CITY OF BELLEVUE

SMART MOBILITY PLAN

2018

Prepared for the City of Bellevue by

transpogroup

HDR

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ACRONYMS

AAA .... American Automobile Association

ACES .... Autonomous, Connected, Electric, and Shared

ADAS .... Advanced Driver Assistance Systems

ATC .... Advanced Transportation Controller

ATCMTD .... Advanced Transportation and Congestion Management Technologies Deployment

ATSPMs .... Automated Traffic Signal Performance Measures

AV .... Autonomous Vehicle

AVL .... Automatic Vehicle Location

CAD .... Computer Aided Dispatch

CCTV .... Closed-Circuit Television

CMAQ .... Congestion Mitigation and Air Quality

CMS .... Changeable Message Sign

CPN .... CommutePool Network

CPP .... Connected Citizen Program

CV .... Connected Vehicle

DMS .... Dynamic Message Sign

DOE .... Department of Energy

DSRC .... Dedicated Short-Range Communications

EV .... Electric Vehicle

FHWA .... Federal Highway Administration

GPS .... Global Positioning System

IoT .... Internet of Things

ITS .... Intelligent Transportation System

LiDAR .... Light Detecting and Ranging

NHTSA .... National Highway Traffic Safety Administration

NORCOM .... North East King County Regional Public Safety Communication Agency

O&M .... Operation and Maintenance

ODP .... Open Data Portal

OEM .... Original Equipment Manufacturer

P&R .... Park and Ride

PSE .... Puget Sound Energy

SCATS .... Sydney Coordinated Adaptive Traffic System

SPaT .... Signal, Phase, and Timing

STP .... Surface Transportation Program

TaaS .... Transportation-as-a-Service

TDC .... Transportation Data Collaborative

TMC .... Traffic Management Center

TSP .... Transit Signal Priority

V2I .... Vehicle-to-Infrastructure

V2V .... Vehicle-to-Vehicle

V2X .... Vehicle-to-Connected Device

VMT .... Vehicle Miles Traveled

WSDOT .... Washington State Department of Transportation

WSTC .... Washington State Transportation Commission

EXECUTIVE SUMMARY

As the City of Bellevue continues to grow and thrive, the demands on the city's transportation system continue to grow as well. This growth has resulted in traffic and parking concerns as being the most significant city issues identified by Bellevue citizens in 2015 and 2017. Bellevue's Smart Mobility Plan aspires to manage this growth through the use of technology to enhance and optimize the transportation system throughout the city.

In 2004, the city adopted an ITS Master Plan that resulted in one of the most advanced intelligent transportation systems in the country—with an adaptive traffic signal control system at all city intersections, a citywide fiber optics-based communications system, and a state-of-the-art traffic management center. These ITS achievements have improved traffic flow, reduced congestion on city streets in a cost-effective way[1] and provide a foundation for the smart mobility initiatives presented in this report.

The future of mobility in Bellevue is about to undergo a transformational change with emergence of new technologies that demonstrate significant opportunities in improving transportation efficiency, mobility, safety, and sustainability. Advancements in autonomous, connected, electric, and shared (ACES) technologies demonstrate that private and public sector can work together toward applying technology to shape the transportation system. Many of these technologies will change the way that people and goods are transported.

They will also shift the roles that the public and private sector will assume in planning and implementing transportation solutions.

Bellevue's Smart Mobility Plan outlines the city's implementation plan toward both traditional and emerging transportation technologies and discusses steps to accelerate and integrate them in the next 5 years. The plan also discusses potential partnership opportunities to achieve Bellevue's Smart Mobility Vision: To use innovation and partnerships to deploy emerging technologies to enhance the safety, sustainability, efficiency. and accessibility of Bellevue's transportation system.

Bellevue's Smart Mobility Plan is divided into six key initiatives:

- Shared-use Mobility
- Autonomous and Connected Vehicles
- Electric Vehicles
- Real-Time Traveler Information
- Data Management
- Traffic Management

Shared-use Mobility

Bellevue's shared-use mobility initiative focuses on partnerships to integrate transportation services that provide or facilitate shared rides between travelers. Encouraging shared mobility in Bellevue will be a key component in the city's Smart Mobility Plan as it addresses the need to reduce the number of vehicles on the road to improve congestion. Bellevue's smart mobility plan includes innovative programs such as the "CommutePool" flexible employer rideshare program that Bellevue is developing with the City of Kirkland and local employers. The program will use mobile application technology to arrange shared rides for the Bellevue and Kirkland workforce in the initial pilot.

Autonomous and Connected Vehicles

In 2018, the auto industry has spent upwards of $60 billion to develop autonomous vehicles (AV) and connected vehicles (CV)[2]. These investments are supported by the potential safety, mobility and environmental benefits that both AVs and CVs offer. Automakers such as Ford, GM, Toyota, and Honda are all anticipating the launch of vehicles capable of full self-driving capabilities by 2021, prompting cities like Bellevue to plan for their arrival. Bellevue's autonomous and connected vehicle initiative targets early pilot deployments that will provide the necessary experience to integrate AVs and CVs as they trend towards ubiquity.

Electric Vehicles

Electric vehicle (EV) adoption has nearly tripled in Bellevue between 2017 and 2018. The city anticipates a continued trend as EV charging infrastructure and the number of available EV models rapidly expand. Bellevue's EV initiative prepares for this growth by partnering with regional stakeholders to build an expansive network of EV charging infrastructure and leads by example by operating and encouraging the use of EVs in the public sector.

Data Management

Transportation data availability has grown exponentially with the widespread increase of data sources from the public and private sector. Bellevue's data management initiative focuses on gathering and managing large volumes of transportation data to help the city make data-driven decisions based on accurate, timely, and reliable information. Data management also encompasses safe data handling to ensure that data privacy is upheld.

Real-Time Traveler Information

Connected devices such as smartphones and in-vehicle navigation systems make it possible for travelers to access traffic information from their fingertips. With mobile phone applications being the primary source for Bellevue travelers, the city's real-time traveler information initiatives will utilize partnerships with the private sector to disseminate the most accurate and relevant information to the public.

Traffic Management

Bellevue's traffic management initiative includes a variety of traditional transportation technologies that provide a foundation for other emerging technologies identified. Traditional transportation technologies include equipment and infrastructure deployments that will enhance the existing Intelligent Transportation System (ITS) and traffic signal system. Projects completed under this initiative will provide city staff with technologically advanced tools to manage the transportation system more effectively.

Beyond the Plan

The City of Bellevue is well-positioned to accelerate and integrate the Smart Mobility Plan into our existing transportation system. As one of the nation's rapidly growing technology hubs, Bellevue is surrounded by both established and new technology companies that are eager to provide innovative transportation solutions. The Smart Mobility Plan's addition of over 30 projects will require the City of Bellevue to seek available funding and additional staff to support the initiatives.

With respect to funding, Bellevue will continue to pursue competitive grant and cost-share opportunities with the public and private sector to advance the Smart Mobility Plan. Grant opportunities such as the FHWA Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant are ideal opportunities for the City of Bellevue to leverage public-private partnerships to propose innovative technologies as candidates for federal funding. As the transportation technology infrastructure grows, the City of Bellevue has also identified a need for additional staff resources to support deployment, operations, and maintenance of the new transportation technology programs and infrastructure. Starting

in 2021, the plan identifies the need for one additional ITS Technician and one additional ITS Engineer in the Transportation Department to continue advancing the Smart Mobility projects that will be underway.

Equally important is that Bellevue's elected officials and policy makers are at the forefront of leadership for the new technologies described in this plan and have given direction to make Bellevue a recognized leader in new mobility[3]. The Bellevue City Council has adopted an interest statement in Smart Mobility that focuses on applying technology toward improving transportation safety, enhancing the quality of life, leading by example, providing regulatory framework, improving transportation efficiency, and complementing other available modes. By meeting these objectives using advanced transportation technologies, Bellevue will also accomplish its goals toward becoming a smart city.

INTRODUCTION

A TRANSFORMATION IN TRANSPORTATION

A combination of new technologies will fundamentally change transportation in the next few years. Some have called it the Three Revolutions—vehicles that are automated, shared and electric. Others have called it ACES, which stands for automated, connected, electric, and shared. Many believe that the convergence of these technologies will make transportation safer, smarter, cleaner, faster, more affordable, and with better access for all on a more equitable basis. Some believe that there is a potential for more congestion or other unintended consequences. All agree that a transformation in transportation is coming soon and that we need to be prepared.

Experts now predict a faster timeline than previously assumed for the deployment of ACES vehicles. The steep decrease in the price of vehicle batteries, continued advancements in computing power, and rapid improvements in sensors combined with deep machine learning have now converged and will soon make ACES vehicles safe, affordable, and ubiquitous. One influential report said: "We are on the cusp of one of the fastest, deepest, most consequential disruptions of transportation in history."[4]

Over the last decade, Bellevue has embraced the use of advanced technology to move people and goods more safely and efficiently. The citywide adaptive signal control system, traffic camera system and video analytics platforms, and citywide fiber optic communications are examples of technologies for which Bellevue is nationally recognized as being unique and technologically advanced. Building on a successful track record in implementing transportation technology, the City of Bellevue intends on becoming a "Smart City," with a clean, high-quality environment and excellent, reliable infrastructure that supports the vibrant and growing city, including high-tech connectivity.

Bellevue's Smart Mobility Plan builds upon the work completed in "Bellevue Smart: Planning for a Smarter City," a strategic plan that includes smart mobility technologies including ACES mobility options. Smart mobility technologies enable the transportation network to operate more safely and efficiently. Bellevue also recognizes that smart mobility technologies can also be an economic development opportunity. This plan builds upon the strategies identified in the 2017 "Bellevue Smart" plan, brings the transportation technology strategies to an implementation level, and outlines specific initiatives and projects that the city will advance within the next 5 years.

With the drive and desire to be leaders in technology, the City of Bellevue has developed this Smart Mobility implementation plan

as a strategic framework to deploy ITS technologies. Bellevue also acknowledges that being leaders in innovation requires a careful balance between benefits, tradeoffs, and risks. There can be unintended outcomes associated with emerging "disruptive" transportation technologies, such as obsolescence of existing transportation modes, job displacement, land use changes, and impacts to travel patterns. While challenges exist, the opportunity for emerging transportation technologies to greatly improve safety, efficiency, accessibility, and sustainability through ACES requires Bellevue to take a proactive approach towards integrating these technologies into the transportation system.

As Bellevue advances its plan toward smart mobility, what is evident is the private sector has been paving the way towards ACES technologies. This has already been evidenced through new business models and partnerships from companies like Waymo, GM, Ford, and Tesla, which are pursuing ACES technologies in a race to be the "first to market." Bellevue's Smart Mobility Plan encourages widespread collaboration with the private sector to influence positive change in regional mobility. Bellevue's plan also invites public-private partnerships that align with the city's core Vision and Goals, while attracting local innovation.

VISION AND GOALS

SMART MOBILITY PLAN *Vision Statement*

Use innovation and partnerships to deploy emerging technologies that enhance the safety, sustainability, efficiency, and accessibility of Bellevue's transportation system.

The City of Bellevue has developed nine overarching goals that are the focal point for how the city will implement technologies to improve safety, sustainability, efficiency and accessibility.

