



Photo Source: U.S. DOT

# PUTTING PEOPLE FIRST

## Smart Cities and Communities



# WHAT ARE SMART CITIES AND COMMUNITIES?



Photo Source: U.S. DOT

Communities around the country are finding innovative ways to use emerging communications, computing, and transportation technologies to make cleaner, safer, and more equitable places to live and work. Smart cities and communities (SC&Cs) use advanced information and communications technologies to find new ways to solve age-old problems like potholes and pollution, traffic and parking, public health and safety, and equity and public engagement. These bold new solutions have the potential to change the face of transportation by closing the gap between rich and poor, capturing the needs of both young and old, and bridging the digital divide through smart design so that the future of transportation meets the needs of all.

SC&Cs create an intelligent, integrated information network by applying sensors and wireless communications technologies to infrastructure, vehicles, wearables, and any number of physical devices. They use this network to receive, analyze, and share data in real time to make better decisions and provide more responsive, efficient, data-driven services.

Three hallmarks of SC&Cs are:

## NETWORKS

They use networks of sensors to gather and integrate data that can be used for various applications and citizen services.

## CONNECTIVITY

They use connectivity to enable city officials to interact directly with the community and to monitor and manage city infrastructure.

## OPEN DATA

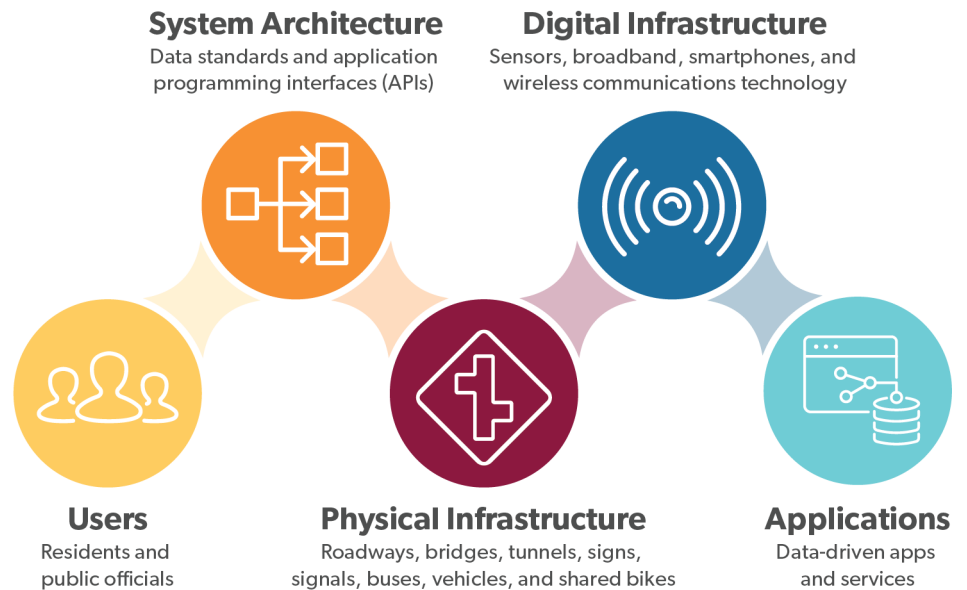
They are committed to an open data philosophy and routinely share operations and planning data with the public.

SC&C technologies include user-focused mobility services; connected, automated, and electric vehicles; intelligent, sensor-based infrastructure; new urban delivery methods; smart payment systems; and advanced analytics, to name a few. These connected applications and systems put timely, reliable information into the hands of users to streamline services and guide decisions. Cities and communities are using new technologies like artificial intelligence and advanced data analytics to discover new ways to look at old problems. The use of SC&C technologies can lead to more affordable transportation options, more reliable and accessible travel information, fewer delays, cleaner air, and safer streets.

