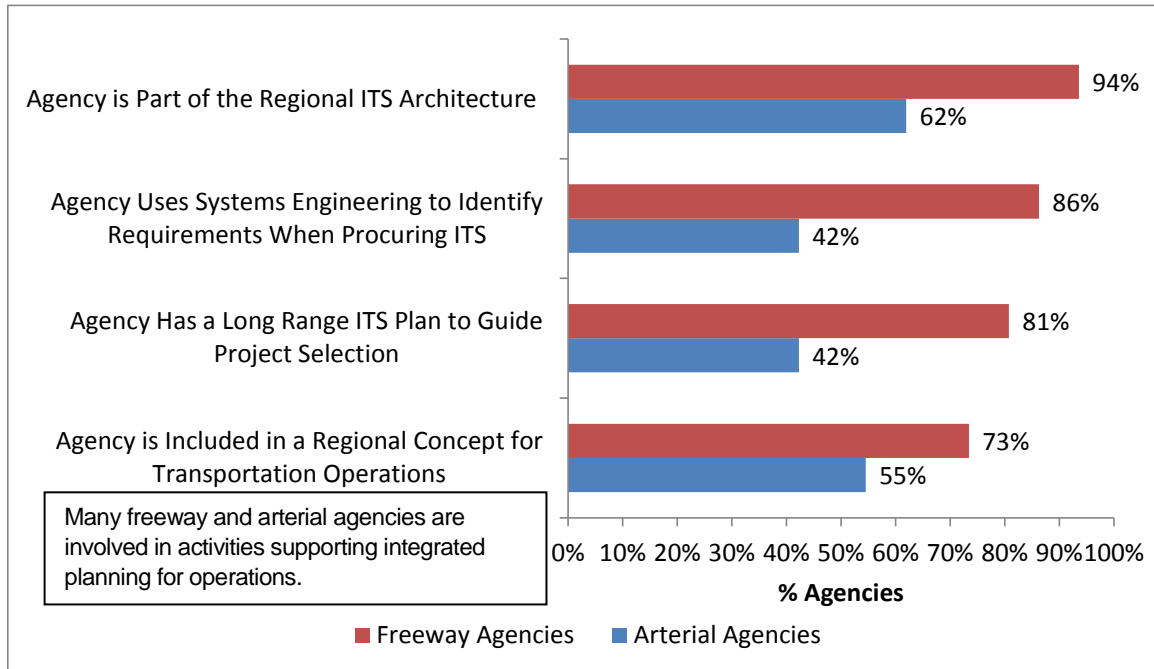


**Figure 3-16. Agencies Receiving Real-Time Operational Data in an Integrated Corridor**

## Planning for Operations

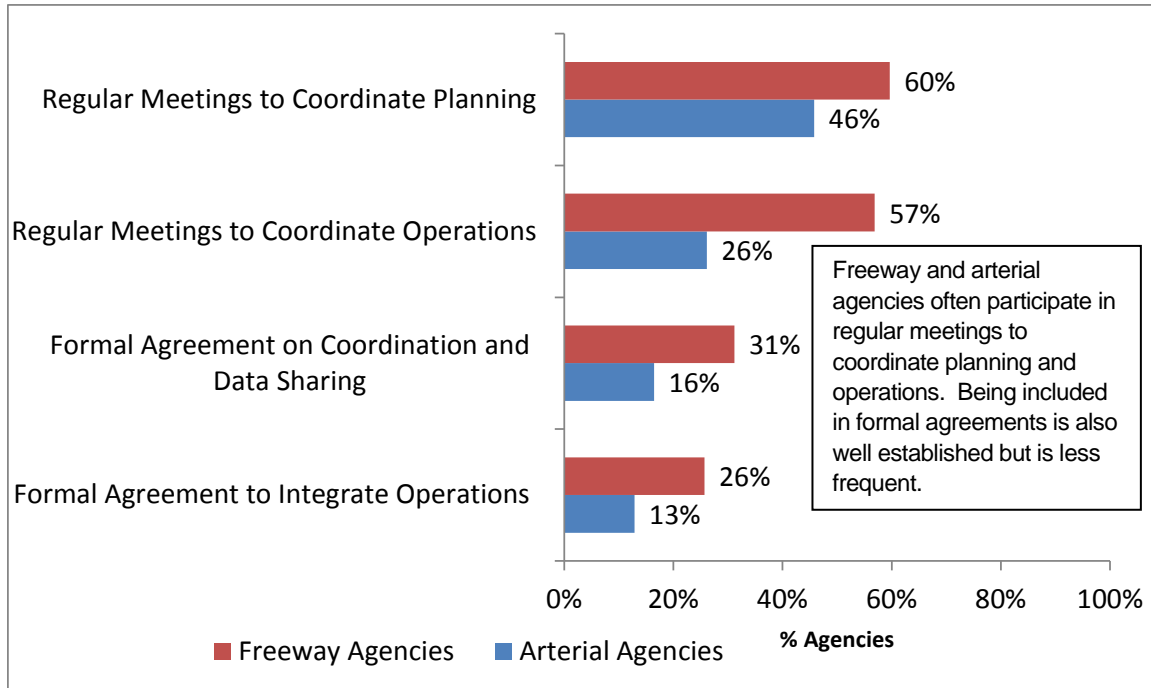
Interagency coordination outside integrated corridors is carried out through planning for operations. Planning for operations is a joint effort between operations and planning that encompasses the important institutional underpinnings needed for effective regional transportation operations collaboration and coordination. Linking planning and operations involves actions that build stronger connections between transportation planners and operators. Regional transportation planning and investment decision making requires a great deal of inter-jurisdictional coordination.

