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Report to Congressional Addressees

April 2025

TECHNOLOGY ASSESSMENT

Smart Cities

Technologies and Policy Options to Enhance Services and Transparency

Accessible Version

GAO-25-107019

The cover image depicts a stylized representation of smart technologies at an intersection capturing data from a vehicle and a pedestrian in a crosswalk. The image also shows different types of data being emitted by the vehicle.

Cover source: GAO (illustration). | GAO-25-107019

Highlights of GAO-25-107019, a report to congressional addressees

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Why GAO did this study

Cities are increasing their use of smart technologies, which are at various stages of adoption, to improve services. Smart technologies integrate cameras and other sensors with communications equipment that transmits data, which can be analyzed to improve city functions.

Those cities using smart technologies may collect large quantities of data obtained either directly or purchased from data brokers. Experts stated that transparency on the use of technologies and controls around managing data is important to successful implementation. Because data from some smart technologies can potentially be used to identify individuals, cities also face issues related to privacy and civil liberties.

This report examines (1) how smart technologies can impact a city's ability to deliver services, (2) the benefits and challenges of using smart technologies, and (3) policy options that could help enhance the benefits or mitigate the challenges of using smart technologies.

Based on GAO analysis of different areas where cities use smart technologies, this report focuses on transportation and law enforcement services. To conduct this work, GAO reviewed working papers and other documents; interviewed federal and city officials, academics, and stakeholders from industry; conducted site visits in Atlanta, Houston, San Diego, and the San Francisco Bay area; and convened a 2-day meeting of experts with assistance from the National Academies of Sciences, Engineering, and Medicine. GAO is identifying policy options in this report.

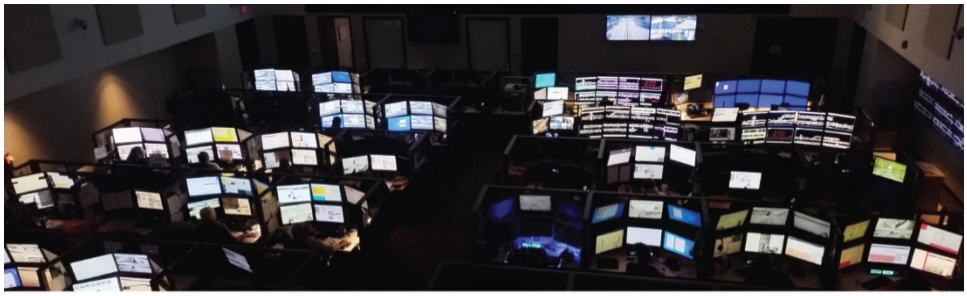
View GAO-25-107019. For more information, contact Brian Bothwell at bothwellb@gao.gov.

What GAO found

Cities use smart technologies to improve transportation and law enforcement services. Smart transportation systems include technologies that can be used to detect the number and speed of vehicles traveling along roadways. Data from these technologies generally feed into a transportation management center, which enables traffic managers to analyze this information. Smart technologies that support traffic management use data collected from roadside sensors and sensors within vehicles.

Some cities use automatic license plate readers and acoustic gunshot detection systems to support law enforcement operations. Among other uses, automatic license plate readers can be used to cross reference images of license plates with lists of wanted vehicles. When a match is identified, police can be dispatched to the vehicle's location. Similarly, acoustic gunshot detection systems can pinpoint gunfire location.

Houston TranStar Traffic Management Center



Source: GAO. | GAO-25-107019

City officials stated that smart technologies can benefit their delivery of transportation and law enforcement services. However, assessments of benefits are difficult to develop. Researchers stated that agencies may use multiple law enforcement or transportation technologies, making any attribution of effectiveness for individual technologies difficult. For example, Houston TranStar officials stated that its operational success can be attributed to technologies and personnel and that any benefits cannot be attributed to any single technology. Similarly, a law enforcement official stated that in a large city, it can be difficult to expand the use of technologies for law enforcement throughout the city. For example, acoustic gunshot detection systems may not reduce gun crime in the city but only shift it to another area.

Experts stated that cities generally lack transparency on smart technologies' intended use because individuals are told of potential benefits but not potential risks. These experts said that, as a result, individuals and communities often have little knowledge about how smart technologies function or the risk they may face from misuse of their data. Research has found that smart technology data may be used to identify individuals, which increases the potential for scams and can result in economic harms such as increased insurance costs. Experts stated that individuals should ideally be able to consent to use of their data. However, absent conditions for individuals to provide consent, local elected representatives may have a role in approving the use of smart technologies that collect data on individuals. These officials could, for example, establish privacy advisory boards and support use of data governance practices in cities' contracts with vendors.

GAO identified three policy options, in addition to the status quo, that may help with implementation of smart city technologies. The purpose of these options is to provide policymakers—who may include Congress, federal agencies, state and local governments, academia, industry, and other interested groups—with a broader base of information for decision-making.

Policy Options to Enhance Smart Technology Implementation

Policy option	Opportunities	Considerations
Facilitate improved collaboration to evaluate technology use **Implementation approach:** *Policymakers could facilitate collaboration among stakeholders to conduct and share more evaluations on the effectiveness and risks of smart technologies in transportation and law enforcement.*	• Partnerships between local or state governments and academic researchers could better focus on local needs and the extent to which smart technologies can be effective in particular communities. • Academics and other stakeholders could better coordinate research efforts and help ensure that existing research resources are better targeted and results more widely shared, helping to avoid duplication, overlap, or fragmentation of research efforts.	• Partnerships between local or state governments and academic researchers may require deliberate planning and consultation across sectors to identify roles and responsibilities of groups best suited to conduct research and make effective use of resources. • Some government entities and experts may require additional resources, such as staff with specific skill sets, to fully collaborate in research efforts.
Increase transparency when procuring and using smart technologies **Implementation approach:** *Cities could increase transparency in the use of smart technologies by (1) providing information to individuals and the public of the potential benefits and the potential risks associated with the use of smart technologies, including from the misuse of data collected by smart technologies, and (2) requiring third parties to obtain consent before collecting data, where practical.*	• City governments could help build trust between the city governments and individuals by providing a clear understanding of (1) how smart technologies function; (2) the means by which the city will store, protect, and dispose of data on individuals and control access to these data by third parties, such as data brokers; and (3) the costs, benefits, challenges, and risks presented by use of the technologies. • Transparency may reduce the chance that use of the technologies will be disrupted due to misconceptions about their use.	• Informing individuals about smart technologies and its implementation—considering that multiple language translations might be needed—may be time consuming, which can delay implementation. • Informing individuals about smart technologies may require multiple approaches that may become prohibitively expensive.
Develop and share effective data governance practices or standards **Implementation approaches:** *Policymakers could work to develop effective practices or standards for data governance and provide training for city procurement officials on them to ensure all city employees, as well as all vendors and contractors, adhere to or adopt such practices and standards.*	• Data governance standards for cities and vendors may help protect individuals from bad actors and may reduce instances of scams, stalking, or other harms. • Cities' data governance agreements with vendors could set terms that protect data on individuals, thereby reducing the likelihood of harmful outcomes. • Data governance standards can help individuals understand how their data will be protected.	• Different levels of government (federal, state, local) may be better suited to implement different data governance standards. • City procurement officials may require training or technical assistance to write contracts that protect data, clarify data ownership, and provide a means to ensure vendor compliance through monitoring or enforcement.
Status quo **Implementation approach:** *Policymakers could take no further interventions, allowing current activities to continue.*	• Policymakers could observe outcomes achieved under the status quo and later consider policy actions. • Cities not currently using smart technologies could delay acquisition until sufficient evidence regarding their effectiveness is available and issues regarding privacy are addressed.	• Maintaining the status quo may not be responsive to transparency and data governance challenges, resulting in unresolved or exacerbated risks with increased use of smart technologies.

Source: GAO. | GAO-25-107019

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Abbreviations

ALPR	Automatic License Plate Reader
LiDAR	Light Detection and Ranging
MARTA	Metropolitan Atlanta Rapid Transit Authority
NIST	National Institute of Standards and Technology
SFCTA	San Francisco County Transportation Authority
V2X	Vehicle-to-Everything

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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Congressional Addressees

Cities are increasing their use of smart technologies to improve services.[1] Smart city technologies, which are at various stages of adoption, integrate cameras, Bluetooth readers, and other sensors with communications equipment that transmits data from those sensors that can be applied or analyzed to improve municipal functions.[2] For example, smart transportation technology systems can use data from roadside sensors and other systems to determine and predict traffic volume, which can support cities' traffic management and safety and transportation planning efforts. Similarly, smart law enforcement technologies, such as license plate readers, can enhance the ability of local police to respond to potential crimes.

As part of their operation, smart technologies collect and use a large quantity of data. These data underpin the analytical capabilities of the associated technologies such as to help manage traffic and aid in law enforcement. Cities can obtain data directly, such as video from roadside traffic cameras, and can purchase data, such as on vehicles' locations, from data brokers.[3] As detailed later in this report, experts stated that transparency on the use of these technologies and controls around managing data collected by these technologies is important to successful implementation. Because data from some smart technologies can be used to identify individuals and reveal information on their behaviors and demographics, cities using smart technologies also face issues related to privacy and civil liberties.