**Undergirding these technologies is an integrated information and communications system. Strong information technology architecture and standards are the backbone of SC&Cs—allowing smooth data connections; creating opportunities for partnerships and public engagement; and enabling innovative cross-cutting, data-driven solutions.**

**FIGURE 1: SC&C LAYERS**

SC&C solutions enhance the capabilities of traditional transportation infrastructure through connected digital infrastructure, such as sensors and wireless technology. A robust systems architecture with consistent data standards makes it possible to share data in real time, enabling the development of data-driven applications and services that users (public officials, private companies, non-profits, and residents) can interact with to make more informed decisions and improve their quality of life.



While SC&C concepts can be applied to any number of community concerns, such as energy, the environment, and public health, transportation is frequently the starting point for communities for applying SC&C concepts. This is because transportation is a concern of all residents and is critical to the local economy. Improving the operation of the transportation system can yield immediate benefits for a region's economy and quality of life.

This report includes some of the forward-thinking ways communities are applying SC&C concepts and how the Department of Transportation (U.S. DOT) is supporting those efforts. It shares results from a survey of more than 50 American cities on their use of SC&C technologies. The report also provides an overview of the benefits and challenges of SC&Cs and the key factors that can drive success. SC&C is a relatively new concept, but it is advancing and maturing quickly. This document gives a glimpse of what the future might hold and how the U.S. DOT is helping communities blaze the way to a brighter future.

# BENEFITS

The technological foundation of SC&Cs may be an interconnected information and communications network that powers open data platforms, operations management centers, and bureaucratic efficiencies, but the benefits to the public are real, practical improvements to the lives of everyday people.



SC&C solutions support safer and healthier communities by improving traffic safety and emergency response, improving access to health care, supporting active modes of transportation, and identifying and addressing emissions hot spots.

## HEALTH AND SAFETY

SC&C solutions are leading the way to a zero-emissions future by improving traffic flows, installing electric vehicle infrastructure, and converting public fleets and buses to electric vehicles.



## CLIMATE CHANGE

## OPEN GOVERNMENT

SC&C solutions provide new pathways and platforms for citizen engagement by creating open-data portals; breaking down silos; and enabling more responsive, integrated, data-driven municipal services.



## EQUITY

SC&C solutions increase access to opportunity by making technologies more accessible and affordable; improving access to broadband and wireless services; connecting underserved communities to employment, amenities, and services by providing affordable, reliable transportation options; and bridging the digital divide.



## MOBILITY

SC&C solutions support better mobility choices, improving the quality and reliability of transit services, enhancing pedestrian and bicycle infrastructure, and making better use of the space allocated to parking.

## ECONOMIC GROWTH



SC&C solutions improve access to employment and, by reducing congestion and improving truck routing, parking, and curbside management, make it possible for goods to be delivered to homes and businesses safely, reliably, and efficiently.