1 Make Bellevue a nationally recognized leader in advanced transportation technologies.

2 Improve safety for all modes of travel in support of Bellevue's Vision Zero initiative.

3 Leverage Bellevue's ITS network and transportation technology partnerships to support the growth of the technology industry in Bellevue and overall economic opportunities.

4 Improve the efficiency of the roadway network to support regional mobility.

5 Expand and enhance the city's current ITS functions.

6 Create more mobility choices for commuters, residents and visitors.

7 Provide accurate and timely transportation information for more efficient travel choices.

8 Enhance sustainability by reducing vehicle emissions.

9 Pursue private and public sector funding partnerships in advancing Bellevue's Smart Mobility implementation strategy.

A LOOK BACK

Bellevue's Smart Mobility Plan builds on the development and implementation of the 2004 ITS Master Plan, which has served as a framework for establishing an ITS foundation and implementing transportation technologies that enhance citywide mobility, safety, and sustainability. The plan identified the need for critical infrastructure that would position Bellevue well for managing the changing trends in transportation and traffic demands. The 2004 plan introduced a progressive approach toward deploying transportation technology that matched the rate of growth in Bellevue and the region.

Fast forward to 14 years later and the City of Bellevue now has the following technologies as part of the transportation system management toolbox:

- **CITYWIDE ADAPTIVE SIGNAL CONTROL SYSTEM** capable of adjusting signal timing in response to real-time changes in vehicle demand.

- **CITYWIDE DETECTION AND DATA COLLECTION SYSTEM** to support traffic operations and performance monitoring efforts.

- **FIBER OPTIC COMMUNICATION SYSTEM** that provides shared connectivity for citywide traffic management, emergency services, academic institutions, utility infrastructure, and health care.

- **CITYWIDE TRAFFIC CAMERAS** capable of providing high definition imagery for traffic management purposes.

- **TRAFFIC MANAGEMENT CENTER** that provides the capability to respond to incidents and events in the city.
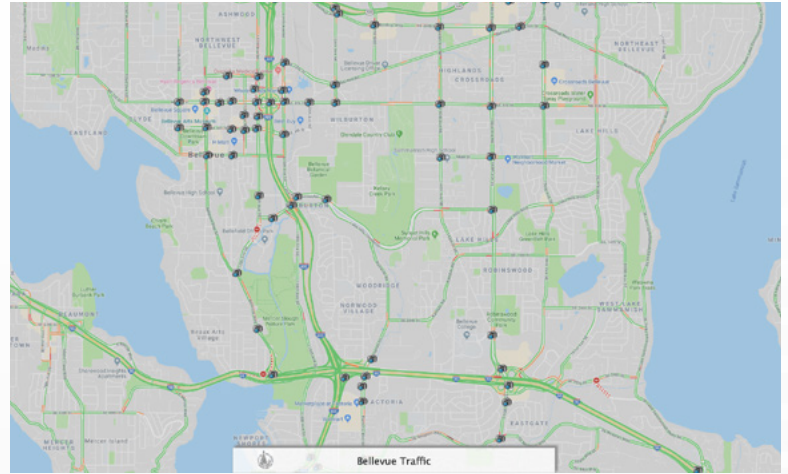

Figure 1. City of Bellevue Online Traffic Map

- **CITYWIDE TRAFFIC FLOW MAP** that provide public access to live traffic conditions.

- **TRAFFIC SIGNAL PRIORITY** on Bus Rapid Transit corridors to improve transit speed and reliability.

The most significant and unique accomplishment in the past decade has been the deployment of the citywide adaptive signal control system, which continues to use real-time data to optimize signal control for over 200 signalized intersections across the city. The sophistication and scale of Bellevue's traffic signal control system is unique and unmatched across the nation.

As a result of these investments in the transportation system, Bellevue has attracted the attention of public and private sector partners to build on the success of the city's transportation technology program. Neighboring cities have integrated into the city's adaptive signal control systems to improve regional mobility, while private-sector innovators have partnered with the city to build technology applications using the city's technology backbone.

The Bellevue-Microsoft data analytics partnership is an example of a highly recognized project across the nation that has expanded throughout North America with involvement from other participating cities. Under this partnership, Microsoft has leveraged Bellevue's investments in a high-definition traffic camera network to develop a scalable video analytics and machine learning platform that is capable of providing insights into transportation system performance.

Experiences in these joint efforts have demonstrated the importance of partnerships, which is a focus area in the city's future smart mobility strategy. As the City of Bellevue carries out the implementation of its Smart Mobility Plan, the existing ITS now becomes the building block for initiatives outlined in this plan and Bellevue's overall Smart City goals.

ANNUAL INJURY AND FATALITY COLLISIONS

Source: City of Bellevue Vision Zero Plan

Figure 2. Bellevue Fatal and Serious Injury Collisions Involving People in Motor Vehicles

PREVIEW INTO THE FUTURE

The advent of ACES will transform transportation in Bellevue. In Washington State, Governor Jay Inslee has encouraged self-driving technologies through Executive Order 17-02 addressing AV pilots and deployments which will help accelerate ACES adoption. While full adoption of ACES technology will inevitably take time, a steady adoption rate will help to meet the goals outlined in this plan. Bellevue strives to encourage accelerated adoption through integrating these technologies into the city transportation system proactively to realize the benefits of ACES in a timely manner.

Ultimately, ACES technologies will transform the way people and goods are being transported, supporting a vision for the future of mobility, where transportation can be provided in a safe, efficient, sustainable, and accessible manner. It is also with ACES technologies that Bellevue's goal of reaching zero roadway fatalities can be confidently achieved as vehicle autonomy will significantly reduce and potentially eliminate the number of collisions related to human error, distracted driving and impaired driving. By removing human factors in driving, Bellevue aims to significantly reduce the annual number of injuries and fatalities on city streets as seen on Figure 2.

Some predictions of AV technology indicate there will be 8 million self-driving vehicles on the road by 2025. Considering the high rate of technology adoption in Bellevue, the city expects to see a large influx of ACES technology in the following years.

ELEMENTS OF THE SMART MOBILITY PLAN

Although this plan focuses on emerging ACES technologies, Bellevue will continue to advance and maintain traditional ITS technologies crucial for everyday transportation data, traffic management, and traveler information needs. In the time period leading up to mature ACES adoption, traditional transportation technologies will continue to play a key role in moving people and goods safely and efficiently.

Bellevue's Smart Mobility Plan is divided into six initiatives to highlight the projects that the city will implement in the next 5 years. The projects, shown in Table 1, are high priorities for Bellevue in maintaining and advancing a transportation system that meets the city's Smart Mobility vision and goals. The city's approach to the six identified initiatives are as follows:

Autonomous and Connected Vehicles

Develop partnership to implement AV and CV demonstration projects leading to larger-scale deployments.

Electric Vehicles

Accelerate policies and infrastructure to achieve continued growth in sustainable and clean transportation in Bellevue.

Shared Mobility

Encourage shared mobility services in Bellevue to provide more equitable, accessible and cost-effective travel alternatives to single occupancy vehicles.

Real-Time Traveler Information

Leverage public and private sector resources to enhance the delivery of accurate, timely, and relevant traffic data to the public.

Data Management

Take advantage of the exponential growth in transportation data to support Bellevue's ability to capture, manage, and analyze data to improve safety and mobility in Bellevue.

Traffic Management

Expand the city's existing traffic management capabilities to enable proactive and data-driven solutions that will optimize transportation efficiency and safety in Bellevue.

PRIORITY PROJECTS SUMMARY

Within the six initiatives, the City of Bellevue has identified 30 priority projects (shown in Table 1) that will provide a smarter transportation system in Bellevue, exemplify technology leadership, and attract public and private sector partnerships.

SHARED-USE MOBILITY	AUTONOMOUS & CONNECTED VEHICLES	ELECTRIC VEHICLES
1. Implement a flexible, on-demand, employer rideshare network (CommutePool)	1. Deploy autonomous shuttle pilot	1. Expand electric vehicle charging infrastructure
2. Remove obstacles and create incentives for shared mobility options	2. Establish 5G cellular partnerships and pilot DSRC communications	2. Advocate for an all-electric King County Metro bus fleet in Bellevue
3. Implement curbside monitoring technology	3. Implement on-demand AV transportation partnership	3. Transition to an all-electric city fleet
4. Collaborate with King County Metro to implement a shared-use mobility hub	4. Investigate public sentiment of AVs	
5. Develop additional shared-use mobility partnerships		

REAL-TIME TRAVELER INFORMATION	DATA MANAGEMENT	TRAFFIC MANAGEMENT
1. Seek out third-party traffic data provider partnerships	1. Promote Bellevue Transportation Data Collaborative (TDC)	1. Expand citywide CCTV camera system
2. Investigate trip planner mobile application	2. Establish open data portal	2. Upgrade citywide communication system
3. Integrate with off-street parking guidance systems	3. Advance City of Bellevue video analytics capabilities	3. Deploy weather information and pavement monitoring system
	4. Support internal data sharing platform development	4. Provide real-time winter road conditions map
		5. Procure portable CCTV camera systems
		6. Upgrade Traffic Management Center (TMC) video wall
		7. Upgrade SCATS adaptive signal system software
		8. Expand lighting control and management system
		9. Enact signal and arterial performance measures
		10. Integrate Computer Aided Dispatch (CAD)/Automatic Vehicle Location (AVL) at the TMC
		11. Deploy school zone traffic monitoring system

Table 1. Bellevue's Smart Mobility Plan Priority Projects Summary

CITY INITIATIVES

The City of Bellevue's Smart Mobility Plan focuses on six key technology initiatives that will shape the transportation system within the next 5 years. The six initiatives are a strategic blend between traditional and emerging transportation technologies. Traditional technologies are ones that are well understood, mature, and often documented as best practices. Emerging technologies are ones that are new to the transportation landscape, many of which are in an early adoption stage or research and development cycle.

For the purposes of Bellevue's Smart Mobility Plan, emerging technologies focus on ACES technologies. Bellevue will rely on traditional technologies in the strategic traffic management toolbox to bridge the gap between present day transportation needs and a future outlook, where emerging technologies become ubiquitous and can optimize operations on city streets. Bellevue also plans to stay at the forefront of emerging technologies to improve mobility, safety, and sustainability. While staying at the forefront of technology often comes with risks and challenges, the opportunities identified in the Smart Mobility initiatives are ones that balance between the associated benefits and risk.

SHARED-USE MOBILITY

GOAL

Shared mobility refers to on-demand ride services which include carshare, rideshare, bikeshare, and microtransit services. This initiative will integrate shared mobility services in Bellevue as a means of providing more equitable, accessible, and cost-effective travel alternatives to single occupancy vehicles.

THE INITIATIVE

Shared-use mobility includes services that move people through car sharing, ridesharing, ride-hailing, carpooling, bike sharing, and public transit. These services aim to provide mobility as a service by sharing rides and vehicles between users to offer an on-demand mode of transportation. Shared-use mobility services benefit the public by expanding the available travel options and provide an alternative to car ownership. In the greater Seattle area, ride-hailing companies such as Uber and Lyft tripled in growth in 2017 compared to 2016, providing more than 20 million rides to their customers[5]. In Bellevue, these services have integrated into the everyday lives of travelers and have also been endorsed by employers seeking to provide additional travel options for their workers. The reasons for the success of shared-mobility is the driving economics of reducing the cost burden of car ownership, reducing the stress from driving, and increasing the availability of first-and-last-mile connections.