We prepared this report at the initiative of the Comptroller General. This report examines: (1) how smart technologies can impact a city's ability to deliver transportation and law enforcement services, (2) the benefits and challenges associated with using smart technologies

[1]Local governments generally include two tiers: counties and municipalities. Municipalities can be structured in many ways with names such as townships, villages, boroughs, cities, or towns. For the purpose of this report, we use the term "city" to describe the local government structure that could encompass both county and municipality functions related to the use of smart technologies.

[2]Smart city technologies encompass multiple components and analytical capabilities that can affect a range of municipal services in areas such as healthcare, energy, transportation, and law enforcement. This report focuses on technologies related to transportation and law enforcement services.

[3]Companies with a primary line of business of collecting, aggregating, and selling information to third parties are referred to as information resellers. They are also sometimes called data brokers or data aggregators. These companies offer several types of products to customers, that include retailers, advertisers, private individuals, nonprofit organizations, law enforcement, and government agencies. For the purposes of this report, we will refer to these companies as data brokers.

to support transportation and law enforcement functions, and (3) policy options that could help enhance the benefits or mitigate the challenges associated with using smart city technologies. To address these objectives, we reviewed agency documents and other literature; interviewed federal and city officials, academics, and stakeholders from industry, among others; conducted site visits; and held a virtual 2-day meeting of experts. The meeting included 26 experts selected based on their technical, legal, or policy expertise.[4] See appendix I for a detailed description of our objectives, scope, and methodology and appendix II for a listing of participants in our 2-day meeting of experts.

We conducted our work from August 2023 to April 2025 in accordance with all sections of GAO's Quality Assurance Framework that are relevant to technology assessments. The framework requires that we plan and perform the engagement to obtain sufficient and appropriate evidence to meet our stated objectives and to discuss any limitations to our work. We believe that the information and data obtained, and the analysis conducted, provide a reasonable basis for any findings and conclusions in this product.

[4]We evaluated potential expert meeting panelists by reviewing, among other things, curriculum vitae, publications, professional recognition, and stakeholder status (e.g., industry, academia, etc.) and determined that each had sufficient expertise for inclusion in this expert meeting. For this report, we will refer to expert meeting participants as experts.

1 Smart Technology Applications in Transportation and Law Enforcement

1.1 Cities use smart transportation technologies to manage traffic and inform planning

We have previously reported that smart transportation systems include many different technologies that can be used to detect the number and speed of vehicles traveling along on roadways or monitor local conditions.[5] Data from these technologies generally feed into a transportation management center, which uses computer systems and other equipment to enable traffic managers to receive and analyze information from technologies and in some cases to remotely control the devices. Smart technologies that support traffic management and planning use data collected from roadside sensors as well as data derived from sensors within vehicles. Figure 1 illustrates technologies used to manage transportation systems and inform planning.

[5]*Intelligent Transportation Systems: Benefits Related to Traffic Congestion and Safety Can Be Limited by Various Factors*, GAO-23-105740 (Washington, D.C.: Sept. 2023).

Figure 1: Technologies for cities to manage transportation systems and inform planning

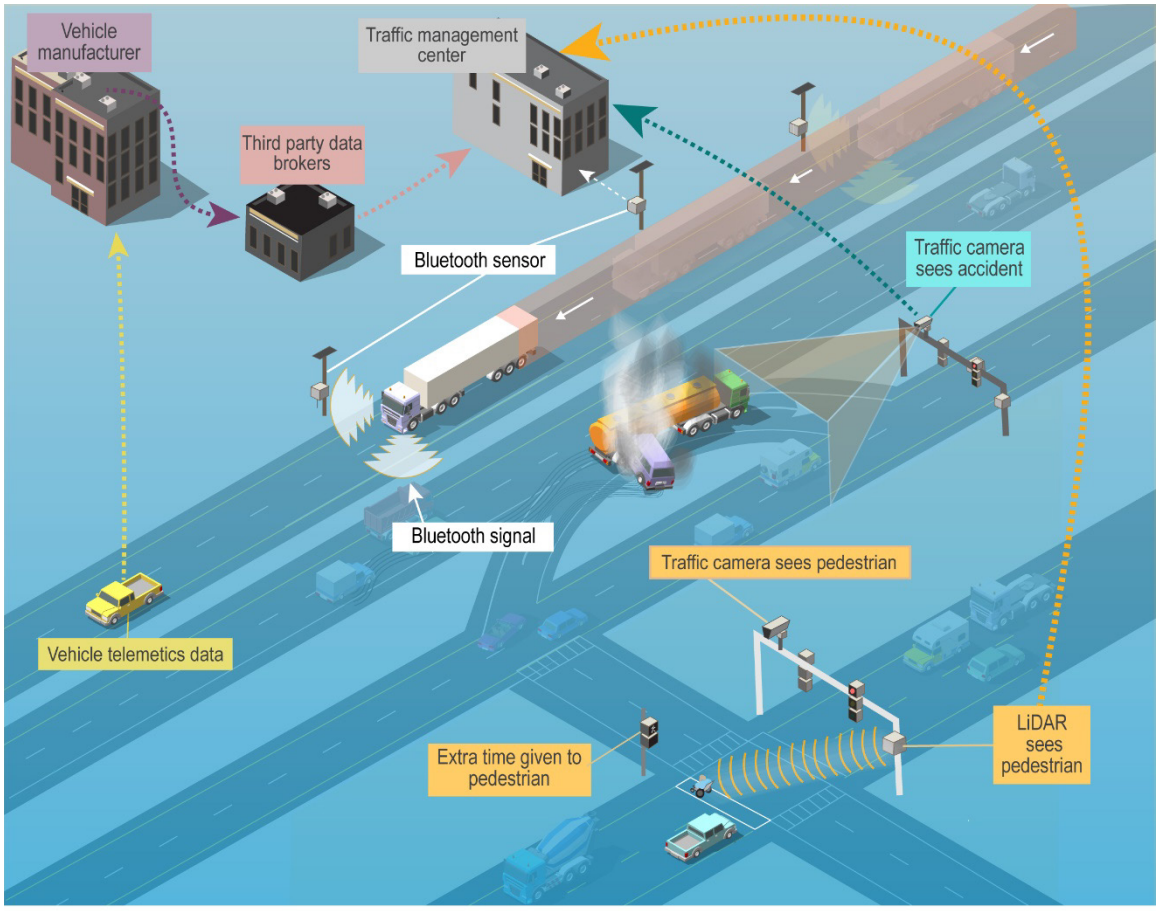
Technology	Function
Hardware/Sensor	
Traffic cameras	Cameras used to monitor transportation incidents, infrastructure, and congestion that transmit video in real time to traffic management centers.
Bluetooth readers	Roadside sensors that detect Bluetooth signal data from passing vehicles emitted by cell phones or the vehicles themselves. Data from readers can be used, for example, to measure traffic volume, travel times, and speed by calculating the time it takes for vehicles to travel between two or more sensors.
Light Detection and Ranging (LiDAR)	A sensing technology that uses laser light to measure distance and construct detailed maps of the environment. It can accurately determine the distance, shape, size, and movement of traffic in its field of view and observe pedestrian behavior to improve safety.
In-vehicle sensors	Vehicles may have different types of sensors, such as cameras, LIDAR, and global positioning systems, that can be used monitor various aspects of vehicle operations including travel history and approximate location of stops, maximum speed, distance traveled, and hard-braking events.
Applications	
Adaptive signal control	A system that automatically adjusts traffic signal timing to accommodate changing traffic patterns and ease traffic congestion.
Vehicle telematics systems	Systems that enable real time transmission of all aspects of a vehicle's location, operation, and function to different entities. Data gathered can include idling time, brake application, vehicle location using GPS, distance traveled, engine condition, speed, gas consumption, and more.
Vehicle-to-everything (V2X) communications	Wireless communications between all road users that can provide alerts to drivers regarding potential threats and obstacles. These alerts could include, for example, collision warnings, notifications of pedestrians in crosswalks, red light warnings, and reduced speed zone warnings.
Digital twins	Digital twins gather and analyze data from sensors (such as those in vehicles and traffic cameras) to mimic what is happening in the selected real-world environment. They provide real time data-based information and allow researchers, for example, to model scenarios and test mitigation strategies.

Source: GAO (data); alexdndz/stock.adobe.com (icons). | GAO-25-107019

1.1.1 Traffic management controls

Through use of various technologies, cities can monitor conditions and manage traffic flow with data provided in real time on current traffic conditions. Traffic managers may use technologies and applications such as Bluetooth readers and Light Detection and Ranging (LiDAR) to monitor traffic flows. Figure 2 shows smart technologies for transportation aggregated to conduct real time traffic management.

Figure 2: Smart transportation technologies aggregated for real time traffic management



Source: GAO (Data); GAO: illustration (roads, buildings, traffic signals, cameras, Bluetooth sensors, person in wheelchair, telephone poles); pleskach/adobe.com (vehicles). | GAO-25-107019

For example, according to an official with Houston TranStar, which manages the road network in the Greater Houston, Texas region, the organization uses Bluetooth readers and other sensors, as well as cameras, to collect information from the roads for which it is responsible. With this information, TranStar operators can perform functions in real time such as alert motorists of driving conditions via dynamic message signs, adjust traffic signal timing, dispatch tow trucks and other emergency responders to clear crashes, redirect public transit buses, control adjustable-direction High Occupancy Vehicle and High Occupancy Toll (HOV/HOT) lanes, and update the TranStar real-time traffic map, which is available publicly on its website and mobile device application. Figure 3 shows the Houston TranStar Traffic Management Center.