Agencies participate in planning for operations through a variety of activities supporting collaboration and coordination. Figure 3-17 shows the participation of freeway and arterial agencies in some of the activities associated with planning for operations. Almost all freeway agencies and two-thirds of arterial agencies are part of a regional ITS architecture. More than 80% of freeway agencies and 42% of arterial agencies use systems engineering to determine requirements when procuring ITS technology and about the same number of agencies report having a long range plan to guide ITS procurement. The participation of these agencies in a regional concept for operations is also high, with 73% of freeway agencies and 55% of arterial agencies included.



**Figure 3-17. Planning for Operations by Freeway and Arterial Agencies**

Agencies participating in planning for operations will attend regular meetings to coordinate planning and operations as well as participate in formal agreements covering issues such as data sharing and integrating operations. Participation in regional coordination activities by freeway and arterial agencies is well established but with room to grow. Figure 3-18 shows that 60% of freeway agencies attend regular meetings to coordinate planning, and 57% do so to coordinate operations. Arterial agencies participation is somewhat less, with 46% of arterial agencies being part of meetings to coordinate for planning and 26% for operations. Participation in formal agreements is less widespread; with 31% of freeway agencies and 16% of arterial agencies reporting they are part of a formal agreement on coordination and data sharing, while 26% of freeway and 13% of arterial agencies are part of a formal agreement to integrate operations.