Shared-use mobility companies that currently operate in the City of Bellevue include the following private companies:

RIDESHARE	BIKESHARE	CARPOOLING	CARSHARE
UBER lyft	LimeBike	scoop	zipcar

KEY FACTS & STATISTICS

- Since its emergence in 2012, rideshare is now a multi-billion dollar industry
- Approximately 60% of travelers in Bellevue indicate that they currently drive alone on their commute, which creates a large opportunity for shared mobility
- Shared mobility provides a travel alternative that is estimated to be 2 to 10 times more affordable than owning a vehicle in urban centers

KEY BENEFITS

Reduced single occupancy vehicle commute travel to relieve congestion

Reduced carbon footprint and greenhouse gas emissions

Improved accessibility to Bellevue employment centers

Improved first-and-last-mile connectivity

SHARED-USE MOBILITY

In Bellevue, shared use mobility has also expanded to non-motorized forms of transportation with LimeBike providing electric-assisted bike share within the city. Since its launch in July 2018, approximately 200 bike-share trips are taken each day in Bellevue. Bellevue expects that bikeshare services like LimeBike will continue to grow as the city builds out a larger network of bicycle facilities that support non-motorized travel.

Additionally, several Bellevue employers have implemented partnerships with carpooling company, Scoop. Scoop's app-based platform allows customers to schedule shared rides to employment centers based on work schedules and proximity to other users. Riders enter their work schedule through the mobile application and schedule a morning trip by 9 p.m. the previous day to secure a ride to work through ride matching with other commuters.

King County Metro has also introduced new partnerships with shared-use mobility providers, Chariot and Ford Smart Mobility, to supplement the transit services offered in Bellevue. Metro's Eastgate first-and-last-mile pilot project, called Ride2, is an example of a partnership aimed at improving access to the Eastgate park-and-ride and transit center facility. Figure 3 indicates a picture of the service that launched on October 23, 2018. This service will provide on-demand rides within a 2-mile radius from the Eastgate park-and-ride facility. Customers will be able to use this service to access employers surrounding Eastgate and residents will be able to access major transit routes more efficiently. Successful

Figure 3. King County Metro Ride2 Shared Mobility Service at Eastgate Transit Center

implementation of the pilot project will result in higher transit ridership surrounding Eastgate as well as reduced congestion at the park-and-ride facility.

WHAT'S NEXT FOR SHARED-USE MOBILITY IN BELLEVUE?

In order to reduce traffic at peak times, the City of Bellevue realizes a need to increase the number of options to get more people into fewer vehicles. Shared-use mobility is one of the key components to reaching this goal. Single occupant travel dominates Bellevue and the greater Eastside, largely because there are few good shared options[6].

More frequent shared-use mobility services, such as flexible vanpools, ride-hailing, and microtransit are expected to complement the high-volume backbone bus and rail service that are vital components to moving people more efficiently as well. As these changes take place, car ownership is also expected to decrease; estimates indicate that shared mobility services could reduce car sales by approximately 30 percent by 2030[7]. Many industry executives expect traditional car ownership to be upended as consumers begin paying for rides

rather than sheet metal[8]. Bellevue's shared-use mobility initiative provides an opportunity for the city to be proactive versus reactive in integrating these modes into the transportation system.

PRIORITY PROJECTS

To support the growth of shared use mobility services and facilitate integration with other public transit options, the City of Bellevue has developed the following projects to prepare for this change:

1. Implement a flexible, on-demand employer rideshare network (CommutePool)

The City of Bellevue plans to work with employers and regional partners to implement a flexible, on-demand rideshare network called the CommutePool Network (CPN). This program would provide on-demand ride-hailing services for commuters to their workplaces. Using a mobile application-based platform, commute trips will be matched for employees during the peak commute periods to service geographies that are currently underserved by transit and other economical commute options. Figure 4 indicates a process flow of how CommutePool would function. The City of Bellevue's role in this program will involve building partnerships with the private-sector to establish the program that includes the following six core components:

1. **Employer Partnerships** – To focus on commute solutions for Bellevue employees

2. **Smartphone Application** – Enable employee reservation and determine pick-up and drop-off locations

COMMUTEPOOL
NETWORK

Rideshare hailed from mobile app.

Rideshare services sets central location pick-up based on users.

Rideshare to Bellevue.

Riders dropped off in same geographic area.

Figure 4. CommutePool Network Ridematch Process

3. **CommutePool Network Administration** – Coordinate, market and administer the CPN platform

4. **Fleet Operator** – Operate a connected, electric, eventually autonomous vehicle fleet for the CPN program

5. **Curb Management System** – Provide safe, convenient drop off locations near employer businesses

6. **EV Charging Infrastructure** – Provide convenient charging in CPN service areas

The introduction of CommutePool is expected to help reduce the number of personal vehicles on the regional transportation system. The aim of CommutePool is to provide shared, electric, and eventually autonomous transportation to employment centers to reduce commute times, regional congestions and costs.

2. Work to remove obstacles and create incentives for shared mobility options

Reducing the number of personal vehicles takes a multidimensional approach that will also require policy changes. The City of Bellevue will work with its regional partners to further encourage the implementation of shared mobility services to solve the regional traffic congestion issues.

3. Implement curbside monitoring technology

The increase in pick-up, drop-off, and delivery activity necessitates a way to monitor the curbside more effectively. Curbside activity is expected to grow exponentially with increasing e-commerce and with the expansion of ride-sharing as a more prevalent commute option. Improved management of the curb space will help stretch the efficient use of this limited resource. This project will implement sensors that are capable of detecting occupancy of parking and load zones and provide valuable enforcement information in an effort to preserve traffic flows and encourage the use of designated areas for shared use mobility services.

4. Collaborate with King County Metro to implement a shared-use mobility hub

A shared-use mobility hub would serve as a multimodal hub that would improve connections between shared-use mobility services and other mass transit options. Improving these connections would help to enhance first-and-last-mile options, making mass transit more viable to a broader population. In addition to providing improved access to mass transit, a shared-use mobility hub can also provide options to transit between shared mobility modes such as car share, rideshare, ride-hailing, and bike share. The shared use mobility hub could also serve as a hub for e-commerce deliveries.

SHARED-USE MOBILITY

5. Develop additional shared-use mobility partnerships

The city plans to engage with other shared-use mobility partners to introduce other transportation-as-a-service (TaaS) models to the public that are aimed at reducing single occupancy vehicle trips. These partners may include other private sector companies, public agencies, and the combination of both. The Waymo partnership in the Phoenix metropolitan area, Drive.ai partnership in Frisco, and NuTonomy partnership in Boston (Figure 5), are examples that bring together government agencies and private sector shared-mobility providers to provide both autonomous and shared mobility services to the public.

Figure 5. NuTonomy autonomous vehicle in Boston

FUTURE OUTLOOK OF SHARED-USE MOBILITY IN BELLEVUE

In addition to reducing the number of personal vehicle trips, Bellevue's Shared-Use Mobility initiative will be essential to supporting the city's other transportation technology initiatives in autonomous and electric vehicles. If EVs are used for pooled service, the energy and climate benefits are expected to multiply. If pooled EVs are automated, the benefits are further enhanced: "The cost per vehicle mile drops dramatically[9]." The synergies between automated, connected and electric cars are enhanced by shared and pooled services, completing the ACES combination. The City of Bellevue will continue to evaluate opportunities where the ACES combination can converge to further accelerate the growth of shared-mobility services and shape the future of more cost effective, equitable, safe, and sustainable transportation in Bellevue.

INITIATIVE

AUTONOMOUS & CONNECTED VEHICLES

GOAL

Explore autonomous (AV) and connected vehicle (CV) demonstration projects on public right-of-way to inform future larger scale deployments in the city and attract industry partners to participate in the city's technological advancements.

THE INITIATIVE

The City of Bellevue is optimistic that autonomous and connected vehicles will reduce traffic incidents, travel costs, and emissions while providing mobility to people who lack access to traditional transportation modes. Currently, human driving errors contribute to over 90 percent of all crashes, which could be significantly reduced by the widespread adoption of AVs and CVs. Over the last decade, AVs and CVs have moved from a futuristic dream to reality. The adoption chart in Figure 6 estimates that by 2040, half the vehicles sales will be offered with advanced autonomous driving capabilities[10].

Over the next decade, the global AV industry is anticipated to exceed $125 Billion in revenue, which will accelerate AV presence on public streets. Industry leaders like Waymo have already established presence in the AV market, with over 10 million miles of autonomous driving on public roads. Waymo's recent deployment of 600 AVs in the Phoenix, Arizona, metropolitan area has allowed them to transition their AVs from research and development to a consumer-facing product. Other cities such as Sacramento, Pittsburgh, and Boston are also piloting AV technologies similar to those in Phoenix. Bloomberg and the Aspen Institute conducted a survey in 2017 and identified 47 cities across the United States that are engaged in partnerships between public and private sector to advance AVs[11]. The AV test pilots included in the survey offered the types of applications within the public right-of-way as shown in Figure 7.

KEY FACTS & STATISTICS

- The global AV industry is anticipated to exceed $125 Billion in market revenue within the next decade
- There are currently only speed-regulated level 4 AVs in the US and no level 5 AVs yet
- Human errors contribute to 90% of all crashes, which can be reduced by AVs

KEY BENEFITS

Increased roadway safety by reducing driver error and collision frequency

Increased traveler productivity

Reduced vehicle emissions

Potential to significantly reduce vehicle operating cost

Autonomous Vehicles

AVs are typically equipped with an array of sensors and cameras including light detecting and ranging (LiDAR) systems, laser, ultrasonic, and radar sensors that enable perception of the roadway and ambient conditions. These systems support Advanced Driver Assistance Systems (ADAS) technologies and work together to provide assisted and automated driving functions as shown on Figure 8. There are currently varying degrees of autonomous driving capabilities, ranging from Level 1 to Level 5. The National Highway Traffic Safety Administration (NHTSA) has defined the following levels in autonomous driving, as shown in Figure 9.