Figure 3: Houston TranStar real-time traffic management center

Source: GAO. | GAO-25-107019

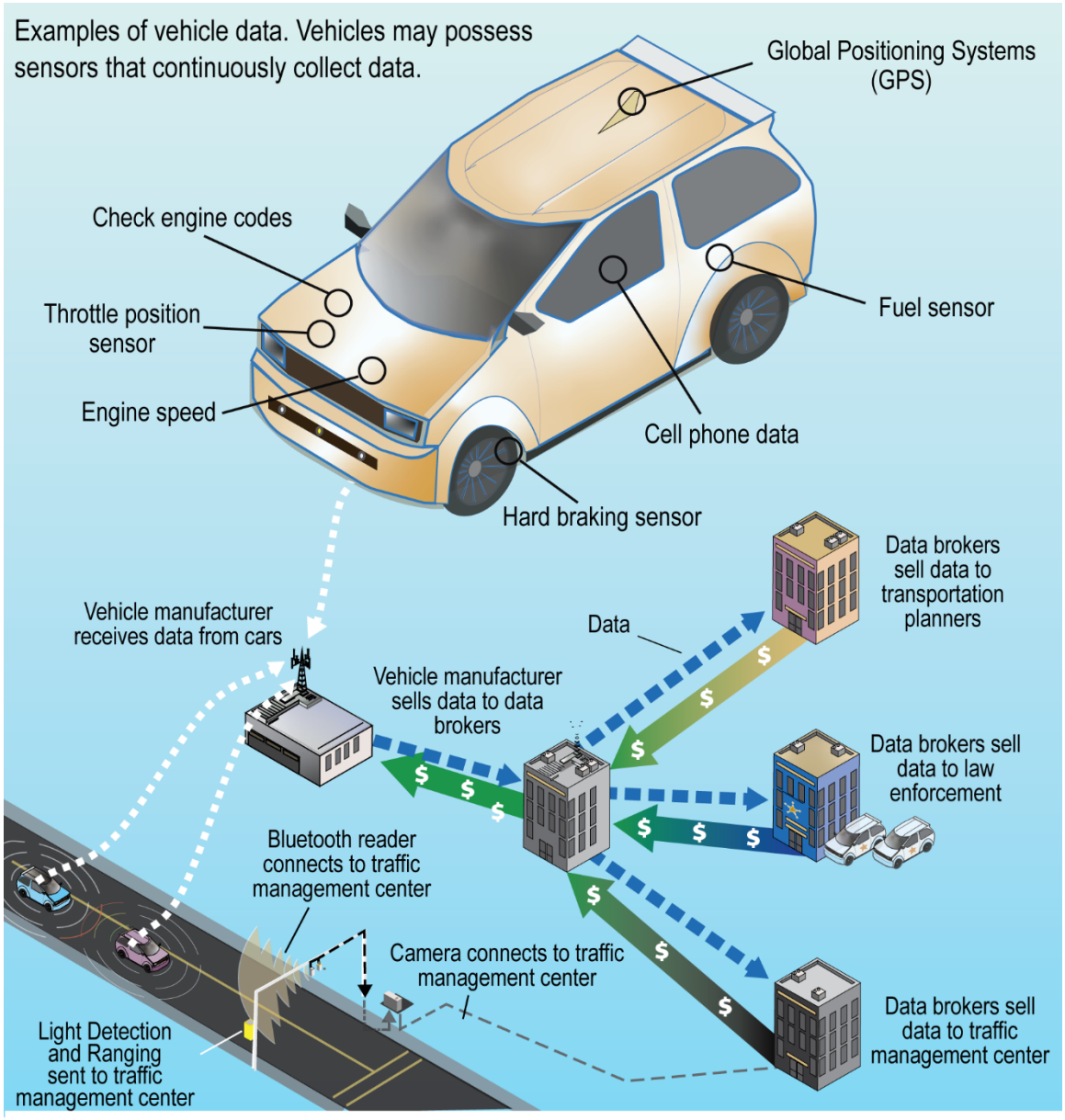
In addition, cities are increasingly using vehicle-generated data to support traffic management. Vehicles typically have an onboard modem or other communications equipment, which allows them to connect and transmit data to an external network. This connectivity allows vehicles to automatically transmit data on speed, acceleration, braking, and steering, in real time or at regular intervals.

According to researchers we spoke to, transportation management organizations can purchase vehicle data, such as geolocation, speed, and heading, from vehicle manufacturers.[6] In addition, data brokers can collect and aggregate many types of data and make it available to retailers, advertisers, private individuals, nonprofit organizations, law enforcement, and other government agencies.[7] Transportation departments can acquire these vehicle data and use them to conduct studies and develop tools with the goal of obtaining information on real time roadway conditions to allow for quicker and more effective responses to any traffic issues identified as well as to improve future planning. They can also use these data to identify roads susceptible to potentially dangerous driving behaviors. According to transportation experts we interviewed, if the data show that hard braking is common at an intersection, for example, it may indicate a hazardous situation that could inform future decisions on road infrastructure improvements. Figure 4 shows how vehicle data are transferred to transportation planners, transportation management centers, and others.

[6] In 2017, we reported that among the 16 automakers we interviewed, 13 produced vehicles that come equipped with technologies and services that transmit and receive data wirelessly. Based on interviews with the 13 selected automakers that offer these vehicles, all 13 reported collecting vehicle health and location data. See *Vehicle Data Privacy: Industry and Federal Efforts Under Way, but NHTSA Needs to Define Its Role*, GAO-17-656 (Washington, D.C.: July 28, 2017).

[7] We have previously reported that under most circumstances, information that many people may consider very personal or sensitive legally can be collected, shared, and used for marketing purposes. This can include information about an individual's physical and mental health, income and assets, telephone numbers, shopping habits, personal interests, political affiliation, and sexual habits and orientation. See *GAO, Information Resellers: Consumer Privacy Framework Needs to Reflect Changes in Technology and the Marketplace,* GAO-13-663 (Washington, D.C.: Sept. 25, 2013).

Figure 4: Flow of vehicle and other data to transportation planners, transportation management centers, and others



Source: GAO. | GAO-25-107019

Additionally, some technologies allow for wireless communication among vehicles and infrastructure in the surrounding environment. Emerging applications that provide "vehicle to everything" (V2X) connectivity can contribute to enhancing safety. For example, we participated in a demonstration in Houston in which vehicles equipped to operate in a connected V2X environment received advance signals upon approaching a school zone, in one case, and an emergency vehicle stopped on the

roadway, in another case.[8] Upon wirelessly receiving these signals, the connected vehicles provided an alert to the driver.

1.1.2 Transportation planning

The San Francisco Bay region has developed the analytical capability to assess the performance of its transportation network using roadway speed data from a data broker and speed data from transit vehicles to assess the performance of the area's transportation network. The San Francisco County Transportation Authority's (SFCTA) 2023 Congestion Management Program report describes various performance measures derived from analyses of these data, including average travel speeds and Buffer Time Index.[9] According to the report, these measures allow for the monitoring of traffic conditions over a long period of time. Further, ongoing monitoring of both automobile and transit speeds has the potential to help SFCTA understand congestion, which is an important factor affecting transit service, and facilitate its assessment of the transportation network's modal performance.

In addition, according to one official, SFCTA uses travel modeling software to predict the travel-related choices of households and individuals. This travel model is based on observed information about transportation networks, land use, and travel behavior from a variety of sources. According to SFCTA's 2023 Congestion Management Program report, the software is an activity-based simulation model that considers a broad array of conditions that influence travelers' choices. For example, according to the SFCTA official, the model captures an entire day of travel activity for residents, which considers conditions such as where trips originate and interrelationships between individual trips made over the day. SFCTA applies the model to support transportation planning, policy analyses, and land use impact assessments, among other uses. For example, the model can develop estimates of future trip counts related to work, school, shopping, and other purposes. Combined with future estimates of the number of automobiles per household and other factors, the model can inform decisions on actions such as building express lanes or extending rail service.

1.2 Cities use smart technologies to assist in identifying real-time criminal activity and investigating crimes

Cities also use a range of smart technologies to support law enforcement activities. License plate readers and acoustic gunshot detection systems are among the technologies commonly used by municipalities in law enforcement operations.