# WHAT IS DOT'S ROLE IN SUPPORTING SMART CITIES AND COMMUNITIES?



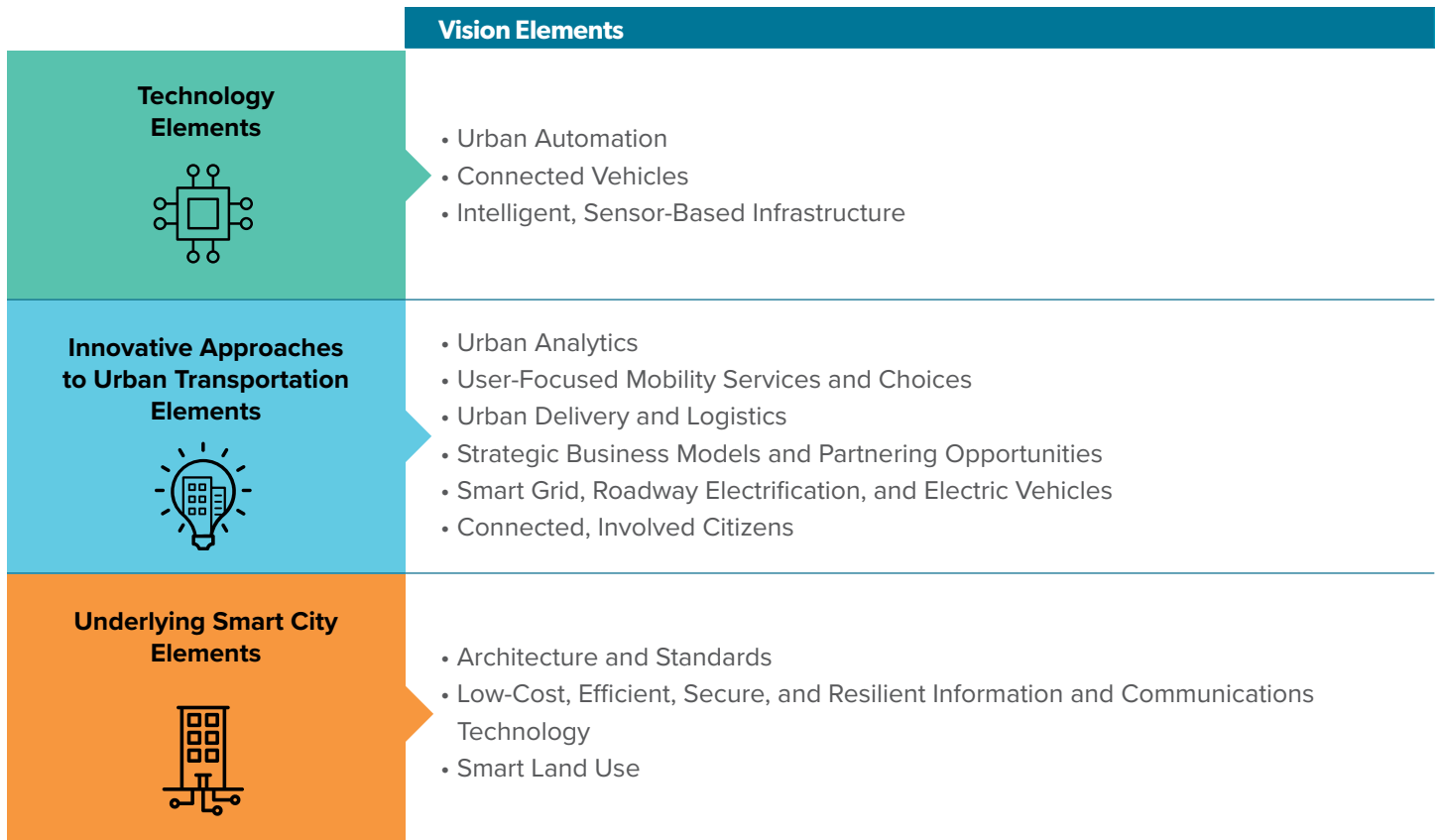
Photo Source: U.S. DOT

Building on a broad base of long-term research and outreach on intelligent transportation systems, the U.S. DOT launched the Smart City Challenge in December 2015. The challenge sought to spur the advancement of smart cities and further the goal of developing a connected society capable of addressing transportation challenges faced by communities of all sizes. It sparked excitement across the country as 78 cities applied, generating hundreds of innovative ideas and dozens of serious plans for using advanced technologies to address a wide range of problems.



U.S. Department of Transportation

FIGURE 2: 2015 SMART CITY CHALLENGE VISION ELEMENTS



Building on the success of the Smart City Challenge, the U.S. DOT has awarded millions of dollars in grants to support community-driven, advanced-technology transportation projects to fight congestion, increase connectivity, and improve access to opportunity. Leveraging funding from local and private partners, grant recipients introduced cutting-edge technology to their communities, demonstrating in real-world settings the tools that will transform our transportation system in the coming years.

As SC&C solutions evolve, the U.S. DOT is working to speed the transformation of research, prototypes, and pilots into market-ready technologies and, ultimately, widespread deployment by preparing the public sector to address challenges associated with their adoption. To that end, the U.S. DOT provides communication and education to facilitate awareness, understanding, acceptance, adoption, and deployment of ITS technologies.