The most advanced forms of AV technology available for consumer purchase come in the Level 2 category. In this category, partial automation options are available. Examples of this technology include Tesla Autopilot, Mercedes-Benz Drive Pilot, and Cadillac Super Cruise. Level 4 AVs with conditional automation are already in operation on roadways in Washington State, particularly on the freeway system. Within the City of Bellevue, the roll-out of ADAS technologies in AVs will have the most significant impact on overcoming distracted driving and a reduction in low-speed collisions, red light running, right-of-way violations, and pedestrian incursions that too often result in

ESTIMATED SALES FOR LEVEL 4 AUTONOMOUS VEHICLES
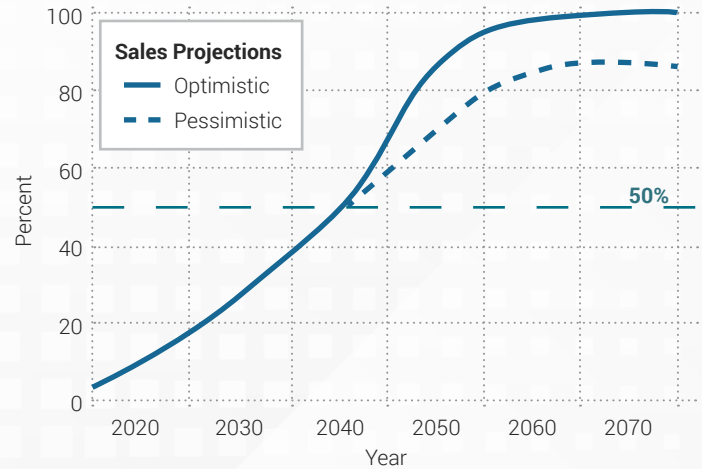*Source: Victoria Transport Policy Institute*

Figure 6. Estimated Sales for Level 4 Autonomous Vehicles

AUTONOMOUS VEHICLE APPLICATIONS IN THE US
Source: Bloomberg Philanthropies

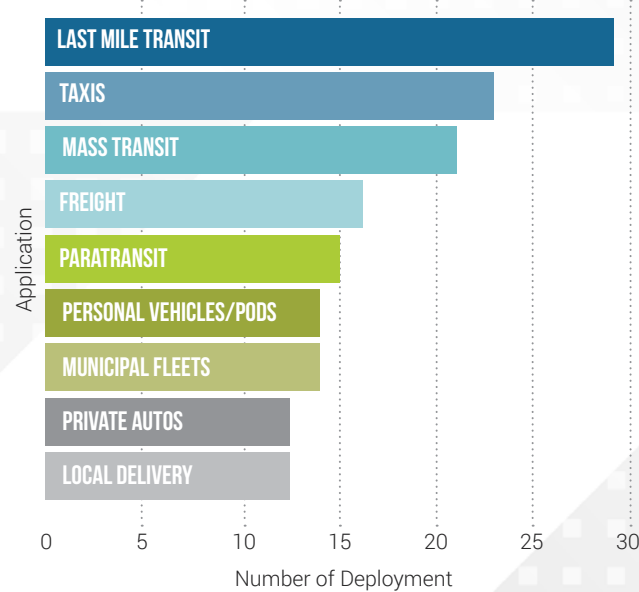*Figure 7. AV Applications in the US – April 2017*

AUTONOMOUS & CONNECTED VEHICLES

fatalities. Beyond Level 2 automation, major manufacturers are investing heavily into advanced autonomous driving capabilities with the goal of commercializing mass market Level 5 AVs. Companies like Ford-funded Argo AI have already invested upwards of $1 Billion to reach this goal.
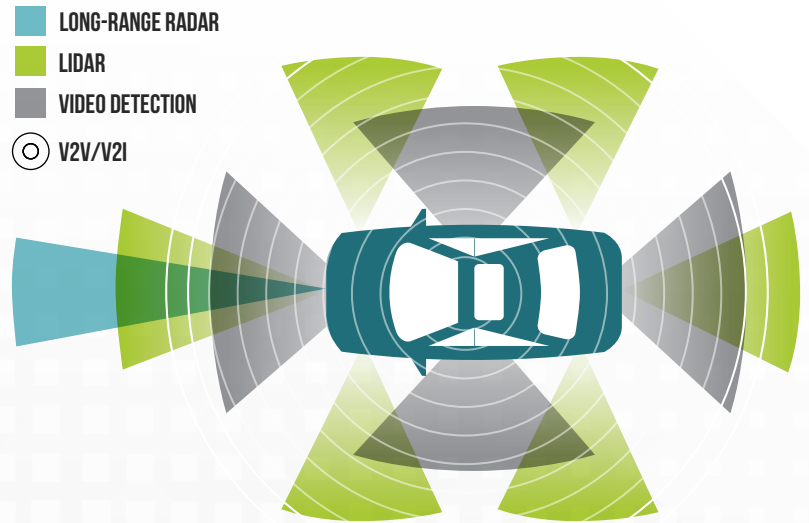
LONG-RANGE RADAR
LIDAR
VIDEO DETECTION
V2V/V2I

Figure 8. ADAS Support Systems on an Autonomous Vehicle

LEVEL 2
vehicle does some driving, human monitors environment

LEVEL 3
vehicle drives/monitors, but human takes over when required

LEVEL 1
vehicle assists with certain functions

LEVEL 4
full self-driving automation only in certain environments

LEVEL 0
human-driver does everything

LEVEL 5
full self-driving automation all the time

LEVEL 0
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
LEVEL 5

Figure 9. NHTSA AV Autonomy Levels

Connected Vehicles

Connected Vehicles rely on the capability of communication between vehicles and infrastructure. The ability to communicate enables vehicles to send and receive alerts regarding imminent danger. NHTSA estimates that the connected vehicle technology has the capability of reducing up to 80 percent of crashes where drivers are not impaired[12]. Both the dedicated short-range communication (DSRC) and 5G cellular communication are potential technology enablers that would allow CVs to function.

The long-standing model of vehicle-to-infrastructure (V2I), vehicle-to-connected device (V2X), and vehicle-to-vehicle (V2V) communications, as shown in Figure 10, is in need of expansion to recognize that government-sourced low-latency communications deployed via fixed, dedicated infrastructure are not the only vehicle communications pathways in use today or proposed for the future. The City of Bellevue recognizes that vehicles are using different combinations of mobile network topologies, including cellular communications, DSRC, and Wi-Fi, to accomplish these communication functions. Within the City of Bellevue, both technologies currently exist in limited deployments. Select intersections on NE 4th Street and 108th Avenue NE in downtown Bellevue are equipped with DSRC capability while 5G communication nodes exist in a North Bellevue subarea.
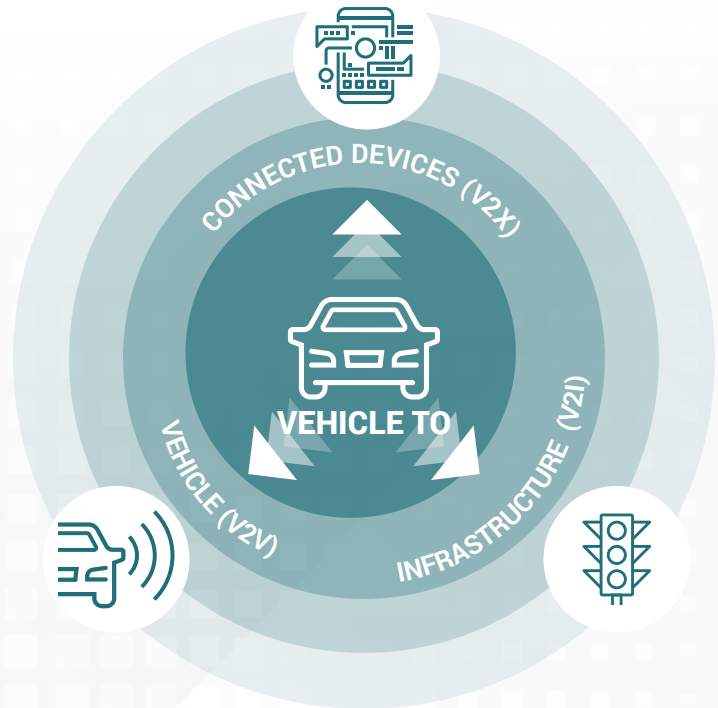

Figure 10. Connected Vehicle Technology

Statewide Efforts

On June 7, 2017, Governor Inslee signed Executive Order 17-02 on AVs which recognized the benefits of AV technologies and set forth an initial framework for testing and deploying AVs in Washington. The state's main interest is to maintain a leadership role by enabling safe testing and operation of AVs on public roadways to nurture, cultivate, and advance AV technology. The state is also optimistic that AVs will promote economic growth, save lives, improve mobility for people and goods, and reduce emissions.

The executive order also resulted in the formation of the Washington State Transportation Commission (WSTC) Autonomous Vehicle

Work Group through Substitute House Bill 2970. The goal of the work group is to develop policy recommendations to address the operation of AVs on public roadways and includes five subcommittees focused on addressing issues related to licensing, liability, infrastructures and systems, safety, system technology and data security

Within each of the subcommittees, the work groups have been tasked with the following tasks:

- Follow developments in AV technology, AV deployments, and government policies that relate to AV operations.

- Consider both commercial and passenger AV operations.

- Explore approaches to modifying state policy, rules and laws to further public safety and prepare for AV technology deployment in the state.

- Disseminate information.

Figure 11. Governor Jay Inslee signs Executive Order 17-02 at Echodyne's headquarters in Bellevue.

Participants in the AV work group include government agencies, legislators, private sector, industry and nonprofit organizations. Bellevue's participation in the work group ensures that the city's interest in AV and CV technologies are translated to potential projects to further test and implement this technology.

WHAT'S NEXT FOR AV AND CV ADOPTION IN BELLEVUE?

The City of Bellevue intends to be a leader in emerging technologies and apply them in a way that provides widespread benefit to those who travel in and around Bellevue. By prompting early adoption of AV and CV technology, Bellevue will not only support statewide initiatives toward improving safety, mobility, and sustainability, the city will also be taking incremental steps that help to build public awareness for this emerging technology. Bellevue's deployment will also draw on the lessons learned though other AV and CV deployments nationwide, to mitigate the risks associated with AV and CV use. The city's progressive approach will help AVs and CVs transition into the transportation ecosystem in Bellevue and build a positive trend towards mainstream acceptance and, eventually, ubiquitous operations.

Figure 12. Bellevue City concept drawing showing an autonomous electric shuttle on the proposed Grand Connection corridor

PRIORITY PROJECTS

Bellevue has identified several key projects to test and deploy AV and CV technology to advance this technology in the city:

1. Deploy autonomous shuttle pilot

This potential project will implement a fleet of AVs to provide first-and-last-mile shuttle service between employment centers, key city landmarks, and transportation centers currently underserved by public transit. Key consideration in operating autonomous shuttles on city streets includes the level of interaction of AVs with other modes and safety. Additionally, the City of Bellevue will need to consider load zones that would best serve the identified landmarks and help AVs integrate with other surrounding modes of transportation. A pilot project will allow the city and public to experience AV technology at a small scale to provide insights and lessons learned toward a larger-scale future deployment.

2. Establish 5G cellular partnerships and pilot DSRC communications

This project will support the deployment of 5G cellular and DSRC infrastructure to enable connected and autonomous vehicle compatibility. As it relates to AVs and CVs, 5G cellular infrastructure and DSRC would support testing of V2V, V2I, and V2X applications.

Example applications that will depend on reliable communications to vehicles includes transmission of traffic signal timing data, safety information, and traveler information.

While there is great divide between those that support DSRC (e.g., GM and Toyota) and others that desire to fast-track 5G (e.g., Ford, BMW), both technologies have shown benefits in the autonomous and connected vehicle environment[13]. With 5G communication, the advantage of it being a private, telecommunications industry-driven deployment will help to accelerate growth. Meanwhile, DSRC technology was developed upon the principles of low latency and high reliability that is suitable for safety applications that have been extensively studied by NHTSA.

The City of Bellevue will continue to support the deployment of both technologies as the technologies continue to mature. With limited deployments of both technologies, the City of Bellevue will continue to work with the private sector and follow industry trends to expand the current deployments to enable the city to become AV- and CV-ready as soon as possible.