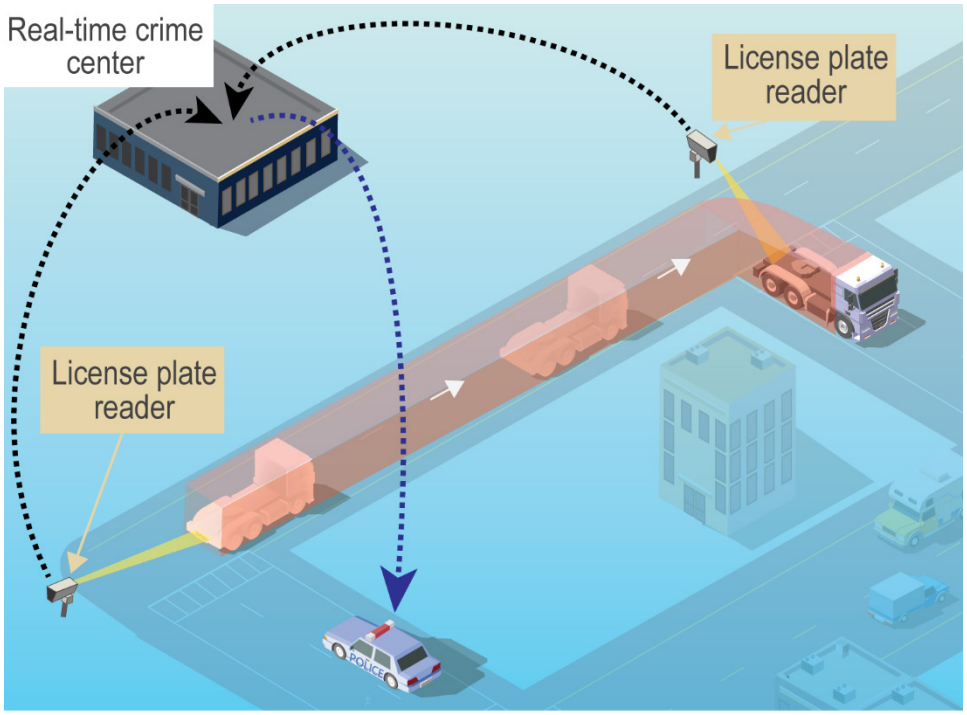
Automatic license plate reader (ALPR) systems use cameras to photograph vehicles as they pass and upload the digitized license plate data to a real-time crime center (see fig.5). The systems then cross-reference license plate numbers against lists of wanted vehicles, such as stolen vehicles or those

[8]In these examples, the sign alerting drivers that they were entering a school zone and the emergency vehicle were equipped with devices that allowed for wireless communication with the demonstration vehicles.

[9]The Buffer Time Index is calculated as the percent of average additional travel time that one needs to budget so that the person has a 95 percent chance of arriving at their destination on time.

associated with AMBER alerts.[10] When a match is identified, police can be dispatched to the location of the wanted vehicle. Stored ALPR data can also be queried to allow law enforcement to retrospectively determine what vehicle or group of vehicles were in an area at a given time.

Figure 5: Example of automated license plate readers transmitting data to a real-time crime center

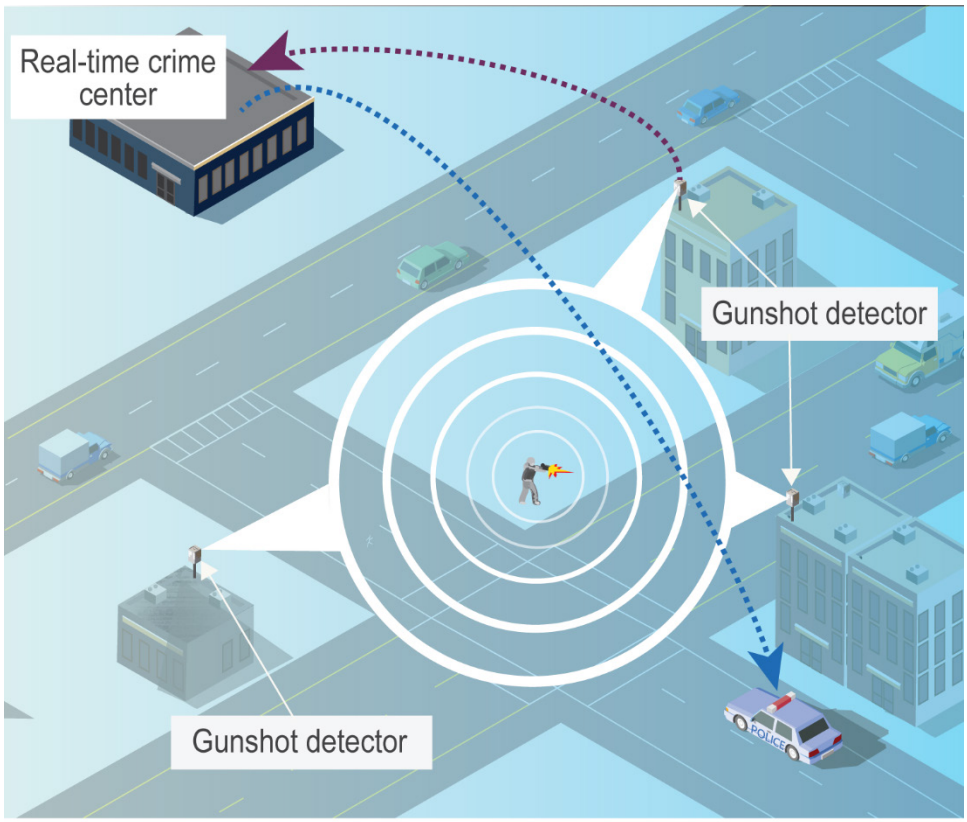


Source: GAO (data); GAO illustration (buildings); pleskach/stock.adobe.com (vehicles). | GAO-25-107019

Acoustic gunshot detection systems identify gunshots and alert law enforcement to the location where the shots were fired. In these systems, microphones capture the sound of the gunshot, and algorithms use the audio data to pinpoint the location. Once a gunshot is detected, police officers can be dispatched to the location to apprehend a suspect or render aid to a victim (see fig. 6).

[10]America's Missing: Broadcast Emergency Response (AMBER) alerts are public bulletins that request help in finding missing or abducted children.

Figure 6: Example of an acoustic gunshot detection system identifying a shooting location



Source: GAO (data); GAO illustration (buildings, roads, person, equipment); pleskach/stock.adobe.com (vehicles). | GAO-25-107019

In addition to the real-time law enforcement functions supported by ALPR and acoustic gunshot detection systems, the analytical capabilities of other technologies can help law enforcement conduct investigations. For example, one municipal police department official demonstrated to us its video analytic technology that allows it to automate the review of video collected by surveillance cameras, allowing users to review hours of video within minutes. Operators can query these systems to identify objects, people, or behaviors. For example, the above demonstration showed that one query might identify images or video of all red trucks or individuals wearing black pants and a white shirt within a specified location and time frame. A law enforcement official stated that the rapid response from the systems to such queries allows law enforcement officials to avoid time-consuming manual reviews of video images.

Some municipalities operate real-time crime centers that allow law enforcement officials to access all their smart technology applications via a single platform. These centers can collect data from multiple sources, such as residential doorbell and retail security cameras. Real-time crime centers can be integrated with operations such that law enforcement officials can access data from the centers while on patrol. For example, according to a city law enforcement official, the Atlanta Police Department's real-time crime center—which collects information

from cameras operated by the department as well as from private entities—operates from a central location and distributes information to law enforcement officials on patrol.

2 Smart Technologies May Benefit Cities' Transportation and Law Enforcement Operations but Data Governance Challenges Pose Privacy Risks

2.1 Some cities report benefits to transportation system operations from the use of smart technologies

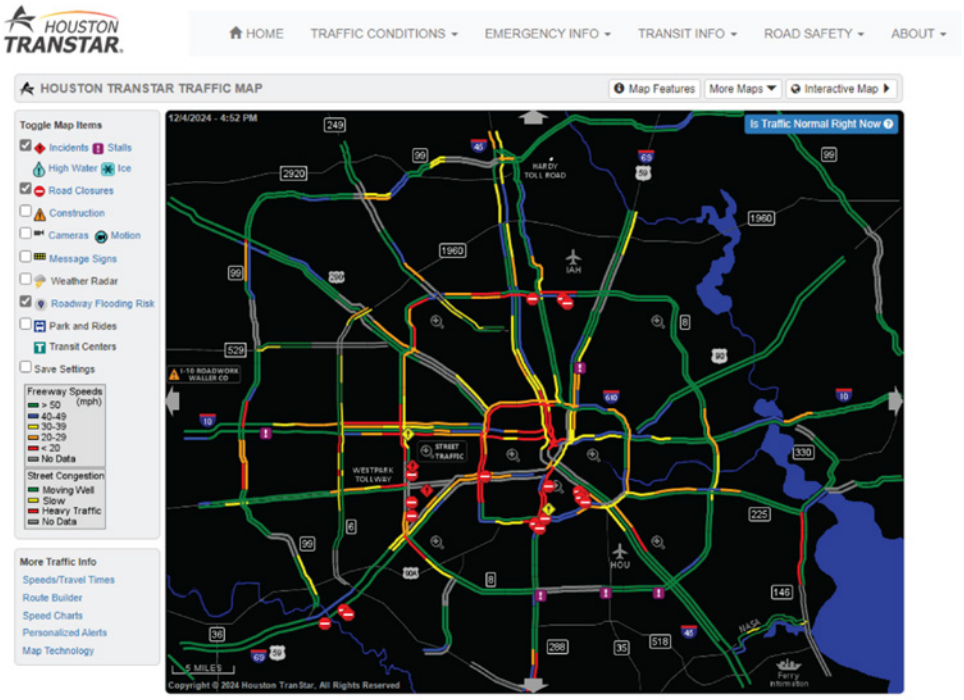
Officials in cities we visited, literature we reviewed, and our past reports describe benefits from smart technologies in specific use cases concerning traffic operations. In addition, officials and researchers described benefits to transportation planning from these technologies.