## SC&C technology deployments and challenges

In August 2019, the U.S. DOT surveyed U.S. cities on their SC&C activities.

**52 cities responded.**

Their most common SC&C activities were:

**69%** Traffic Management

**63%** Data Management

**63%** Public Transportation

**63%** Automation or Connectivity for Vehicles, Bicycles, or Pedestrians

The most frequently identified challenges included:

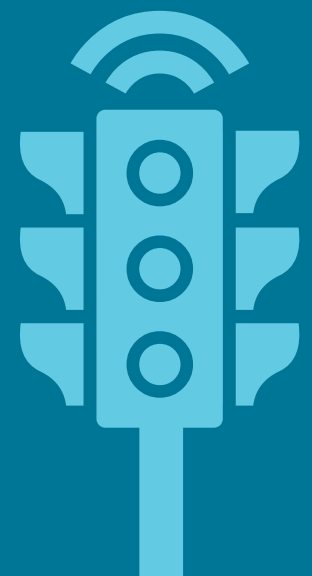
**62%** Funding

**38%** Lack of Standards

**37%** Coordination Across City Departments

**32%** Lack of Mature Technology

**32%** Lack of Cybersecurity



# SUCCESS FACTORS



Photo Source: U.S. DOT

Recent experiences with SC&C pilots and demonstration projects have resulted in a number of lessons learned. The U.S. DOT's review of evaluation literature, interviews with municipal officials, and survey of more than 50 cities point to clear success factors.



## Set clear goals

It's important to remember that becoming a smart city or community is not a goal but rather a means to an end. **SC&C initiatives are a way to solve real-world problems.** While the “glitz” and “shine” of new technologies may attract attention, communities need to focus on their goals—deploying the technologies that can help achieve those goals and solve their transportation challenges. Since many SC&C initiatives require substantial investments of time and money, it's also important to clearly communicate the practical value of these efforts to the public in solving common problems and improving the quality of everyday life.



## Break down silos

A common challenge to achieving the cross-functional efficiencies and holistic insights of SC&Cs is that departments within a given municipality tend to work in silos, particularly with respect to data sharing and operations. SC&C solutions work best when they leverage data across different city domains (e.g., transportation, public services, energy, and public safety) and use this integrated data for optimized city operations. In practice, however, many SC&C deployments have been standalone applications, rather than fully integrated decision-support systems that coordinate multiple city services. Lessons learned from these pilots can prepare communities to take the next step.

**To enable an integrated approach to SC&C solutions, municipalities need to build a strong data architecture and centralized data system that enables a single platform for facilitating planning, data analysis, and greater operational efficiencies.** Establishing cross-functional, interdisciplinary teams can also help to break down silos, eliminate redundancies, and facilitate data sharing.





## Use a structured engineering approach

Take the time for a dedicated planning phase that considers user needs, privacy, and cybersecurity from the start. Following a structured, systems-engineering-based approach can help to ensure that connected systems are both interoperable and secure, improving system resiliency while reducing the risks of schedule and cost overruns. Documenting system processes and architecture can also improve the likelihood that an SC&C project meets user needs and is replicable.



## Speak the same language

Achieving big things means starting from the ground up: it all starts with standards. **“Lack of standards” was the second most common challenge to deploying SC&C technologies identified by cities in response to a U.S. DOT poll. How do standards help? For systems to work together, they have to speak the same language.** Communications protocols and standards are a critical ingredient for scaling up from standalone pilots to an integrated system that serves the whole community. Having clear data standards, integrated systems, and a robust application programming interface (API) enables timely data sharing. This allows users to connect to the data they need, fostering the entrepreneurial uses of data and innovative partnerships that drive successful SC&Cs.