Figure 13. Waymo On-demand Jaguar iPace AV

3. Implement regional on-demand AV transportation partnership

This project will pursue partnership opportunities with private sector AV original equipment manufacturers (OEM) such as GM Cruise, Waymo, and Nutonomy and regional public agencies in support of an on-demand AV transportation service. Since initial introduction of AVs will come from shared fleets providing shared rides, Bellevue sees this project as an opportunity for early adoption of AV technology in the city. This concept has already taken place through large-scale tests in the greater Phoenix and Atlanta areas, where AVs are providing on-demand rides to the public. Bellevue seeks to partner with surrounding agencies to offer a similar service that would provide a cost-effective and efficient travel experience across the region through a regional on-demand AV transportation partnership.

Successful implementation of this project will require collaboration with neighboring cities to support seamless operations across city limits. Since a large proportion of trips that originate in Bellevue are not destined within Bellevue, partnership is important to provide a mobility option that can serve a broad region and population. Additionally, the city will advocate for a regional on-demand AV service that helps to reduce rising growth of single occupancy vehicles. A successful implementation of this project will encourage the application of shared rides to maximize the available capacity on Bellevue city streets and the regional transportation system.

4. Investigate public sentiment of AVs

This project will provide organized events to showcase AV technology and provide test rides to the public. Through this study, the city aims to better understand public sentiment and acceptance of AV technology. This project will provide the city with a better understanding of where to focus efforts in supporting the launch of AV technology in Bellevue.

In addition to studying the public sentiment of AVs, this project will also provide the public with an opportunity to experience AVs in a managed environment. An April 2018 American Automobile Association (AAA) study found that 73 percent of US drivers would be afraid of riding in an AV and 63 percent of US drivers would feel less safe sharing the road with an AV while walking or biking[14]. These statistics demonstrate the importance of providing opportunities for the public to experience and learn about AV technology, as well as provide feedback for safer inclusion on city streets.

FUTURE OUTLOOK OF AUTONOMOUS AND CONNECTED VEHICLES IN BELLEVUE

While the promise of AV and CV technology is clear, there are still many uncertainties about how AVs and CVs will integrate into the mass transportation system. Examples of common concerns related to AVs include:

- What happens if an AV gets into an accident?
- What are the insurance requirements for AVs and CVs?
- How long will drivers still be needed to supervise the operations on-board an AV, before a safe track record is established and wide public acceptance is achieved?
- What is the minimum amount of infrastructure and information required to operate AVs safely?
- What types of regulation and policies are needed to govern and manage the operations of AVs?
- How reliable do AVs need to be in adverse weather conditions where visibility to pavement and surrounding conditions are poor?
- How well will AVs operate in unforeseen conditions such as emergency maneuvers?
- What are the societal impacts of AVs toward industry job loss?

AUTONOMOUS & CONNECTED VEHICLES

Some of these questions will likely remain unanswered until AVs and CVs become mainstream. However, early deployments will begin to provide the city with the experience necessary to accommodate further adoption and prepare for a ubiquitous future. Early deployments will most likely exist in managed fleets as shared mobility services, due to the economics of reduced operating costs. Economists have estimated that a tenfold cost savings can be realized with the convergence of driverless, electric, and shared vehicles. For this reason, it is crucial to consider a future where ACES technologies are combined when considering the effects of AVs.

Beyond passenger transportation, autonomous driving technology is already expanding into goods transportation. Several truck makers are also testing autonomous trucks, including Bellevue-based PACCAR (Figure 14). Additionally, companies like Ford, Nuro, Udelv are examples of companies that are partnering with restaurants, retailers, and e-commerce companies to launch autonomous delivery bots and vehicles that will travel on public roadways. These are just a few examples of the expansive potential that AVs will offer beyond passenger transportation. While Bellevue plans to stay current with these future applications, the focus on the next 5 years will be to explore passenger transportation applications where the four elements of ACES can be realized together.
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Figure 14. Bellevue-based PACCAR tests autonomous truck at the Mount Vernon test facility

ELECTRIC VEHICLES

GOAL

In keeping with the City of Bellevue's Vision to "use innovation and partnerships to deploy emerging technologies that enhance the safety, sustainability, efficiency, and accessibility of Bellevue's transportation system," the Electric Vehicles Initiative serves to meet several goals that are identified in the Smart Mobility Plan, including sustainability and economic growth.

THE INITIATIVE

The percentage of EVs compared to traditional cars is about to dramatically change with declining battery costs and aggressive competition among automakers, accelerated by world and state policies. With the projected trend that EVs will eventually become increasingly more cost effective, there is a growing need to support widespread adoption through infrastructure and policy. As a city that already has a higher EV ownership per capita than most US cities, the City of Bellevue plans to continue supporting the rapidly increasing EV growth through the strategies and policies outlined under this initiative. Figure 15 shows the number of EVs and plug-in hybrids registered in Bellevue between January 2014 and October 2018. Over the last four years, this data shows that Bellevue is experiencing an exponential growth in EV and plug-in hybrid registrations with a year-to-date growth of over 35% alone. This growth is projected to continue as EVs become more affordable and charging infrastructure becomes more available throughout the city.

Under the Washington State Electric Vehicle Action Plan, mandated by Washington State Executive Order 14-04 (Washington Carbon Pollution Reduction and Clean Energy Action), Washington State set a goal of 50,000 registered EVs by 2020[15] Implementing the strategies outline in Bellevue's EV initiative supports the State's

KEY FACTS & STATISTICS

- Bellevue has one of the highest adoption rates of electric vehicles per capita in the US - 24,624 EVs registered in WA as of June 2017, compared to 17,941 in June 2016

- In the first half of 2017, the U.S. experienced a growth of ~40% in EV sales when compared to the previous year

- King County Metro's first all-electric bus began operating from Eastgate P&R in 2013

KEY BENEFITS

Reduced carbon footprint and green house gas emissions

Reduced noise

Reduced maintenance and fuel expense

ELECTRIC VEHICLES

ELECTRIC VEHICLE AND PLUG-IN HYBRID REGISTRATIONS IN BELLEVUE

Source: Washington State Department of Licensing

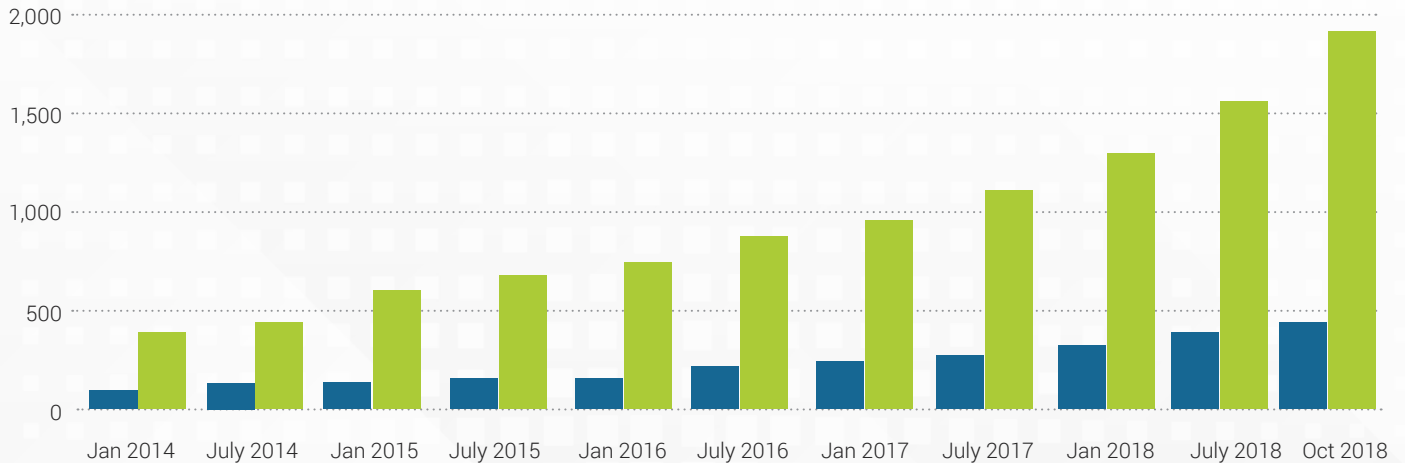**Legend:** Plug-in Hybrids | EVs

Figure 15. EV and Plug-in Hybrid Registrations in Bellevue

goal in reaching their 2020 target. In support of the State's EV Action Plan, Bellevue has already taken initial steps toward reaching this goal through deployment of over 20 public charging stations, which the city also operates.

Within the City of Bellevue, there are currently over 170 charging ports installed at more than 50 retail, office, residential, and curbside locations. The Figure 16 map highlights the locations spread across the city.
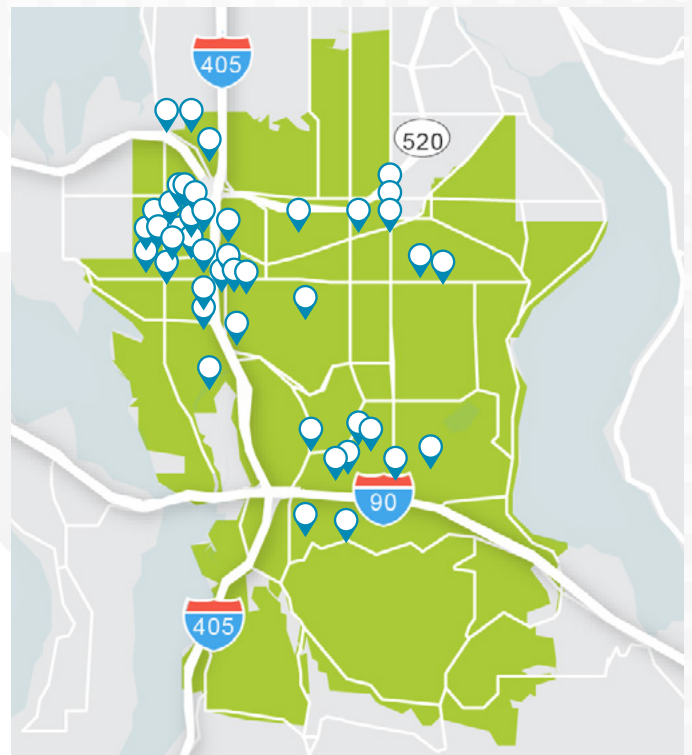

Figure 16. Electric Vehicle Charging Stations in Bellevue

WHAT'S NEXT FOR ELECTRIC VEHICLE IMPLEMENTATION IN BELLEVUE?

The City of Bellevue's plan to accelerate EV adoption is predicated on rapid expansion of available charging infrastructure and promoting alternatives to internal combustion engines. Advancing EV infrastructure in Bellevue is a high priority because it will unlock the potential for widespread EV adoption and facilitate a faster transition from oil to electricity, which is a crucial element toward meeting the State's 2020 goal. This transition will result in the following benefits:

- Reduced vehicle emissions and enhanced sustainability.
- Lower transportation costs by moving from fossil fuels to electricity.
- Reduced operation and maintenance for public-agency owned fleets.

Figure 17. Bellevue On-Street EV Charger

PRIORITY PROJECTS

To support further advancement and growth of EVs in the City of Bellevue, the following key projects have been defined.

1. Expand EV charging infrastructure

Bellevue is a leading high-tech center home to many early adopters of EVs. With a growing number of EV models being sold in large numbers, Bellevue anticipates a further increase in EV ownership throughout the city.