2.1.1 Traffic operations

As discussed earlier, Houston TranStar, the transportation management authority for the Houston region, uses various smart technologies to respond quickly to changing roadway conditions. For example, if a vehicle collision is blocking traffic on a freeway, officials can adjust traffic signals on the intersecting streets to better accommodate the volume of vehicles that will be exiting onto these streets from the freeway. TranStar officials also stated that these technologies allow officials to more rapidly identify disabled vehicles and dispatch tow trucks to clear them. According to these officials, the rapid delivery of services benefits both the individuals within the disabled vehicles and other drivers by lowering the risk of secondary crashes and reducing travel delays. The officials stated that these smart transportation technologies are used in small demonstration projects to measure benefits prior to any full-scale implementation.

TranStar's 2023 annual report found that its operation resulted in travel time savings and reduced fuel consumption. The report also stated that the benefits of its operation outweighed its cost in 2023. TranStar officials added that providing real-time traffic condition information to drivers via their website can contribute to reducing travel times by allowing drivers to avoid traveling when traffic volume peaks and by helping them safely navigate the roadways during emergency situations (see fig. 7).

Figure 7: Houston TranStar website provides a range of real-time traffic conditions to local drivers



Source: Houston TranStar. | GAO-25-107019

In another example, researchers optimized traffic signal timing in Birmingham, Michigan, using a statistical model and trajectory data obtained from vehicles.[11] The researchers used data from a single U.S. vehicle manufacturer, which constituted only about 7 percent of vehicles in the area, for a 3-week period. Using these data, operators adjusted the timing of traffic signals at 34 intersections to smooth traffic flow. This action decreased the delay at these intersections by up to 20 percent and the number of stops by up to 30 percent. According to the study, traffic signal retiming is a cost-effective method for reducing congestion and energy consumption in urban areas because it does not require changes to the existing infrastructure. However, according to the study, signal retiming at a large proportion of the intersections with signals in the U.S. relies on manual data collection and is only completed every 3 to 5 years. In their study, the researchers note that monitoring traffic through vehicle trajectory data offers advantages over fixed-location sensors such as cameras because vehicle trajectory data provide more detailed information on

[11]Wang, Xingmin and Jerome, Zachary et al. Traffic light optimization with low penetration rate vehicle trajectory data. *Nature Communication* 15, 1306 (2024). https://doi.org/10.1038/s41467-024-45427-4.

measures such as delay, number of stops, and travel path.

Further, as we have previously reported, some transportation agencies have used connected vehicle technologies to improve the reliability of transit operations and reduce emergency vehicle response time.[12] For example, the Utah Transit Authority has used connected vehicle technologies in which equipped buses send messages to traffic signals to request a longer green light if they are behind schedule. According to the Utah Transit Authority, the use of this technology has improved the schedule reliability of buses from 88 percent to 94 percent and has saved fuel as buses have fewer delays at traffic signals. In addition, the Maricopa County (Arizona) Department of Transportation deployed connected vehicle applications that give priority to emergency vehicles at traffic signals. The use of these applications has reduced crashes involving emergency vehicles and decreased the average response time of first responders in target areas.

2.1.2 Transportation planning

Smart city technologies can provide city and transportation planners with additional information to make better informed planning decisions. For example, the City of San Francisco's analysis of trip data showed that worsening congestion between 2010 and 2016 was in part attributable to ride share operators.[13] To address this congestion, the city imposed a trip tax on ride share operators. The tax varies based on the number of riders per trip, with the tax for single riders being higher than the tax for multiple riders. SFCTA uses the revenue from the trip tax for capital projects that can provide for increased pedestrian and bicycle safety and traffic calming, among other uses.

In another example we learned of on one of our site visits, researchers in Atlanta, Georgia, piloted an on-demand transit system. Using machine learning and optimization techniques, researchers sought to scale the system to address one of the significant problems with mass transit—the distance that transit riders must walk to reach their stops or stations influences rider satisfaction of the transit system. In using the system during its 6-month pilot in 2022, Metropolitan Atlanta Rapid Transit Authority (MARTA) riders could request through a smartphone application that a shuttle pick them up at a specified location, such as at home or work, and take them to a transit hub. The long-term objective in developing this system is to provide cost-effective transportation to residents in underserved communities, connecting them to jobs, healthcare, education, and healthy food. In November 2024, MARTA issued a request for proposals from firms to provide software and associated equipment for on-demand transit service as MARTA seeks to deploy the service in selected zones.

[12]*Connected Vehicles: Additional DOT Information Could Help Stakeholders Manage Spectrum Availability Challenges and New Rules*, GAO-23-105069 (Washington, D.C.: Nov. 22, 2022).

[13]San Francisco County Transportation Authority, *TNCs & Congestion Final Report, (October 2018).*

2.2 Some cities report increases in speed of law enforcement actions and greater efficiency in criminal investigations

Experts we spoke with stated that their use of smart technologies has (1) resulted in some instances of faster responses to crime and (2) improved efficiency in conducting criminal investigations. The following examples illustrate these benefits.

2.2.1 Automatic license plate readers (ALPR)

Law enforcement officials we visited stated that ALPRs have improved their ability to make arrests and recover stolen property more quickly. For example, officials in one city we visited stated that the ALPR system can identify a vehicle that has been reported as stolen and provide real-time notices to police officers. When this occurs, a nearby police vehicle that received the notice can quickly find and pull the vehicle over and begin an investigation. According to these officials, this real-time response to vehicles reported as stolen has resulted in an increase in the number of stolen vehicles being recovered and returned to owners. Further, according to these officials, because ALPRs identify a vehicle, it can allow for searches that disassociate the vehicle from its driver and reduce concerns about police profiling.

Officials in another city we visited stated that ALPRs can help to investigate crimes other than car theft. For example, these officials stated that ALPRs allowed them to identify and prosecute individuals who had been engaging in illegal dumping. In another example, experts stated that ALPRs can aid investigations at crime scenes involving a vehicle where, absent ALPR technology to identify the vehicle, police might have to rely on only a portion of a license plate number provided by a witness, or in some instances no identifying information at all. One expert stated that ALPR systems eliminate the need for officers to circulate over a large geographic area. Another expert said ALPRs resulted in fewer police stops of vehicles and reduction of the risk of negative law enforcement interactions with drivers. However, at least one lawsuit has been filed that argues the use of cameras such as in ALPR systems violates the Fourth Amendment to the Constitution.[14]

2.2.2 Acoustic gunshot detection

A guide developed under agreement with the Department of Justice notes that advantages of deploying acoustic gunshot detection systems can include faster response time, victim assistance, and the likelihood that evidence, such as shell

[14]U.S. Const. amend IV. In this lawsuit, which was filed in federal court in Virginia, the plaintiffs allege that the City of Norfolk has installed a network of cameras that makes it impossible for people to drive anywhere without having their movements tracked, photographed, and stored in an AI-assisted database that enables the warrantless surveillance of movement, in violation of the Fourth Amendment right against unreasonable searches and seizures. *Schmidt Et Al v. City of Norfolk, Et Al,* No. 2:24cv621 (E.D. Va. filed Oct. 21, 2024).

casings, can be found at crime scenes.[15] Related to these potential benefits, city officials we visited in Oakland, California, stated that the city's acoustic gunshot detection system has enhanced their ability to identify and respond to gunshots, particularly in areas where gunshots go unreported. Further, the Oakland Police Department reported that in 2023, the use of gunshot detection equipment alerted police to 29 homicide victims and 170 victims who sustained gunshot injuries. According to this report, in these instances, almost no reporting of gunshots had been made by other means, and some of the 170 injured victims may have suffered greater injury or died without the notification from the gunshot detection equipment and the subsequent emergency response.

2.3 Assessing benefits of smart technologies across cities is difficult

Assessments of transportation and law enforcement technology benefits across cities are difficult to develop. We have previously reported that most state and local transportation officials we spoke to stated that the benefit they experienced with intelligent transportation systems, which includes smart technologies, were hard to quantify.[16] Researchers we spoke to stated that law enforcement agencies may use multiple technologies simultaneously, making any attribution of effectiveness for any individual technology difficult.

A Houston TranStar official stated that TranStar uses various smart technologies to manage traffic and transportation in Southeast Texas, and the success of its operations can be attributed to both technologies and the personnel dedicated to traffic management. Houston TranStar is made up of representatives from the City of Houston, Harris County, and the Texas Department of Transportation. It also houses a vehicle towing program to provide safe and rapid clearances of vehicles that have broken down on area freeways, which can reduce traffic congestion and the chance of secondary accidents. TranStar officials noted that while the organization's composition has been stable, benefits reported by TranStar cannot be attributed to any single technology or aggregation of technologies. Rather, benefits are the result of how the collaborative system functions as a whole.

Similarly, stakeholders told us that assessing the impact of law enforcement technologies presents challenges because isolating the effect of these technologies relative to other factors is difficult. For example, one law enforcement official stated that while ALPR systems can lead to more recovered vehicles, it may not result in lower overall rates of vehicle theft. This official said that cities that allow for "no cash" bail often release vehicle theft suspects quickly, allowing the suspects to potentially commit more thefts. In instances such as this, the ALPR system may have no or little impact on overall vehicle theft rates. In another example, a law

[15]Mares, Dennis, Problem-Oriented Guides for Police, Response Guide Series No. 14, Gunshot Detection: Reducing Gunfire through Acoustic Technology, October 2022.