## Foster a culture of innovation

Doing new things involves risk. In some cases, communities may be reluctant to embrace new technologies or innovative practices. This is natural. The public sector has a responsibility to balance risk-taking with fiscal stewardship. To get past resistance to change, some public-sector agencies have focused on developing a culture of innovation by encouraging their staff to use new approaches, technologies, and tools in performing their jobs, creating opportunities to take risks and learn from failures. While SC&C solutions can achieve operational efficiencies and improve staff capacity, they can also disrupt a municipality’s traditional operations. To achieve the benefits of SC&Cs, municipalities must be flexible and agile in meeting the challenges posed by change.



## Engage citizens

Public engagement is a tool for obtaining feedback from citizens on the usefulness and effectiveness of new technologies, but it also serves to educate the public and obtain buy-in on new efforts. Successful efforts often draw on community resources by working with community-based organizations and engaging in meaningful public outreach. In this way, communities help to ensure that the needs of low-income households, people of color, immigrants, older people, people with disabilities, and other underserved communities are identified and addressed.



## Explore with living labs

To accelerate the implementation of SC&C solutions, many cities are establishing living labs. Living labs are physical locations where public agencies and their partners can pilot and demonstrate SC&C solutions. It may be a special district, a college campus, or a new community. Living labs are an effective way to safely experiment with potential solutions at a limited scale while allowing the public to engage with new technologies. Living labs are different than test beds in that they are typically open and people-centered, allowing residents to interact with and provide feedback on new technologies and services. Living labs can serve as a tool for building partnerships, fostering economic growth, and educating the public about SC&C solutions.



## Partner strategically

Municipalities can also leverage their capacity by partnering with stakeholders in their communities to strategize, plan, deploy, and fund SC&C initiatives. Partnerships with non-profit organizations, universities, and the private sector can provide additional funding and institutional capacity and flexibility to achieve innovative solutions. Partnerships can provide the necessary funding for projects, as well as technical expertise and access to proprietary technology. Partnerships also enable knowledge transfer, which facilitates broader technology adoption.

Partnerships are not without challenges, however, and public-sector actors need to be prudent about working with vendors who may oversell their capabilities or do not clearly understand public-sector goals. For example, when initiating partnerships for SC&C initiatives, it is important to establish up front streamlined processes for sharing data and an understanding of who owns the data. Where the public sector owns the data, it can allow greater transparency, data sharing, and discovery of cross-cutting synergies.

The figure below summarizes some of the lessons learned for engaging with SC&C partners.