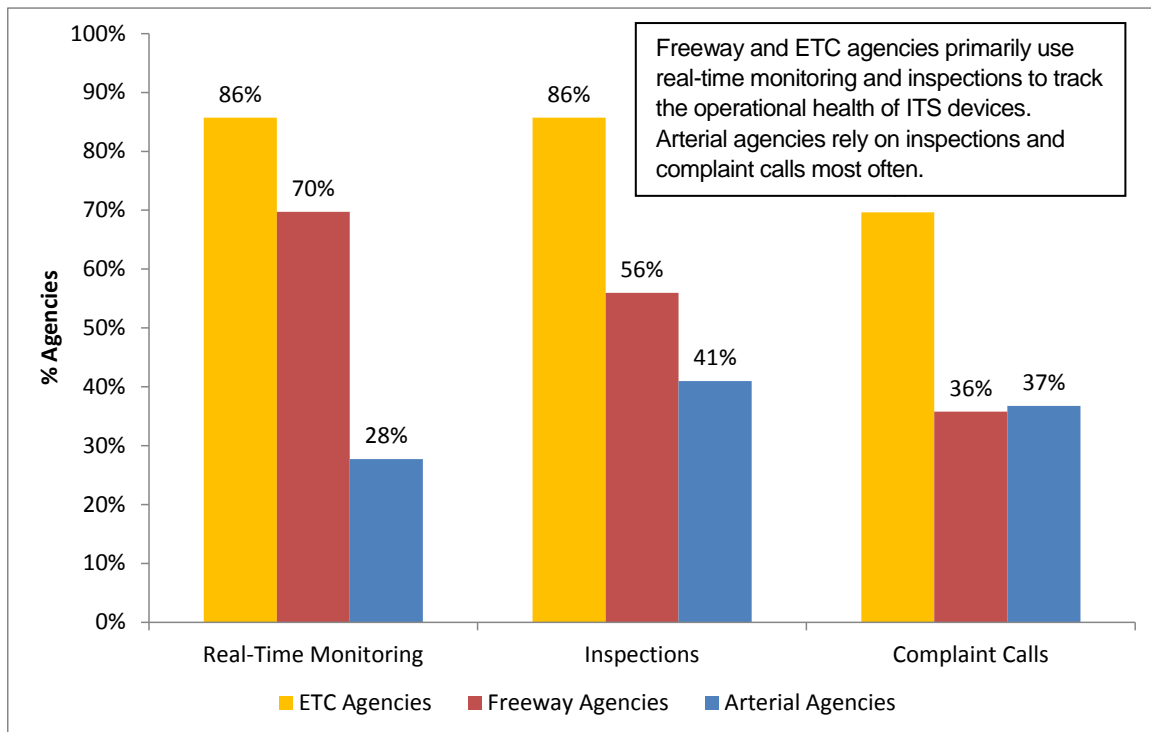


**Figure 3-18. Participation in Regional Coordination Activities by Freeway and Arterial Agencies**

## Maintenance of ITS Technology

ITS technologies are complex, integrated amalgamations of hardware, technologies, and processes for performing an array of functions, including data acquisition, command and control, computing, and communications. System maintenance refers to a series of methodical, ongoing activities designed to minimize the occurrence of systemic failures and to mitigate their impacts when failures do occur.

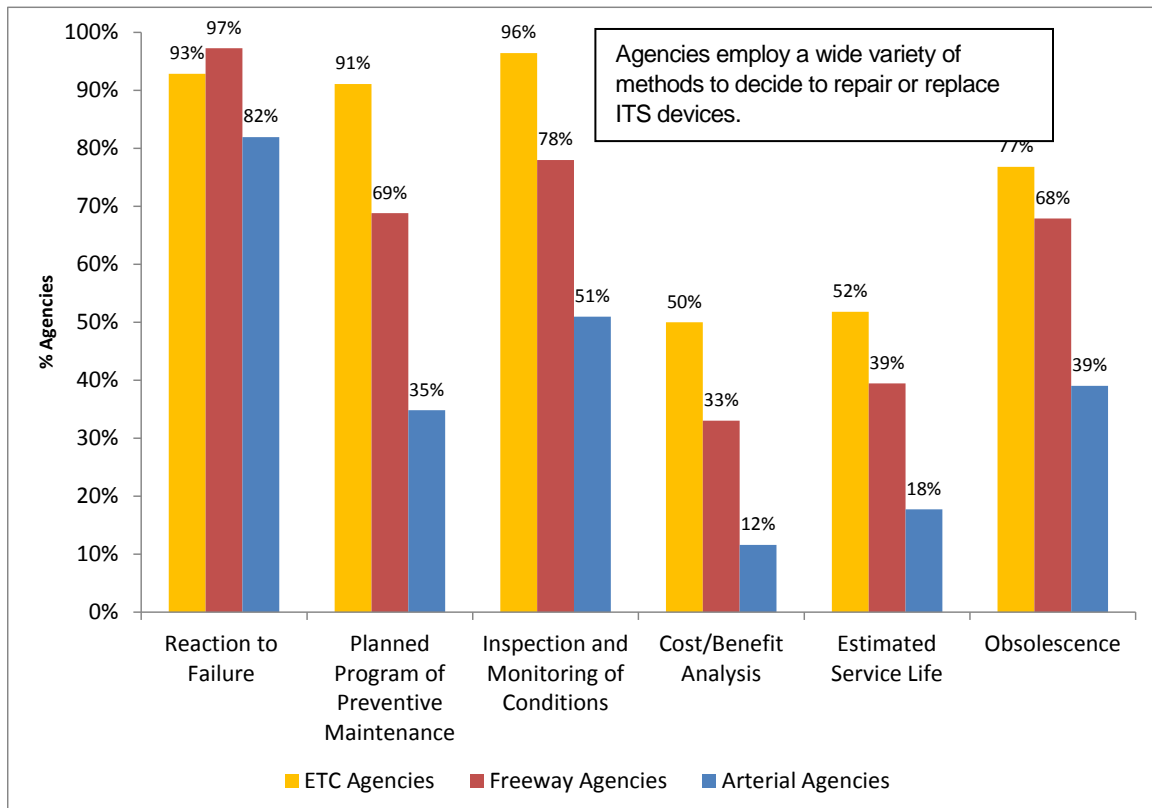
Maintenance begins with assessing the operational health of devices, which is carried out through the use of data on operational status of the devices. The timeliest method of tracking the status of ITS devices is through continuous real-time monitoring using a direct link to the device. Less timely is relying on regularly planned inspections of devices in the field. Finally, and least reliable of all, complaint calls will alert operators to maintenance problems. Figure 3-19 shows the survey results for ETC, freeway, and arterial agencies. The data show that ETC agencies (86%) and freeway agencies (70%) rely most often on real-time monitoring. ETC agencies also employ inspections to the same extent (86%), and their use is reported by 56% of freeway agencies. Both ETC and freeway agencies rely on complaint calls as well, but to a lesser extent. Arterial agencies, on the other hand, employ inspections (41%) and complaint calls (37%) most often to monitor the health of ITS devices, with less use of real-time monitoring (28%) than the other two agency types.