[16]GAO-23-105740.

enforcement official stated that in a geographically large city, it can be prohibitively difficult to expand the use of acoustic gunshot detection systems throughout the city. This official stated that, in these instances, the systems may not reduce gun crime in the city but only shift it to another area.

Two researchers we interviewed stated that despite these law enforcement technologies (ALPR and acoustic gunshot detection) working as expected, it is unclear whether the use of these technologies results in less crime. They explained that limited empirical research on the effect of these technologies on crime rates exists because the randomized controlled experiments needed to develop findings are difficult and expensive to conduct. As a result, according to these experts, available data on whether these smart law enforcement technologies lead to a reduction in crime are inconclusive. One researcher stated that (1) additional research conducted in collaboration with law enforcement agencies and other relevant stakeholders should be performed to investigate how technology impacts crime, public safety, and public legitimacy and (2) field experiments are necessary to have better empirical data for police departments to conduct cost-benefit analysis of smart technologies.

2.4 Challenges implementing smart technologies include competing priorities for limited resources

Officials we interviewed stated that buying and operating smart technologies for transportation and law enforcement can be prohibitively expensive. For example, Houston TranStar faces high costs because it uses multiple technologies to measure average speed and travel times of vehicles. A Texas Department of Transportation official said that it is difficult to find funding to maintain TranStar's existing capabilities, much less to fund technological improvements. Another expert noted that transportation technologies like dedicated short-range vehicle-to-infrastructure communication can be cost prohibitive.

Similarly, a law enforcement official we interviewed stated that acoustic gunshot detection systems are costly to purchase and operate. According to the official, this challenge makes it difficult to widely deploy these systems, particularly in geographically large cities. Another law enforcement official questioned the efficacy of these systems, noting that reports of gunfire detected with these systems are often false alarms. For example, the New York City Comptroller assessed a limited and purposefully selected time frame of performance and found that in July 2022, September 2022, and between January 2023 and June 2023, 8 to 20 percent of alerts made by the city's acoustic gunshot detection system resulted in evidence being found that gunshots had taken place.[17] The

[17]City of New York Office of the Comptroller, Audit Report on the *New York City Police Department's Oversight of Its Agreement with ShotSpotter Inc. for the Gunshot Detection and Location System*, FP23-074A, (New York, New York: June 20, 2024).

report also found that the New York Police Department spent more than 400 staff hours investigating unfounded and unconfirmed alerts in June 2023. According to an expert we spoke to, there is also an opportunity cost associated with purchasing these technologies when these funds can be used for other city priorities.

2.5 Transparency and data governance pose challenges to cities using smart technologies

As smart city technologies continue to be implemented, the public may not have a clear understanding of their use, the amount and types of data on individuals collected, or the entities that collect, manage, and share these data. In our meetings with experts, some stated that transparency on use of the technologies and controls around managing data collected by these technologies is important to successful implementation. However, experts stated that cities generally lack transparency because they do not provide information to individuals or the public about the technologies and their intended use by entities with access to this data. Experts also stated that when individuals are told smart technologies will be implemented, they are told of the potential benefits but not the potential risks. These experts stated that, as a result, individuals and communities often have little knowledge about how smart technologies function or the risks they may face from misuse of their data.

Use of cameras by the City of San Diego

In 2016, the City of San Diego began installing camera-based smart streetlights to save money on utilities and improve street lighting. In 2018, San Diego police began using these cameras to assist with criminal investigations. According to city officials, some residents expressed concerns that use of these camaras by the police violated their privacy. In response, the city stopped using these cameras in 2020 and passed an ordinance in 2022 that requires any new technology to be used for surveillance be reviewed by a community privacy board and approved by the city council. The ordinance also requires law enforcement officials to notify the public on the use of these technologies. In December 2023 the city began installing new smart streetlights and has since used video evidence, along with data and information from smart streetlights, to conduct criminal investigations against persons and property.

Source: GAO (analysis). | GAO-25-107019

In discussing their concerns about smart technology data, experts said that individuals and the public are generally not informed about what data are collected by smart technologies, who owns these data, or to what degree the data are shared. These smart technologies and the data they collect may be owned by vendors who operate the technologies on behalf of a city and allow the city to access the data collected.

Because vendors may own and manage data collected on individuals, they can sell these data to data brokers, who may then aggregate them with other data and sell them to advertisers, publishers, state and local governments, traffic management entities, federal government agencies, law enforcement agencies, and others.[18] For

[18]According to Duke University's Cyber Policy Program, data collected by smart technologies, which can include vehicle data, security camera data, and other data, can be obtained by data brokers who may be able to use these data to make predictions or inferences about sensitive information on

example, cities can purchase from data brokers data on individuals' locations that can be used to redesign bus networks and improve operations.

Academic research has found, and experts concurred, that these data can be used to identify individuals. The capability to use data to identify people poses risks to their privacy and civil liberties and may increase the potential for negative outcomes such as individuals identified becoming victims of scams or stalking or experiencing economic harms such as an increase in insurance costs.[19] Experts told us that transparency in implementing and operating smart technologies requires taking actions to ensure that individuals understand not only the potential benefits associated with the technologies but also the risks, particularly risks to privacy stemming from the collection of data that could be used to identify an individual.

These experts said that individuals should ideally be able to consent to use of their data and that these data should be deleted were a person to deny consent. For example, experts agreed that in situations where data used in the operation of smart technologies derives from personally owned items such as phones or vehicles, the individual should be allowed to choose whether and how these data are used.[20] This could include allowing the individual to opt-in to sharing these data and to limit data use to a specific purpose. However, absent the conditions for individuals to provide their direct consent, these experts said local elected representatives could play a role in approving the use of smart technologies that collect data on individuals. Experts noted that local elected representatives may be best positioned to communicate with individuals in their jurisdictions about technologies that are approved for use.

For example, as a requirement for approving the procurement and use of these technologies, elected officials could call for establishing privacy advisory boards to conduct research on smart technologies, consider harms to individuals that could result from use of the technologies, and work with privacy advocates to address potential harms. Elected officials could also work to specify limitations on the use of smart technologies and the data they collect in cities' contracts with vendors (e.g., requiring that any data collected within a city be the property of that city or that vendors cannot sell data collected by smart technologies). For data obtained by cities from data brokers, officials could require that the original collectors of data (e.g., vehicle manufacturers) who sell through data brokers provide individuals

individuals, including their race, gender, sexual orientation, immigration status, income level, and political preferences.

[19]For example, a 2019 study found that only five location and time records were enough to identify about 90 percent of individuals over a 12-hour period. See *Gao, J., Sun, L., Cai, M., 2019. Quantifying Privacy Vulnerability of Individual Mobility Traces: A Case Study of License Plate Recognition Data.* Transportation Research, Part C. 104, 78-94. *https://doi.org/10.1016/j.trc.2019.04.022.* Similarly, a 2013 study showed that only four location and time records per day from cell phones were needed to identify 95 percent of the owners of the devices. See *De Montjoye, Y.A., Hidalgo, C.A., Verleysen, M., Blondel, V.D., 2013. Unique in the Crowd: The Privacy Bounds of Human Mobility,* Scientific Reports. 3, 1376.

[20]One expert we spoke to, for example, said that when Bluetooth or Wi-Fi data are collected by smart technologies on a roadside on behalf of a city, there is no opportunity for individuals to provide consent on the collection or use of these data.

from whom the data are collected with information on potential benefits and harms and receive affirmative consent before collecting their data.

Use of vehicle data

Vehicle telematics data can include real time vehicle location, fuel usage, miles traveled, vehicle speed, acceleration and other data collected from vehicles. Transportation agencies can procure certain telematics data and combine them with other data, such as census data, to help understand traffic volume and develop transportation plans. Vehicles with telematics systems can transmit data wirelessly to vehicle manufacturers in real time, who may then provide them to data brokers. However, consumers who purchase these vehicles may not be able to provide informed consent regarding the use of their vehicle data because, according to a privacy organization official we spoke to, understanding the extent to which these data are being collected involves reading vehicle manufacturer privacy policies that are prohibitively long. For example, the organization found that one vehicle manufacturer's privacy policy was over 66,000 words and would require 5 hours and 31 minutes to read. Further, the same privacy organization found that vehicle dealerships do not provide accurate information on vehicle data collection or use. For example, the privacy organization surveyed 116 vehicle dealerships in 2024 and found that nearly three quarters of vehicle dealership representatives did not provide accurate information to consumers regarding what data their vehicles collected, and more than half incorrectly stated that data collected from consumers' vehicles would not be sold or shared with third parties such as data brokers, insurance companies, or the government. According to the privacy organization, all 116 vehicle dealerships deviated, often significantly, from the vehicle manufacturers' privacy policies.