Expanding the city's EV charging infrastructure (Figure 17) will mean providing enough charging stations to meet the growing demand of high EV use. The EV charging infrastructure initiative would include the following actions:

- Partner with Puget Sound Energy (PSE) and charging companies to expand EV charging options, including fast charging options for ride-share services, Metro electric buses, and electric delivery services.
- Explore partnerships with private-sector on-street charging.
- Work with Sound Transit, Metro, and the Washington State Department of Transportation (WSDOT) to expand Level 1 and 2 EV charging capabilities in park-and-ride facilities
- Investigate and provide for direct current fast charging infrastructure where it is cost effective.
- Design infrastructure for future charging stations into current roadway projects.

- Develop programs that encourage private companies and property owners to add charging infrastructure to existing facilities.

2. Advocate for an all-electric King County Metro bus fleet in Bellevue

In 2013, King County Metro chose Bellevue as the first city in the state to pilot the all-electric Proterra bus (Figure 18). Now that Metro has an order for over 120 all-electric buses, Bellevue plans to continue its partnership with King County Metro to achieve an all-electric bus system into and throughout Bellevue[16]. In addition to saving fuel and maintenance costs, an all-electric bus fleet would reduce vehicle emissions and noise. It would also be a cost-effective way to draw attention to the new EV technologies and to encourage economic development.

Other aspects of a program include the following:

- Work with PSE and Metro to reform regulated rates for bus charging to eliminate costly demand surcharges.

- Encourage additional advanced autonomous features in the new electric buses to reduce collisions. (Proterra is testing fully-autonomous electric buses in California.[17])

- Advocate for use of EVs for other transit services

3. Transition to an all-electric city fleet

The city can lead by example by migrating its own fleet vehicles to an all-EV fleet to meet city emission goals, reduce overall fleet vehicles costs and meet state emission goals. Initial migration would include EV passenger vehicles that are readily available (Figure 19), with an eventual migration that would also include light-, medium-, and heavy-duty trucks. Leading by example would also encourage other regional fleet operators to change from oil to electricity.

Figure 18. Metro's All-Electric Bus at Eastgate Park-and-Ride

ELECTRIC VEHICLES

FUTURE OUTLOOK OF ELECTRIC VEHICLES IN BELLEVUE

With nearly all major US automakers announcing plans to introduce EV models, mainstream EV adoption is arriving quickly. Some manufacturers have committed to providing an electric option for their entire portfolio by 2021, which demonstrates the urgency in supporting EV technology with the necessary charging infrastructure. By 2040, Bloomberg estimates that EVs will constitute one-third of the vehicles on the road compared to 1 percent in 2018.

In March 2018, Washington State ranked as the second highest state in the nation for EV adoption, with approximately 6 percent of new vehicle sales being EVs. Between 2014 and 2017, statewide EV adoption has also increased by over 300 percent. Bellevue will continue to stay current with the trends in EV adoption to ensure that adequate charging capabilities are provided in the city to support the EV demand.

Figure 19. City of Bellevue 2018 Nissan Leaf Electric Vehicle

REAL-TIME TRAVELER INFORMATION

GOAL

Leverage both public and private sector resources to enhance the delivery of accurate, timely and relevant traffic data for effective traveler information.

THE INITIATIVE

With the advent of the smartphone, access to traveler information is now part of most people's day-to-day lives. Studies indicate that there will be approximately 40 times more transportation data available in 2020 than in 2009, most of which will be accessible on handheld devices and in vehicles[18]. This growth has resulted in a significant transformation in how traveler information is provided and managed. In the past, traveler information was mostly disseminated through public-sector systems such as agency traveler information maps, congestion maps, and 511 systems. Nowadays, new data sources and probe-based data have enabled the private-sector to provide traveler information applications that supplement information from agencies and, in many cases, operate independently of public agency data.

Widespread adoption of traveler information is directly related to the timeliness, accuracy, and relevance of data. The factors that influence a traveler's decision often include time, cost, accessibility, anticipated delay, reliability, weather, and parking. Transportation mode choice also plays a role in influencing a traveler's decision, given the high availability of Shared Mobility services such as car share, rideshare, ride-hailing, bike share, and dynamic carpool services. These new modes of travel impact how individuals choose to travel through the City of Bellevue's transportation network.

KEY FACTS & STATISTICS

- Over 70% of people in Bellevue indicate that they use a smartphone application as their primary traveler information source
- Travelers in Bellevue value real-time information and travel time predictions as the most useful types of traveler information
- Google Maps is the preferred application used by most Bellevue travelers

KEY BENEFITS

Allows travelers to make more informed travel decisions

Reduced delay for commute trips by providing more optimized route for travelers

Increased awareness of available travel options

In a series of public surveys and focus groups conducted in 2017, Bellevue travelers expressed a strong desire for enhanced traveler information that is readily accessible from a smartphone application, as seen in Figure 20. Route guidance, real-time travel time data, and estimated arrival times are the top three features that travelers currently find useful. The same study confirmed that Bellevue travelers have already adopted mobile devices as a mainstream traveler information tool.

WHAT'S NEXT FOR TRAVELER INFORMATION IN BELLEVUE?

The mainstream adoption of traveler information sources such as Google Maps requires the City of Bellevue to focus on building public-private partnerships to provide the most accurate, timely and relevant data possible. With Google Maps being the number one application used by Bellevue travelers, the importance of delivering useful traveler information on mobile applications platforms is crucial. Travelers in Bellevue expect reliable data to inform them about how to make smarter travel choices. Through the real-time traveler information initiative, Bellevue will expand the amount of data and information that is publicly available to improve accessibility for third-parties and the public.
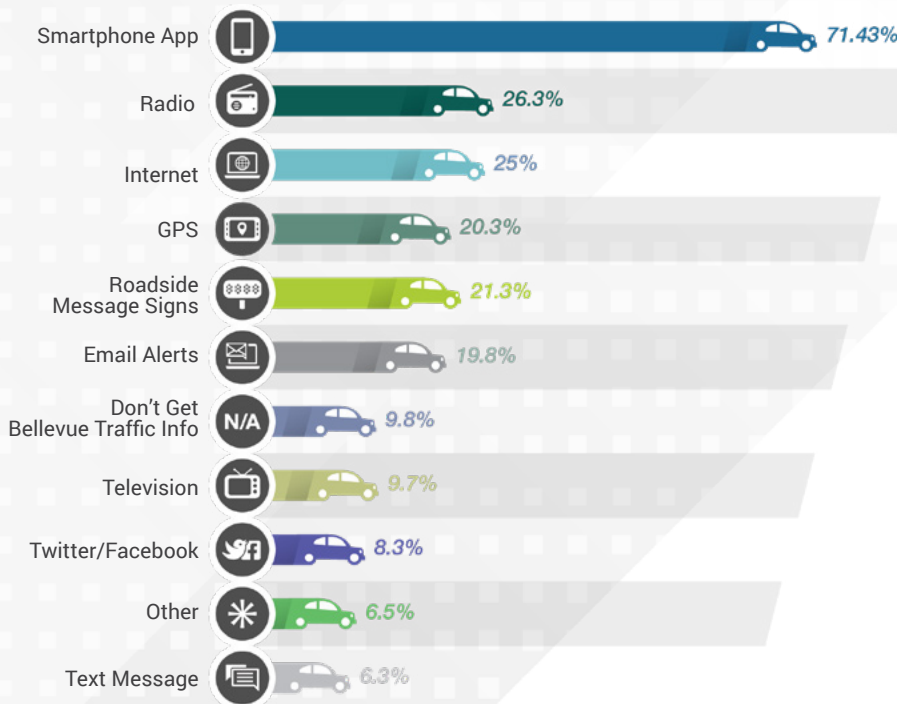

Source	Percentage
Smartphone App	71.43%
Radio	26.3%
Internet	25%
GPS	20.3%
Roadside Message Signs	21.3%
Email Alerts	19.8%
Don't Get Bellevue Traffic Info	9.8%
Television	9.7%
Twitter/Facebook	8.3%
Other	6.5%
Text Message	6.3%

Figure 20. Bellevue travelers' preferred source for traveler information

PRIORITY PROJECTS

To support the enhancement of traveler information services in the City of Bellevue, the following key projects have been identified:

1. Seek out third-party traffic data provider partnerships

The project will initiate data partnerships with third-party data providers (i.e., Waze, Google, Inrix, Apple Maps) to improve citywide mobility and safety by sharing more accurate, timely and reliable transportation data. Data will be consumed by both participants in the partnership to help move people and goods more safely and efficiently. Figure 21 indicates the type of traveler information mobile applications used by Bellevue travelers.

SMARTPHONE APPS USED BY TRAVELERS
Source: City of Bellevue Survey Data

App	Percentage
Google Maps	57.06%
Washington State DOT	27.36%
Waze	24.1%
One Bus Away	21%
Other	14.81%
Apple Maps	9.73%
King County Trip Planner	3.7%
Bing Maps	3.64%
Inrix	2.5%

Figure 21. Bellevue travellers' smartphone app types used most often

Waze's Connected Citizen Program (CCP) is an example of a third-party data provider partnership program where government agencies and the private sector share traffic and incident information. Using this information, cities are able to gain insights into data contributed by users on the Waze platform, such as collision reports and unanticipated congestion. Beyond Waze, Bellevue will explore the data sharing opportunities between the various private-sector data providers and negotiate a partnership that will provide the most timely, accurate, reliable, and safe data to the public.

2. Investigate trip planner mobile application

There are a variety of mobile applications that currently allow travelers to choose their preferred mode of travel in Bellevue and the surrounding region. More commonly, these tools encourage a single mode of travel. This project aims at collaborating with the private sector to develop and promote a mobile application that integrates travel options between modes, based on travel time and cost information. As an example, a trip between the Bellevue Collection and downtown Kirkland may include walking, transit, and bike share to provide the most economical and efficient trip during the peak hours. Working with the private sector to develop this tool will help to encourage viable alternatives to driving alone and optimize transfer efficiency between modes through more comprehensive traveler information.

3. Integrate off-street parking guidance system

The project will implement parking guidance system for off-street parking facilities, such as park and ride facilities and privately-operated parking garages, to reduce on-street traffic circulation and improve trip planning for commuters. Since off-street parking facilities are outside of public right-of-way, Bellevue will partner with local businesses and transit agencies to implement a system that would provide mutual benefit to parking facility operators and traffic operations in the city. Under the scope of this project, the City will also explore the use of a smartphone application to provide mobile access to parking information in Bellevue.

FUTURE OUTLOOK OF TRAVELER INFORMATION IN BELLEVUE

The ability to provide timely, accurate, and useful traveler information is critical to moving people and goods efficiently in Bellevue. Traveler information can also encourage the traveling public to consider alternative mode choices, thereby reducing the number of personal vehicle trips. The integration of enhanced traveler information services with internal and external data sources will also provide synergies with other Bellevue Smart Mobility Plan initiatives like the Shared Mobility initiative. As an example, information about curbside availability will help shared mobility services safely and efficiently provide pick-up and drop-off services at permitted locations. Furthermore, projections that shared mobility services will continue to soar provides an indication there is likely to be a stronger reliance on access to traveler information related to shared mobility services. In alignment with these trends, Bellevue will continue to build upon its relationships with the private and public sector partners to help travelers make informed choices about transportation in and around the city.

DATA MANAGEMENT

GOAL

Make use of the exponential growth in available transportation data by improving the processes related to data capture, management and analysis to improve safety and mobility within Bellevue.