**Figure 3-19. Sources of Data on the Overall Health of ITS Devices**

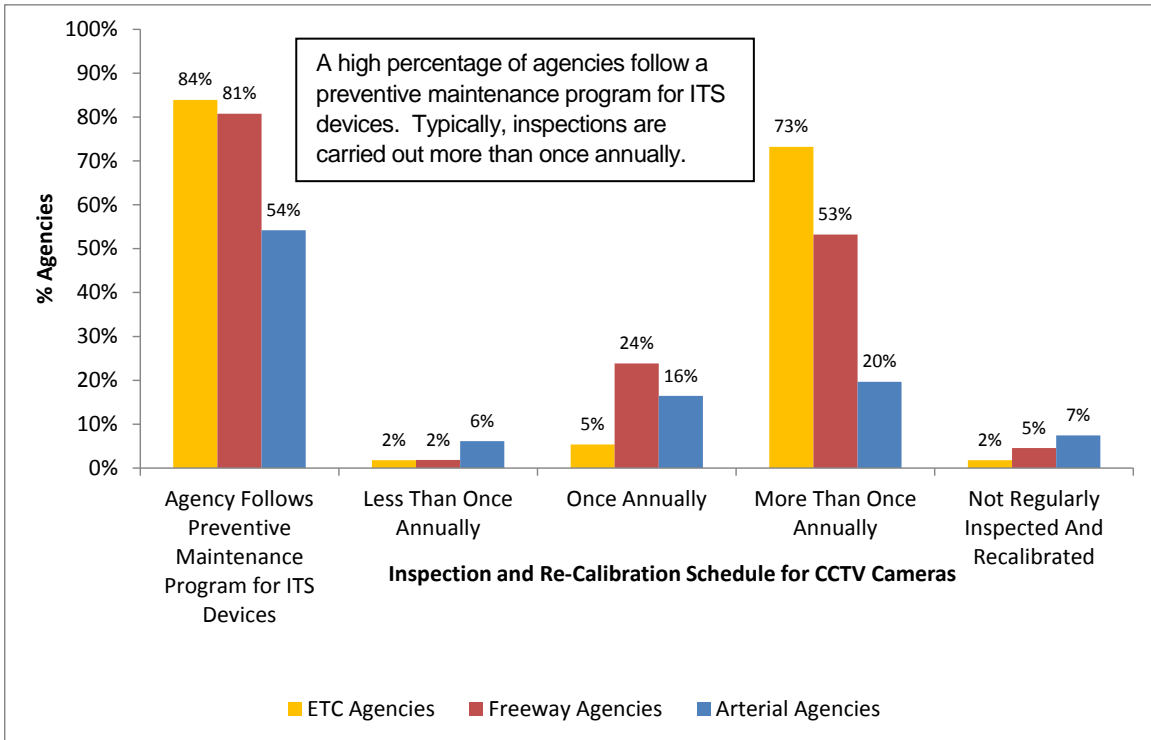


The reason for tracking the health of ITS devices is to reach a decision to maintain, repair, or replace a device. Figure 3-20 shows the factors for freeway, arterial, and ETC agencies influencing decision-making to take maintenance action. The most influential factor for taking action is response to failure, almost universally reported by the three agency types. The next two most often cited reasons--planned program of preventive maintenance and inspection and monitoring of conditions—are almost universally adopted by ETC agencies, but less so by freeway agencies (69% and 78%) and arterial agencies (35% and 51%). Obsolescence is next in the order of reasons for maintenance, while less frequently; these decisions are the result of cost/benefit analysis or estimated service life.



**Figure 3-20. Decision Factors for Maintenance, Repairs, and Replacement of ITS Devices**

Figure 3-21 shows the percentage of ETC, freeway, and arterial agencies that follow a preventive maintenance program for their ITS devices and the schedule of inspection and re-calibration for CCTV cameras. A high percentage of agencies (84% ETC, 81% freeway and 54% arterial) follow a preventive maintenance program. The most common interval of inspection is more than once annually, but a significant number of freeway (24%) and arterial (16%) agencies report a once annual interval with a small number of agencies inspecting at more than annual intervals or not at all.



**Figure 3-21. Agencies Following a Preventive Maintenance Program and Inspection Schedule for CCTV Cameras**

## Dedicated Short Range Communications (DSRC) Standard

The DSRC is a two-way short- to medium-range wireless communications standard that permits very high data transmission. Vehicle safety applications that use vehicle-to-vehicle and vehicle-to-infrastructure communications need secure, wireless interface dependability in extreme weather conditions, and short time delays; all of which are facilitated by DSRC. The 2013 survey explored the level of familiarity of various transportation agencies with the standard and whether they had any current or planned deployments using the standard. The targets for these questions were freeway, arterial, transit, and ETC agencies.

Figure 3-22 shows that the familiarity with the standard was high for freeway (63%) and toll collection agencies (84%) and substantially less for arterial (24%) and transit agencies (20%). There is a similar pattern of response for the extent that agencies are currently using DSRC, with tolling agencies (36%) and freeway agencies (17%) doing so much more often than arterial agencies (7%) and transit agencies (3%). Future deployment plans are generally limited, with a high of 17% of freeway agencies and a low of 4% of transit agencies. From a quarter to more than a third of the agencies report having no plans to use DSRC.