Source: GAO (analysis). | GAO-25-107019

According to one expert, once transparency and consent have been established, the appropriate data governance standards can be implemented. To aid cities in promoting transparency in the use of smart technologies and responsibly managing the data produced by these technologies, experts suggested the following practices:

- **Data minimization**: Data minimization involves limiting the collection of personal information to what is directly relevant and necessary to accomplish a specified purpose. Experts stated that the best way to ensure the security of data is not to record it in the first place. For example, officials with Houston TranStar stated that Bluetooth sensors deployed in Houston only record a partial Bluetooth address rather than the full address to help protect driver anonymity. Similarly, an academic representative we spoke to stated that researchers are developing cameras that do not record images of vehicles. Rather, vehicles and individuals are presented as boxes on the video screen. This allows traffic management officials to continue to use cameras to manage traffic flows while maintaining the anonymity of drivers and preventing vehicles from being tracked.

- **Limits on data retention**: Data retention limits allow the holding of personal data for only certain purposes. According to experts, cities and smart technology manufacturers should establish data retention time limits because limiting the amount of time that data are retained can reduce their availability and probability for misuse. Experts we interviewed stated that any retention periods would need to reflect the purpose of the data and be consistent across regions. In 2020, the California State Auditor reported inconsistencies in cities'

management of ALPR data, which were stored by individual cities. According to the report, the law enforcement agencies they examined retained ALPR images from 1 year to 5 years. The report also found that none of the agencies reviewed had considered the usefulness over time of the ALPR images when determining their retention periods, which raised privacy concerns.

- **Cybersecurity:** Cybersecurity requires the protection of networks, devices, and data from unauthorized access or criminal use. Experts stated that cities may not be able to ensure that data are sufficiently secured to the risk of cyberattack, and one indicator of this vulnerability is the number of ransomware attacks that have occurred in recent years. Such attacks have disrupted services in cities such as Baltimore, Maryland, and Oakland, California. Experts stated that implementing federal cybersecurity standards, such as the NIST Cybersecurity Framework or the U.S. Cyber Trust Mark, would provide greater assurance of data security. They noted that currently, these standards are voluntary and are not universally implemented. To be most effective, any cybersecurity standards identified would have to become mandatory for all entities that manage smart technology data.

- **Anonymization:** Data can be considered anonymized when they no longer identify an individual and cannot be combined with other data to identify an individual. However, experts stated that there are currently no standards for anonymizing data collected from or for smart technologies. These experts agreed that developing standards and best practices for data anonymization could reduce the likelihood of the data being used to identify individuals. For example, concerning vehicle location data from trips taken by an individual, industry representatives we interviewed stated that there are various ways to anonymize vehicle data, such as by removing data from the first or last 2 minutes of each vehicle trip. This practice may reduce information about the vehicle driver's residence or workplace. However, one industry expert said transportation managers would like to know where people are traveling to and from in their vehicles; therefore, anonymization may make the data less valuable to city transportation departments.

Use of geofencing

Advertisers and other entities sometimes use location data collected by smart technologies to create a virtual perimeter around a location and track when an individual or vehicle enters and exits the perimeter. Known as geofencing, this approach is used for a variety of purposes, including sending targeted advertising to consumers. For example, a personal injury law firm could use geofencing to direct advertisements to people visiting local emergency rooms.

Privacy advocacy organizations have reported that geofencing could pose civil liberties, consumer protection, and privacy concerns. One example they cited was of a Massachusetts data broker that, according to the Massachusetts Attorney General, applied geofencing capabilities to identify individuals visiting clinics that provide reproductive or opiate addiction health care. When a person entered the geofenced area, an advertiser who had purchased data from the broker would attempt to display an advertisement tailored to the location and other information about the user. According to the Massachusetts Attorney General, the practice of tracking a consumer's physical location near or within medical facilities and targeting consumers with potentially unwanted advertising based on inferences about their private, sensitive, and intimate medical or physical conditions without consent violates the state's consumer protection laws. The Massachusetts Attorney General entered into a settlement agreement that prohibited the data broker from engaging in this practice in Massachusetts. Experts we interviewed stated that geofencing constituted an invasion of privacy, and one expert stated that the same geofencing technology could be used to track individuals participating in constitutionally protected activities, such as religious services or gun purchases.

Source: GAO analysis of interviews with experts and documents, including from the Massachusetts Attorney General's Office. | GAO-25-107019

- **Data ownership and control:** According to experts, cities should consider controls on data collected by smart technologies owned or operated by vendors. Specifically, cities need to consider who owns and who controls data collected by smart technologies and how to prevent this data from being sold by vendors onto data markets. According to experts, cities can specify in vendor contracts that the city must maintain ownership of data collected by smart technologies within the city. Vendor contracts could also contain clear guidelines on which data can be shared externally and under what circumstances.

- **Data interoperability:** Interoperable data are formatted to allow diverse datasets to be merged or aggregated in meaningful ways. According to an expert we spoke to, smart city data generated by different sources using different proprietary formats may prevent the interoperability of data across technology systems. This may prevent a city from integrating and analyzing these data if it procures a new smart technology system. According to experts, when cities sign contracts with technology vendors, the vendors often store data collected in a proprietary format. As a result, if a city changes technology vendors, the data from the original vendor will not be accessible or usable by the new vendor or will only be available to the city at a prohibitively high cost. This lack of interoperability can result in vendor lock-in, making cities dependent on a single vendor's services and unable to use another vendor without incurring significant costs. Experts stated that smart technologies should have data collected on individuals in a format that allows interoperability.

- **Training city government officials on data governance practices:** According to experts, cities face broad governance challenges with

managing the significant amounts of data associated with smart technologies, including the general lack of expertise among procurement officials in writing technology acquisition contracts that protect data and clarify data ownership. Experts stated that this limited expertise may increase the risk of acquiring data that the city does not need, open the city to cybersecurity risks, and increase the risk of vendor lock-in. To address these challenges, experts stated that city procurement officials could be provided training and technical assistance on data governance practices to help ensure that appropriate data governance provisions are included in contracts for smart technologies.

3 Policy Options

We identified three policy options, in addition to the status quo, that policymakers could consider to enhance the benefits or address the challenges to implementing smart city technologies. This is not an exhaustive list of policy options, and the purpose is to provide policymakers with a broader base of information for decision-making. Policymakers may include Congress, federal agencies, state and local governments, academia, industry, and other interested groups.

3.1 Facilitate improved collaboration to evaluate technology use

To allow for the efficient use of resources and knowledge sharing about effective use of smart city technologies, policymakers could facilitate collaboration among cities, researchers, and other stakeholders on evaluations of smart technologies. Table 1 provides further details of this policy option.

Table 1: Policy option – Improve collaboration to evaluate technology use

Implementation approach	Opportunities	Considerations
• Policymakers could facilitate collaboration among stakeholders to conduct and share more evaluations on the effectiveness and risks of smart technologies in transportation and law enforcement.	• Partnerships between local or state governments and academic researchers could better focus on local needs and the extent to which smart technologies can be effective in particular communities. • Academics and other stakeholders could better coordinate research efforts and help ensure that existing research resources are better targeted and results more widely shared, helping to avoid duplication, overlap, or fragmentation of research efforts.	• Partnerships between local or state governments and academic researchers may require deliberate planning and consultation across sectors to identify roles and responsibilities of groups best suited to conduct research and make effective use of resources. • Some government entities and experts may require additional resources, such as staff with specific skill sets, to fully collaborate in research efforts.

Source: GAO. | GAO-25-107019

3.2 Policy option – Facilitate transparency when procuring and using smart technologies use

To promote transparency in the use of smart city technologies, and with consideration of the risks to privacy and civil liberties that may be presented by collecting smart technology data that can be used to identify individuals, policymakers could help cities develop means to clearly communicate how smart technologies are intended to be used, potential benefits and risks associated with these smart technologies, and how data from these technologies are obtained and aggregated. Table 2 provides further details of this policy option.

Table 2: Policy option – Increase transparency when procuring and using smart technologies

Implementation approach	Opportunities	Considerations
• Cities could increase transparency in the use of smart technologies by (1) providing information to individuals and the public of the potential benefits and the potential risks associated with the use of smart technologies, including from the misuse of data collected by smart technologies, and (2) requiring third parties to obtain consent before collecting data, where practical.	• City governments could help build trust between the city and individuals by providing a clear understanding of (1) how smart technologies function; (2) the means by which the city will store, protect, and dispose of data on individuals and control access to these data by third parties, such as data brokers; and (3) the costs, benefits, challenges, and risks presented by use of the technologies. • Transparency may reduce the chance that use of technologies will be disrupted due to misconceptions about the use and intrusiveness of such technologies.	• Informing individuals about smart technologies and its implementation—considering that multiple language translations might be needed—may be time consuming, which can delay implementation. • Informing individuals about smart technologies may require multiple approaches that may become prohibitively expensive.

Source: GAO. | GAO-25-107019

3.3 Policy Option - Facilitate effective data governance through the development and sharing of effective practices or standards

To promote responsible management of the data produced by smart city technologies, policymakers could support the development and sharing of effective data governance practices. Considering that these data can be used to identify individuals, developing effective governance practices provides the opportunity for stakeholders to consider key issues such as how individuals may be able to consent to use of data collected on them and how data will be secured, retained, stored, and controlled to prevent misuse. Table 3 provides further details of this policy option.