THE INITIATIVE

The last decade has seen ascending growth in the amount of transportation data generated by Internet of Things (IoT) devices, including vehicles and handheld mobile devices, as well as agency-owned infrastructure. In 2016, it is estimated that the number of connected transportation devices in the US exceeded $22.9 Billion[19]. While access to a vast array of data can provide the potential to offer useful insights into transportation operations and performance, it also comes at a price of managing large volumes of data, which remains a challenge for most agencies, including Bellevue.

The addition of ACES will further amplify the need to streamline data management as each AV is expected to generate more than 4,000 gigabytes of data per day[20]. Bellevue's Data Management initiative seeks to make use of the exponential growth in available transportation data by improving the processes related to data capture, management, and analysis to improve safety and mobility within Bellevue. It also seeks to streamline the way in which data is consumed for decision-making purposes. This involves maximizing the application of existing data system, formulating useful data partnerships with public and private entities, integrating data between different platforms, and aggregating datasets to improve overall data reliability and availability.

KEY FACTS & STATISTICS

- An autonomous vehicle is anticipated to produce more than 4,000Gb of data per day
- Mobile data traffic is expected to increase sevenfold between 2016 and 2021
- The Microsoft-Bellevue partnership video analytics data capture achieves an accuracy exceeding 95% for vehicle detection using machine learning capabilities

KEY BENEFITS

Improved situational awareness related to prevailing traffic conditions

Protects data integrity and privacy

Enhanced accuracy and reliability of available transportation data

DATA MANAGEMENT

WHAT'S NEXT IN BELLEVUE?

The future of transportation data will ultimately integrate both public and private data platforms seamlessly. Data will need to be efficiently exchanged in a secure and protected way that leverages the strengths of both private and public-sector data. With greater visibility into comprehensive transportation data, the city can enhance overall business intelligence, which is expected to result in enhanced safety and efficiency.

PRIORITY PROJECTS

To accomplish improved data integration, the city will implement the following projects, which will expand the number of transportation- and mobility-related data sets, facilitate improve data sharing, and enable improved data analytics:

1. Promote Bellevue Transportation Data Collaborative (TDC)

Bellevue's TDC initiative would utilize a third-party data platform that provides data-sharing capabilities between private and public partners. The objective of a TDC is to streamline the method in which data can be packaged and delivered to participating partners. The TDC is intended to accomplish the following objectives:

- Implement a common platform that would provide accessible data to participating partners.

- Implement data standardization to facilitate improved sharing between parties.

- Protect the privacy and security of sensitive datasets.

Successful implementation of a TDC would require regional partnership with surrounding municipalities, other government agencies, and the private sector. With the implementation of a TDC, Bellevue will be able to make informed decisions that are supported by quantifiable data. This approach will enable city staff to make data-driven decisions relating to transportation improvement priorities, traffic operations optimization, and system performance

DATA MANAGEMENT

measures. Additionally, a TDC would provide improved visibility of Bellevue transportation data to improve collaboration with regional partners. The wealth of data from future autonomous and connected vehicle technology would potentially be a TDC data source that would be valuable for regional operations and planning needs.

2. Establish open data portal

Bellevue's existing open data portal (ODP) is an online web page that provides public access to real-time and historical transportation datasets. Currently, the city's Transportation ODP includes limited transportation datasets. This project would significantly expand the availability of data sources to include a more comprehensive capture of citywide transportation data. Examples include traffic count data, infrastructure data, collision data, traffic detector sensor data, construction information, and road conditions data. The ODP would integrate both historical and real-time transportation information for public access.
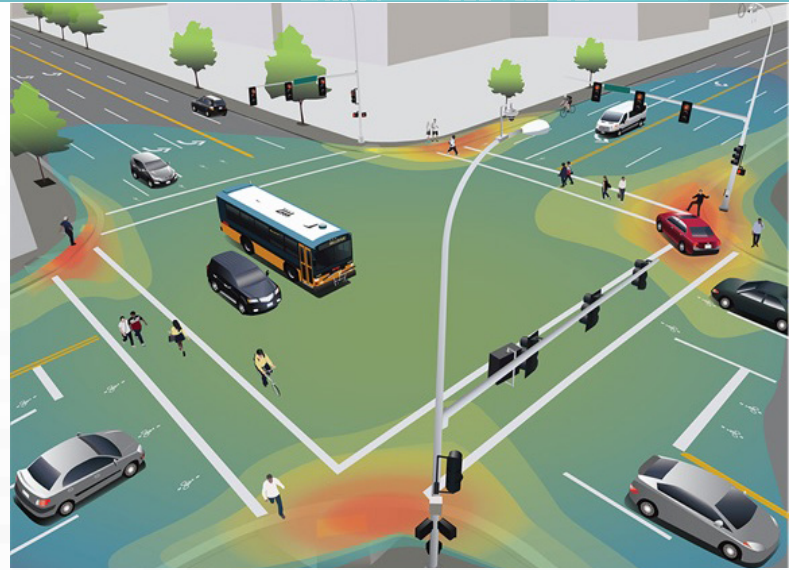

Figure 22. City of Bellevue Prototype Video Analytics Data Platform

3. Advance City of Bellevue video analytics capabilities

This project is aimed at innovating video and data analytics capabilities to provide intelligent real-time and predictive insights into traffic operations and safety (Figure 22). The City of Bellevue's will leverage its experience in collaborating with the technology industry to advance video analytics and machine learning technology to automatically reveal traffic patterns, traffic anomalies, and traffic safety performance measures. These patterns will ultimately provide city staff with useful insights to proactively respond to congestion and traffic incidents at locations where traffic camera coverage exists.

4. Support internal data sharing platform

An internal data sharing platform would implement an integrated data platform that is shared across city departments to streamline workflows. This platform would make transportation data more accessible for various business functions whereby engineering, planning, and operations tasks can be coordinated more efficiently. The city's emergency dispatch system and traffic management center paging system is one example where data integration has helped to improve traffic flows in the city during emergencies. Visibility into a broader array of datasets would further improve the city's ability to proactively manage traffic and improve coordination between workgroups.

FUTURE OUTLOOK OF TRANSPORTATION DATA MANAGEMENT IN BELLEVUE

Bellevue's approach towards transportation data management prepares for the data surge that continues to grow at an unprecedented rate from emerging technologies and mobility trends. Shared mobility companies like Uber have collected data on over 375 million North American trips in 2017 since its inception in 2009[21]. Telecommunication companies are now able to generate over 800 million location-specific data points for every 1 million devices on the network[22]. As cloud solutions continue to expand, the city will also evaluate opportunities to migrate transportation data platforms to a virtual presence, as opposed to on-site storage, to efficiently manage the anticipated data payloads. These are compelling statistics that demonstrate why Bellevue needs to prepare for a future where transportation data is both ubiquitous and shared. In addition to the near-term initiatives outlined in this plan, a regular evaluation of the city's role in data management will be necessary as the private sector continues to play a larger role in providing insights into how people and goods move around.
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TRAFFIC MANAGEMENT

GOAL

To build upon Bellevue's existing advanced transportation system, this initiative will provide enhancements to the city's existing toolbox with a focus on implementing proactive and data-driven traffic management processes to optimize network capacity and improve efficiency of operation and maintenance activities.

THE INITIATIVE

Bellevue's Traffic Management initiative seeks to provide enhancements to the city's existing traffic management capabilities, with a focus on improving safety, optimizing network capacity and enhancing operational efficiencies. Traffic management in Bellevue is an intricate operation that strives to balance the needs between demand and capacity. Since many of the city's transportation issues cannot be resolved by increasing capacity through roadway construction alone, the city has relied on ITS as it has proven to yield a high benefit-to-cost compared to infrastructure improvements.

Over the last decade, the city has progressively implemented new ITS and technology partnerships that aim at managing the movement of people and goods more effectively in the city. As an example, in 2010 the city initiated the implementation of an adaptive signal control system that uses real-time detector information to dynamically adjust signal timing in accordance with the demand. Nearly a decade later, this system is now implemented for all signalized locations, an accomplishment that is unique in the United States. This system now provides a citywide optimized signal control system.

KEY FACTS & STATISTICS

- Real-time traffic cameras are used for signal operation observation, incident management, and traveler trip planning
- SCATS adaptive signal control system has reduced delays by up to 40% in Bellevue
- The city has upgraded to a 1Gb/10Gb high-speed fiber communications to support connectivity to roadside devices and future Smart Mobility applications

KEY BENEFITS

Provides improved response to traffic incidents, emergencies, and traffic congestion

Provides tools to streamline operations for greater efficiency

Optimizes the available capacity on Bellevue's transportation network

Performance metrics will enable city staff to prioritize resources for future transportation improvements

TRAFFIC MANAGEMENT

Bellevue also realizes that traffic management strategies must evolve with changes in mobility trends. A few examples of recent changes that requires cities to adapt their business processes include the introduction of share-used mobility services, e-commerce deliveries and ubiquitous access to real-time trip data. The implications of these changes often require infrastructure improvements and policy support to ensure that traffic is most effectively managed. Focusing on near-term strategies to adapt to these changes, the scope of the city's Traffic Management initiative concentrates on technology components that can be implemented soon.

WHAT'S NEXT IN BELLEVUE?

The City of Bellevue will enhance its current ITS capabilities by upgrading existing systems, expanding the deployment of existing technologies and deploying new systems. Traffic Management initiatives will build upon a mature ITS system that includes a citywide fiber optic backbone, traffic detection system, and adaptive signals system platform. A number of new systems are planned to allow additional operational and management capabilities.

PRIORITY PROJECTS

A brief description of near-term projects under this initiative are described as follows:

1. Expand citywide traffic camera system

This project will deploy additional closed-circuit television (CCTV) traffic cameras for roadway monitoring at high-priority locations and support the advancement of Bellevue's video analytics capabilities. The full buildout of Bellevue's traffic camera system would include multidirectional (Figure 23) and pan-tilt-zoom cameras at each signalized intersection. Consistent with the city's policy to record traffic camera video, this project will also provide increase network recording capabilities.

Figure 23. Bellevue Traffic Camera - NE 4th St/108th Ave

2. Upgrade citywide communication system

As the backbone for communication to all electronic traffic management devices, Bellevue's citywide communication system upgrade will improve network bandwidth, resiliency, redundancy, and security to all signalized intersections. These upgrades will provide a dependable communication backbone for existing traffic control and ITS systems. It will also provide adequate network capacity to support future emerging technologies and the ability to share communication infrastructure with other city partners.

3. Deploy weather information and pavement monitoring system

Weather information and pavement monitoring systems will allow traffic management and maintenance staff to maintain traffic flows during adverse weather conditions. These sensors provide pavement and air temperature, water level, and precipitation information. Information derived from this system can help to proactively clear roadways when needed.

4. Provide real-time winter road conditions map

The impact of winter weather conditions on Bellevue roads is significant due to the terrain and elevation in various parts of the city. Many neighborhoods in Bellevue rely on the winter weather response efforts from the city's Transportation Department to restore mobility. This project will implement a public-facing webpage to provide real-time snow removal and deicing operations information. Equipped with automatic vehicle locating capability, Bellevue's winter weather response fleet will inform the public of locations that have been recently cleared and de-iced. Many cities across the nation have implemented similar tools to provide the public with visibility into road conditions during the winter months. In addition to the benefit that this tool provides for the public, it will also provide city staff with better data to manage response efforts to winter weather events more efficiently and cost effectively.