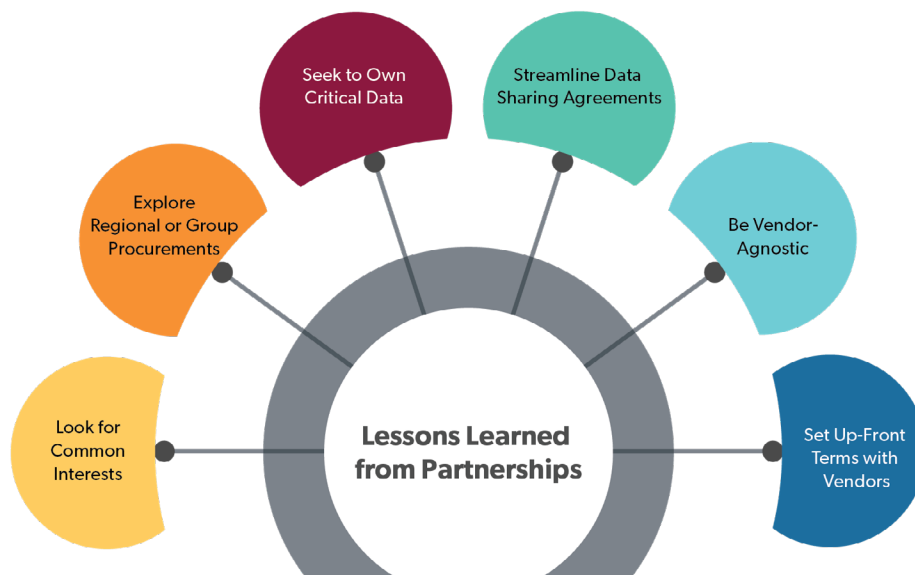


FIGURE 3: LESSONS LEARNED FROM PARTNERSHIPS

# HOW SMART CITIES AND COMMUNITIES ARE TACKLING THEIR TRANSPORTATION CHALLENGES

## Safety

Transportation safety is a top priority for the U.S. DOT and local communities, many of which have seen rising pedestrian and cyclist fatalities in recent years. Despite declines in travel over the past year due to the COVID-19 pandemic, transportation-related fatalities and serious injuries increased in many communities. Connected vehicle and infrastructure technologies can help communities identify safety issues, reduce crashes, and improve emergency response. For example, some communities are installing pedestrian detection and warning systems on city vehicles to improve pedestrian safety. To reduce emergency response times, communities also are installing signal preemption systems that grant priority right-of-way to emergency vehicles, such as ambulances and fire trucks.

## Curb management

Competition for curb space can cause congestion and safety hazards. Cars circle while looking for spots, creating traffic. Trucks double-park so that they can load or unload merchandise. Ride-hailing companies stop in bike lanes to pick up passengers. To address these problems, some communities are deploying advanced parking and curb management systems.

Curb management systems use infrastructure-based sensors or camera systems that use machine vision to detect when spots are occupied or empty and alert end users through mobile apps or variable message signs. Curb management systems can also support advanced booking, cashless payment, and dynamic pricing for loading spaces or public spots. By improving data, they can even enable analytics that predict when spaces will be available and dynamic pricing that reflects the true demand and value of a limited public resource. Improving driver awareness of space availability can reduce congestion and facilitate safe curb use for various users, including personal vehicles, ride-hailing vehicles, transit users, pedestrians, and cyclists.



Photo Source: U.S. DOT

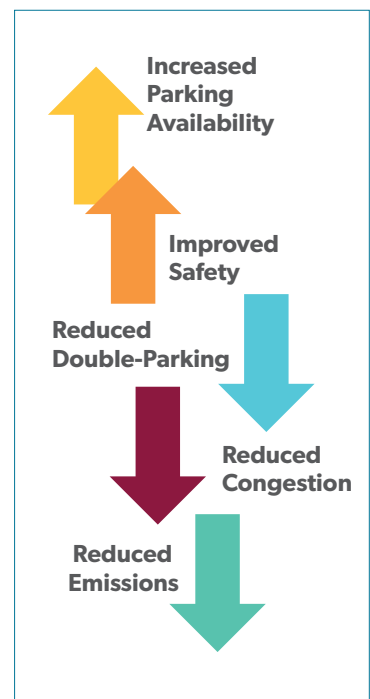


FIGURE 4: CURB MANAGEMENT BENEFITS



Photo Source: U.S. DOT



Photo Source: U.S. DOT

## Mobility justice

Many residents lack access to affordable transportation options to get them where they need to go in a reasonable period of time. Even in transit-rich cities, there are gaps in the transit networks and challenges in providing reliable services. Over the past decade, a host of new mobility services have emerged to meet the demand for convenient transportation alternatives. These include ride-hailing companies, shared bicycle and e-scooter systems, and new microtransit options. These systems are multiplying rapidly in cities and towns around the country, creating new options for travelers and new challenges and opportunities.

While most of these new mobility services are privately operated, communities are finding ways to leverage these services to improve first-mile/last-mile connections to transit, meet demands for affordable transportation in underserved communities, and reduce demand for personal vehicle travel. For example, transit agencies are forming partnerships with ride-hailing companies to supplement paratransit services in some regions. These partnerships have the potential to improve the convenience of paratransit for customers while lowering the costs for transit agencies.

Recognizing that a significant portion of the population lacks access to bank accounts and/or smartphones, municipalities are partnering with mobility service providers to expand access to mobility services and information by ensuring the equitable distribution of services, subsidizing the use of mobility services for low-income residents, or providing universal transportation payment cards to support use of services by residents without bank accounts. Public policies can also help to ensure that micromobility and on-demand microtransit systems are equitably distributed across a region and are affordable and accessible to those who may not have a bank account or smartphone.