Table 3: Policy option – Develop and share effective data governance practices or standards

Implementation approach	Opportunities	Considerations
• Policymakers could work to develop effective practices or standards for data governance and provide training for city procurement officials on these data governance practices or standards to ensure all city and state employees, as well as all vendors and contractors with whom a city does business, are required to adhere to or adopt such practices and standards.	• Data governance standards for cities and vendors who sell those data may help protect individuals from bad actors and may reduce instances of scams, stalking, or other harms. • Cities' data governance agreements with vendors could set terms that protect data on individuals, thereby reducing the likelihood of scams, stalking, or other harmful outcomes. • Data governance standards can help individuals understand how their data will be protected.	• Different levels of government (federal, state, local) may be better suited to implement different data governance standards. • City procurement officials may require training or technical assistance to write contracts that protect data, clarify data ownership, and provide a means to ensure vendor compliance through monitoring and enforcement.

Source: GAO. | GAO-25-107019

3.4 Policy Option – Status quo

Policymakers could choose not to take any new actions to enhance the benefits or address the challenges in cities' use of smart technologies. Under the status quo, cities not currently using a particular smart technology, or a city considering expanding the use of a technology, could delay action until more is known about their effectiveness and issues regarding privacy are addressed. Table 4 provides further details of this policy option.

Table 4: Policy option – Status quo

Implementation approach	Opportunities	Considerations
• Policymakers could take no further interventions, allowing current activities to continue.	• Policymakers could observe outcomes achieved under the status quo and later consider policy actions, including those above. • Cities not currently using smart technologies, or considering expansion of their use, could delay acquisition until sufficient evidence regarding their effectiveness is available and issues regarding privacy are addressed.	• Maintaining the status quo may not be responsive to transparency and data governance challenges, resulting in unresolved or exacerbated risks with increased use of smart technologies.

Source: GAO. | GAO-25-107019

4 Agency and Expert Comments

We provided a draft of this report to the Department of Commerce, Department of Energy, Department of Justice, Department of Transportation, Federal Communications Commission, and Federal Trade Commission with a request for technical comments. We incorporated agency comments into this report as appropriate.

We also offered our expert meeting participants and a selection of experts we interviewed the opportunity to review and comment on a draft of this report. We sent the report to 15 of those experts for review, and 5 provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the relevant federal agencies, and other interested parties. This report will be available at no charge on the GAO website at https://www.gao.gov.

If you or your staff members have any questions about this report, please contact Brian Bothwell at BothwellB@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

//SIGNED//

Brian Bothwell, MS
Director,
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List of Addressees

The Honorable Rand Paul, M.D.
Chairman
Committee on Homeland Security and Governmental Affairs
United States Senate

The Honorable Brett Guthrie
Chairman
The Honorable Frank Pallone, Jr.
Ranking Member
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House of Representatives

The Honorable Sam Graves
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The Honorable Rick Larsen
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The Honorable Gus Bilirakis
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The Honorable Jan Schakowsky
Ranking Member
Subcommittee on Commerce, Manufacturing, and Trade
Committee on Energy and Commerce
House of Representatives

The Honorable Nancy Mace
Chairwoman
Subcommittee on Cybersecurity, Information Technology, and Government Innovation
Committee on Oversight and Government Reform
House of Representatives

The Honorable Jamie Raskin
House of Representatives

Appendix I: Objectives, Scope, and Methodology

We prepared this report under the authority of the Comptroller General of the United States to assist Congress with its oversight responsibilities in light of congressional interest in smart city technologies. This report examines: (1) how smart technologies can impact a city's ability to deliver transportation and law enforcement services; (2) the benefits and challenges associated with using smart city technologies to support transportation and law enforcement functions, and (3) potential policy options that could help enhance the benefits or mitigate the challenges associated with using smart city technologies, and the opportunities and considerations of these policy options.

To conduct our work, for all objectives, we:

- Identified six areas where cities use smart technologies to provide services: transportation, healthcare, law enforcement, electrical grid, wastewater, and smart buildings. We evaluated these areas based on selection criteria, including whether there were established metrics of the benefits of the technology, whether the technology overlapped with other GAO work, and other criteria. Based on this analysis, we selected two areas, transportation and law enforcement, to be within the scope of our work.

- Interviewed officials from the Department of Energy, Department of Justice, Department of Commerce, Department of Transportation, Federal Trade Commission, and Federal Communications Commission. We also interviewed stakeholders from academia, non-governmental organizations, and industry. Our interviews focused on smart city technology impacts, applications, benefits, risks, and technology development activities. We selected federal officials and stakeholders that represented a diverse set of views on the uses, benefits, and challenges of using smart city technology. We informed our selection of stakeholders using a review of relevant documents and through obtaining recommendations from interviewees about others to contact.

- Reviewed selected literature from the years 2018 to 2023 identified by a GAO librarian. The librarian searched a variety of databases including ProQuest, Scopus, and EBSCO using terms related to "smart cities," "data security," "privacy issues," "civil liberties," "costs," and "metrics." We reviewed abstract information on periodical reviews, journal articles, working papers, conference papers, trade articles, and reports from this search and selected the most relevant documents to include in our review based on our research objectives.

- Visited selected cities in Texas, California, and Georgia to observe the operation of smart technologies and to meet with local government officials and other stakeholders involved with the development and implementation of these technologies. The cities that we visited included Atlanta, Houston, San

Diego, San Jose, San Francisco, and Oakland. We selected these cities based on recommendations from interviewees, and their known use of smart technologies for transportation or law enforcement applications. The information gathered on the site visits does not represent a generalizable sample of technologies or stakeholder views.

- Conducted virtual meetings to facilitate group discussions with experts from state and local governments, non-governmental organizations, academia, and industry with the assistance of the National Academies of Sciences, Engineering, and Medicine (National Academies). In consultation with the National Academies, we selected experts with technical, legal, or policy expertise representing a balanced and diverse set of views in the set of panel discussions conducted over the course of 2 days. The meeting participants and their affiliations are listed in appendix II. Participants in this set of panel discussions provided documentation of any potential conflicts of interest, and upon review, we found the group of experts as a whole did not have any inappropriate bias. This meeting of experts was planned and convened with assistance from the National Academies to better ensure that a breadth of expertise was brought to bear in its preparation. However, all final decisions regarding meeting substance and expert participation were made by GAO. Before issuance, we provided the meeting participants an opportunity to review a draft of our report and provide technical comments. We incorporated expert comments in the report, as appropriate.

- We also identified three policy options that policymakers could consider to enhance the benefits or address the challenges to implementing smart city technologies. The policy options are neither recommendations to federal agencies nor matters for congressional consideration. Rather, these policy options are intended to represent possible actions policymakers can take to address their policy objectives.[21] The policy options we present are not inclusive of all possible options.

We conducted our work from August 2023 to April 2025 in accordance with all sections of GAO's Quality Assurance Framework that are relevant to technology assessments. The framework requires that we plan and perform the engagement to obtain sufficient and appropriate evidence to meet our stated objectives and to discuss any limitations to our work. We believe that the information and data obtained, and the analysis conducted, provide a reasonable basis for any findings and conclusions in this product.

[21] Policymakers is a broad term including, for example, Congress, federal agencies, state and local governments, academic and research institutions, and industry.

Appendix II: Expert Participation

We convened a 2-day meeting of experts with assistance from the National Academies of Sciences, Engineering, and Medicine to inform our work on technologies for smart cities; the meeting was held virtually on May 13-14, 2024. The experts who participated in this meeting are listed below. Some of these experts gave us additional assistance throughout our work, including fifteen who received a copy of our draft for review, and five who provided comments, which were incorporated as appropriate.

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Assistant Chief of Police and Administration Division Chief

Miami Police Department

Andrea Amico

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Privacy4Cars

Kate Burns

Executive Director

MetroLab

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Transportation Professional Engineer

Texas Department of Transportation

Mashrur "Ronnie" Chowdhury

Eugene Douglas Mays Chaired Professor

Founding Director, USDOT National Center for Transportation Cybersecurity and Resiliency

Clemson University

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National Policing Institute

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Andrew Guthrie Ferguson

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John Hibbard

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Elizabeth Joh

Martin Luther King, Jr., Professor of Law

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Smart City PDX Data Services Manager

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Assistant Professor of Law and Political Science

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Laura Schewel

Co-founder and Chief Executive Officer

StreetLight

Andrew Smyth

Robert A. W. and Christine S. Carleton Professor of Civil Engineering & Engineering Mechanics

Director and PI, NSF Engineering Research Center for Smart Streetscapes

Columbia University

Jay Stanley

Senior Policy Analyst

Speech, Privacy, and Technology Project

American Civil Liberties Union

Jason Tashea

Founding Director of the Judicial Innovation Fellowship

Georgetown University Law Center

Katie Turnbull

Senior Research Fellow and Regents Fellow

Texas A&M Transportation Institute

Nalini Venkatasubramanian

Professor, Department of Computer Science

University of California Irvine

Dan Work

Chancellor Faculty Fellow

Professor in Civil and Environmental Engineering, Computer Science

Institute for Software Integrated Systems

Vanderbilt University

Yinhai Wang

Director and Thomas and Marilyn Nielsen Endowed Professor in Engineering

Pacific Northwest Transportation Consortium

University of Washington

Jan Whittington

Associate Professor, Department of Urban Design and Planning

Director, Urban Infrastructure Lab

Associate, Tech Policy Lab

University of Washington

Stanley Young

Advanced Transportation and Urban Scientist

National Renewable Energy Laboratory

Center for Integrated Mobility

Appendix III: GAO Contact and Staff Acknowledgments

GAO contact

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