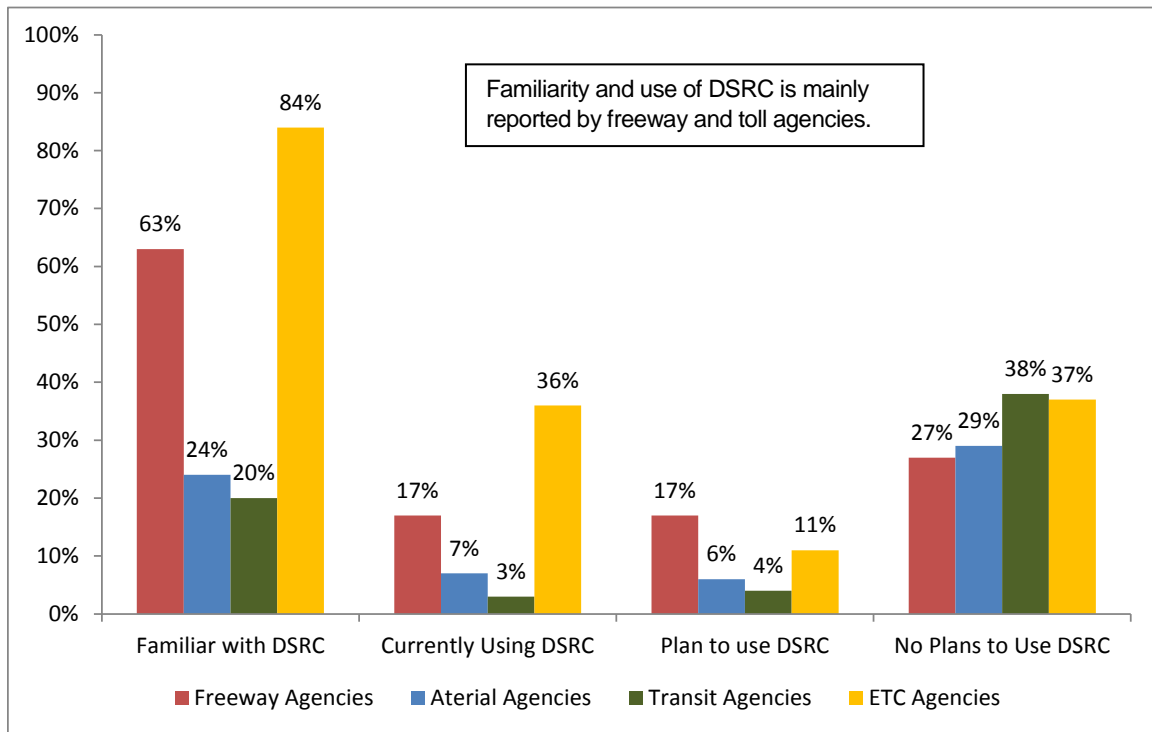
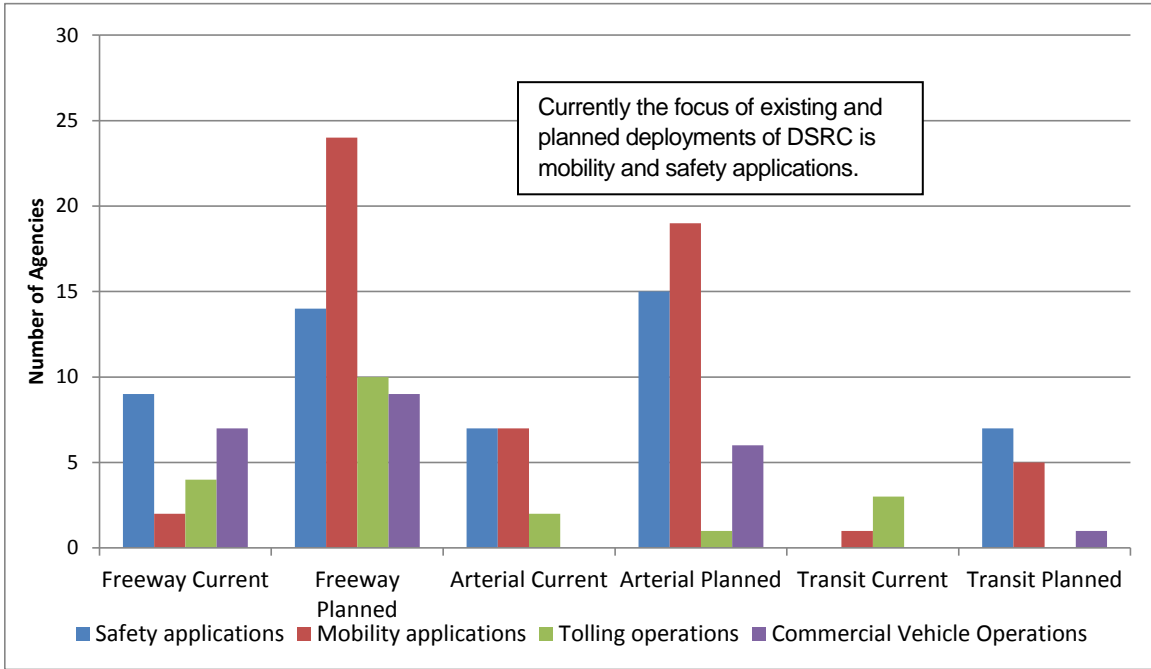


Figure 3-22. Awareness and Use of Dedicated Short Range Communications (DSRC)

While the current deployment of DSRC is limited, it is useful to look at existing applications being supported to see where the standard is having an impact. Figure 3-23 shows the types of applications currently deployed and planned in four categories: safety, mobility, tolling operations, and commercial vehicle operations. The data show that safety and mobility applications are most frequently deployed and are most frequently planned for deployment. The number of agencies planning to deploy DSRC applications in the future is substantially higher than those currently using the standard.