## Congestion

Traffic delays in American cities and their surrounding suburbs cost travelers tens of millions of dollars in wasted time and fuel each year, resulting in increased emissions and lower quality of life. SC&C concepts such as smart traffic lights can reduce congestion and improve travel time reliability by creating smoother traffic flows. Communities are also leveraging connected infrastructure and vehicle technologies to improve the speed and reliability of traditional transit services. To improve service, agencies are establishing bus rapid transit corridors, installing signal systems that prioritize buses, and collecting and sharing real-time transit information so that riders can make better decisions. Sensors on traffic lights and on city vehicles can detect when a bus or city vehicle nears a signal-controlled intersection, turning the traffic signals to green sooner or extending the green phase, thereby allowing the vehicle to pass through. This can improve the reliability of transit services or the speed of emergency response. Collecting and analyzing data on public transit usage and traffic can also help transit agencies make better decisions about transit routes and services.



Photo Source: U.S. DOT

## Energy efficiency and pollution

Many cities and communities are seeking ways to improve air quality while reducing carbon emissions. Poor air quality is an important public health issue that disproportionately affects underserved communities. Climate change affects everyone, and some low-lying coastal communities or communities in areas prone to wildfire may be particularly vulnerable.

Many of the SC&C solutions aimed at reducing congestion, improving traffic flows, and providing shared and active mobility alternatives have the additional benefit of reducing vehicle emissions. Electrification of vehicles is an important SC&C solution that can significantly reduce emissions. To accelerate electrification, communities can transition bus, city vehicle, and on-demand ride-hailing fleets to electric vehicles and install electric charging stations. SC&C solutions like smart street lights can also improve the energy efficiency of basic infrastructure. Low-cost air quality sensors can also be mounted on infrastructure to help provide real-time, location-specific information on air qualities, helping communities identify and address emissions hot spots. Understanding the locations of poor air quality more precisely can help municipalities address equity and public health.

## Responsive government services

SC&C solutions can generate massive amounts of data. Sometimes finding ways to use the data to make municipal services and infrastructure more efficient and effective can present the greatest challenge. Successful communities succeed by finding innovative ways to leverage the intellectual and social capital of their citizenry and institutions to understand their needs, save public resources, and deliver better services.

One way that SC&Cs are engaging partners and the public is through open-data platforms and real-time APIs. These platforms give citizens, researchers, and developers the opportunity to use standardized data sets to develop applications, identify issues and opportunities, and bolster engagement and advocacy. By providing transparent data and opportunities for civic engagement, communities can drive increased equity and ensure government is responsive to the needs and desires of its residents.



Photo Source: U.S. DOT

# WHAT IS THE FUTURE OF SMART CITIES AND COMMUNITIES?



Photo Source: U.S. DOT

Our nation has ambitious goals for climate, equity, and economic growth that hinge on our transportation network. Local communities have been leading the charge to address these goals. By embracing bold policies and innovative solutions that leverage rapidly advancing technologies, communities are not only solving local problems like traffic and parking, they are creating a model for more inclusive, connected, and sustainable communities of the future.

The U.S. DOT stands ready to support local governments as we learn together from early pilots and begin moving toward integrated, sustainable systems. It begins by listening, learning, and sharing with each other what works, what doesn't, and what's next.

To this end, over the course of the next year, the U.S. DOT will support a series of webinars and listening sessions on SC&C. These webinars will provide an opportunity to share best practices and lessons learned, with the ultimate goal of creating a sustainable coalition of communities that can support further implementation of effective SC&Cs initiatives.

Cities and communities have already learned a lot about the ingredients that can put a community on the path to success, such as setting clear goals, establishing an integrated information network, and leveraging partnerships. Most importantly, successful SC&Cs put people first. For communities that embrace SC&C solutions as a means to engage people to accomplish collective goals, that future is fast arriving.



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