**Figure 3-23. Types of Applications Deployed or Planned Using Dedicated Short Range Communications (DSRC)**

## Chapter 4 Summary Findings

- ITS technology has attained a central role in operations and planning of transportation agencies. A high percentage of agencies have plans to expand ITS deployments and to invest in new technologies in the near future. Agencies see very high benefits from the deployment of ITS technology, generally seeing the highest benefit from systems supporting collection and dissemination of real-time information.
- While support for safety and mobility are two key factors cited by agencies in deciding to invest in ITS technology, agencies generally report cost as the most important factor.
- The focus of future deployments is the collection and use of real-time information. Freeway and arterial agencies plan to deploy DMS, cameras, and traffic sensors. These agencies will use these resources to distribute real-time traveler information as well as to improve traffic management through the use of managed lanes, ramp metering, traffic adaptive signals and traffic control software systems.
- The deployment of traffic sensors on freeways and at signalized intersections is continuing to expand rapidly and agencies are upgrading traffic sensors to systems that are easier to deploy and are more reliable. Freeway agencies are moving from loop detector sensors to radar and probe readers, particularly Bluetooth systems. Similarly, arterial agencies are rapidly expanding the use of Bluetooth readers and radar sensors.
- The widespread deployment of traffic sensor systems by arterial agencies has been accompanied by a significant increase in arterial agencies planning to deploy traffic adaptive signaling. Increased familiarity with adaptive signaling by arterial agencies appears to be overcoming objections to its deployment. In 2013 the percentage of arterial agencies citing reasons for not deploying adaptive signaling is half what it was in 2010.
- Several new media for dissemination of traveler information emerged in 2013, particularly the use of social media, including Twitter, Facebook, and apps for smart phones or tablets.
- The widespread deployment of technologies to track and dispatch transit vehicles has allowed agencies to improve customer service by providing travelers with real-time information on schedule adherence, as well as supporting demand responsive operations and improved route planning.
- Almost all toll collection agencies reported participating in traffic management through the use of price managed lanes.
- Public safety agencies are expanding the use of ITS technology to support response and recovery through the use of integrated communications to coordinate with traffic management as well as the use of AVL/CAD to assist in locating, assigning, and routing responders.
- Freeway and arterial agencies are expanding the collection of operational performance data and comparing observed performance to established goals to evaluate status of customer service and diagnose areas for future improvement. Measures such as travel time, vehicles per hour and travel time reliability are becoming widely adopted.

- ITS technology is widely used to improve safety. Work zone safety is enhanced through the use of technology to monitor status, detect queues, enforce speed limits, and merge lanes. Outside work zones, ITS technology provides automated warnings about weather conditions, over-height conflicts, and dangerous curves. Pedestrian and bicyclist warning systems are widely deployed by arterial agencies. Nearly three-fourths of buses are equipped with audio or video surveillance to enhance security.
- The capability of ITS technology to support real-time data sharing and communications is supporting efforts to improve operational collaboration between agencies. A significant number of agencies report being part of an integrated corridor in which the different transportation agencies manage the transportation corridor as a single system, rather than managing individual assets. Outside of integrated corridors, agencies are working to improve coordination through activities like participating in a regional ITS architecture, being part of a regional concept for transportation operations, and developing formal agreements to coordinate data sharing and integrate operations.

# List of Acronyms

AVL	Automatic Vehicle Location
CAD	Computer Aided Dispatch
CCTV	Closed Circuit Television
DMS	Dynamic Message Signs
DSRC	Dedicated Short Range Communications
ESS	Environmental Sensor Stations
ETC	Electronic Toll Collection
HAR	Highway Advisory Radio
ICM	Integrated Corridor Management
ITS	Intelligent Transportation Systems
TMC	Transportation Management Center
VIDS	Video Imaging Detector Systems

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