5. Procure portable CCTV camera systems

Acquiring an inventory of portable CCTV cameras will provide the ability to manage traffic around areas where construction activity is taking place. Construction activity can often result in disruptions to traffic flow and detours. Using a portable camera system, staff can remotely view the associated traffic impacts from the Traffic Management Center and initiate countermeasures as appropriate.

6. Upgrade traffic management center video wall

Additional camera coverage throughout the city warrants the need to replace and expand the existing Traffic Management Center (TMC) video wall infrastructure (Figure 24) to improve traffic management operational efficiencies and the ability to view simultaneous video. The new system will improve coordination efforts during major events and roadway closures in the city because staff will be able to manage traffic at multiple locations concurrently.

7. Upgrade SCATS adaptive signal system software

The city's adaptive signal control system has modernized traffic signal operations in Bellevue. As the system continues to grow and expand, the city plans to implement progressive upgrades to increase available traffic detection channels, traffic signal phase combinations, advanced transportation controller (ATC) compatibility and provide signal, phase, and timing (SPaT) compatibility for future connected and autonomous vehicles. These functions are anticipated to provide improved efficiency for the signal control system and provide a potential interface with emerging ACES technology.

Figure 24. Bellevue Transportation Management Center

8. Expand lighting control and management system

This project will deploy a lighting control and monitoring system (Figure 25) to conserve electricity use, improve safety through enhanced LED lighting, and provide a centralized platform to operate and maintain the citywide street lighting system. The system will provide operational efficiencies for managing light levels and detecting lighting failures and help the city to meet its sustainability goals when deployed as the city continues converting to LED lighting. These benefits will ultimately results in reductions to energy and maintenance costs for the city.

9. Enact signal and arterial performance measures

Gaining quantifiable measures regarding the transportation system is critical to making transportation improvements and prioritizing efforts within the Transportation Department. This project will implement automated traffic signal and arterial performance measures (ATSPMs) to provide metrics on the operational efficiency of the citywide traffic signal and arterial roadway system. These metrics will help city staff to make data-driven decisions related to fine tuning signal operations, prioritizing improvements, and understanding before-and-after conditions.

Figure 25. Lighting Control and Management System at 140th Ave and Lake Hills Connector

10. Integrate Computer Aided Dispatch (CAD)/ Automatic Vehicle Location (AVL) at the TMC

The North East King County Regional Public Safety Communication Agency (NORCOM), which is responsible for Bellevue's emergency dispatch, and the City of Bellevue have partnered to integrate the regional CAD system with the city's TMC operations. A dashboard and paging system currently allows city staff to gain real-time situational awareness on locations where collisions block or impede traffic. This project will further enhance this integrated system and provide a dynamic mapping interface and internal communication feed. These functions will help city staff to coordinate response efforts, manage multiple events, and visualize the impacts from adjacent or wide-scale events.

11. School zone traffic monitoring system

Bellevue's School Zone Traffic Monitoring system is intended to collect information about traffic demands and wait times around school zones. Information collected will be communicated to travelers impacted by school zone traffic. It is anticipated that this information may help parents and students plan pick-up and drop-off activities around peak periods as well as provide real-time information on current wait times during peak periods.

Figure 26. School zone flashing beacon near Woodridge Elementary School

ADDITIONAL TRAFFIC MANAGEMENT PROJECTS

In addition to the near-term projects identified, the City of Bellevue has also defined additional traffic management projects that are important to Bellevue's overall Smart Mobility strategy. While these projects were prioritized in succession to the near-term projects, the city will regularly evaluate shared opportunities to implement or accelerate work with other near-term projects, where practicable.

INITIATIVE
TRAFFIC MANAGEMENT

The City of Bellevue's longer-term projects include:

1. Centralized Transit Signal Priority (TSP) system

To align with the regional goal of streamlining TSP operations to improve transit speed and reliability, Bellevue plans to continue its partnership with King County Metro to implement a centralized platform that will improve integration between the city's adaptive signal control system and Metro's TSP system. This project will utilize center-to-center communication capabilities that will provide increased system reliability, accuracy, and flexibility for how TSP operates in the City of Bellevue. Collaborating with King County Metro on deploying a centralized TSP system will allow transit to benefit from the City of Bellevue's adaptive signal control system at a citywide scale.

2. Global Positioning System (GPS) emergency signal pre-emption system expansion

This project will expand upon the city's existing GPS emergency signal preemption system. Further expansion will improve emergency response times as this technology is able to identify the route of the responding emergency vehicles and coordinate their arrival at consecutive intersections to provide clear passage through the intersection. This system will complement the existing infrared-based preemption system that has been standardized across the region.

3. Transportation management system dashboard Phase 1

Bellevue's transportation management system dashboard will provide a software user interface that displays transportation data. A summary of key performance indicators will provide information regarding transportation system performance to city staff at various levels in the Transportation Department. This tool will provide a dashboard that is tailored for operations staff, managers, and directors, as each group's need for data and understanding of system operations varies.

4. TSP system expansion

In partnership with King County Metro, Bellevue will continue to advance the city's TSP infrastructure. King County Metro has identified additional TSP (RapidRide) corridors in their 2017 MetroConnects plan. These improvements will provide priority movement for transit vehicles at identified intersections to provide a more efficient and reliable transit experience for riders in Bellevue.

5. Bicycle monitoring technology

As bicycle infrastructure expands in the City of Bellevue, bicycle counting technology will help to provide quantifiable data on bicycle volumes and ridership. This data will be useful towards planning new bike corridors and infrastructure in the city. Additional insights may also include success metrics for programs such as bike share and how to manage the supply and demand of available bikes under this program.

6. SCATS system redundancy

The city's adaptive signal control system relies on a centralized server to distribute signal timing to the intersections. This project will provide physical redundancy for the city's server infrastructure to maintain system operations in the event of an emergency. Server redundancy may reside in a virtual environment to ensure that hardware failure is not a factor for system downtime.

7. Transportation management system dashboard Phase 2

As an extension of the Phase 1 transportation management system dashboard, this project will implement a public-facing dashboard that will provide travelers with visibility into operations of key corridors in the city. This dashboard may include information such a travel time (by travel modes), travel time reliability, corridor delay, and construction information.

8. Remote device communication system

This project would provide network connectivity to traffic management and electronic traffic control devices that are outside the proximity of a signalized intersection. Remote connectivity to devices helps to manage device operations more efficiently from a centralized location. City staff will evaluate the use of cellular, wireless, and leased communications to provide connectivity to these locations.

9. Portable changeable message sign – remote monitoring system

A remote monitoring system for portable Changeable Message Signs (CMS) system will provide staff the ability to monitor the messages that are posted on portable CMSs. The ability to manage temporary signs remotely will help to monitor and change messages with ease. For signs that are operated by contractors, city staff will have the capability to monitor the messages posted and ensure that they are effective.

NEXT STEPS

FUNDING

The successful implementation of Bellevue's Smart Mobility Plan is dependent on available funding to initiate the projects identified within a timely manner. A recent poll conducted by the Institute of Transportation Engineers suggests that access to available funds was the leading barrier for public agencies to implement emerging transportation technologies. While this is the case for infrastructure investments that require public-agency funding, private-sector business models that encourage advancements in transportation technology are beginning to change the focus of reliance on government funding to improve transportation. Private sector companies involved in ACES development realize the potential prospects and profitability of ACES technology. In 2017, the Brookings Institute estimated that approximately $80 Billion has been invested by the private sector to bring fully-autonomous vehicles to the public[23]. While the shift from public to private sector funding helps to alleviate the public-sector financial barriers that have been reported, the role of government exists to support the operations of advanced technologies on roadways. In Bellevue, many of the infrastructure-focused projects require city funding and staff resources within the Transportation Department to successfully implement. To meet these needs, Bellevue will actively compete for available grant opportunities to fund and implement the projects identified. To date, the City of Bellevue has pursued projects under the following grant opportunities to implement transportation technologies:

- FHWA Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant
- FHWA Congestion Mitigation and Air Quality (CMAQ) grant
- FHWA Surface Transportation Program (STP) grant
- Department of Energy (DOE) Grants
- Bloomberg Philanthropies Mayor's Challenge

In addition to grant opportunities, the City of Bellevue has apportioned funds through the 20-year Neighborhood Safety, Connectivity and Congestion Levy to support advanced technology partnerships and ITS projects. In the near-term, this funding source will be crucial for jump-starting many of the identified projects due to the long lead time associated with competitive grant funding sources. Through the Levy, the city has already been able to fast-track several high priority Smart Mobility projects to keep up with the transportation demands in the city and pace of technology.

Where possible, the City of Bellevue will also seek to accomplish many of the projects identified through partnerships and asset exchange. In many instances, access to the city's datasets and infrastructure is valuable to the private sector, where exchange of services or assets can be offered. As an example, traffic signal data has proven to be useful to the private sector, where the data can be applied towards applications that are integrated into private vehicles and fleets. In return, an exchange of system performance monitoring is provided to the city at little to no cost. In this example, the exchange of information is mutually beneficial. What is clear is that business models around transportation are rapidly evolving with emerging technologies, as evidenced through transportation-as-a-service and data-as-a-service models. What is not clear is the city's financial role in many of these emerging technologies. The City of Bellevue plans to stay current with the changing trends and seek partnership opportunities that can leverage existing city resources.

As it relates to infrastructure-driven projects outlined in the Smart Mobility Plan's Traffic Management initiative, the city has estimated annual capital expenditures and operation and maintenance (O&M) expenditures, as shown in the Table 2.

YEAR	CAPITAL EXPENDITURE	O&M EXPENDITURE
2019	$885,000	$289,500
2020	$1,065,000	$329,500
2021	$575,000	$374,500
2022	$675,000	$438,000
2023	$400,000	$494,000

Table 2. Estimated Traffic Management Initiative Annual Cost

STAFF RESOURCES

Successful implementation of the Smart Mobility Plan also requires staff resources to manage project implementation, design, deployment, and evaluation. Staff resources include both internal staff within the City of Bellevue and private sector contributors. The City of Bellevue acknowledges that a proportion of the projects defined will be largely influenced by private sector, especially related to Smart Mobility technologies. Closely related is the level of private sector resources available to accomplish Bellevue's Smart Mobility Plan, which is often predicated on the availability of technology, maturity of technology, research and development efforts, and capacity to deliver. As an example, the private sector industry involved in AV pilots has been selective in dedicating resources due to high demand and the number of requests received. The importance of economic development and building relationships with key industry partners will be necessary to securing the private sector resources needed to accomplish the city's Smart Mobility vision and goals.

City staff resources will be focused on coordination between internal and external staff, and integrating Smart Mobility technologies into the existing transportation system. In 2017, the City of Bellevue created a new Transportation Technology Partnerships Manager role to fulfill many of these functions. Initial efforts include establishing policy framework to encourage technological advancement and formulating partnerships with the public and private sector to attract innovation in Bellevue. What is less certain is the level of effort related to the operations of Smart Mobility technologies. Examples of unknowns include the rate of public adoption, transportation mode shifts, and impacts to travel demand. More experience and awareness from pilot projects in Bellevue and other deployments across the nation will help to provide a better understanding of the operational needs over time. Bellevue staff plan to stay proactive with city efforts and apprised of those in other cities to define these resource needs as pilot projects are initiated. Once a reasonable understanding of operational resources is understood, the City of Bellevue will be able to define the staff resources needed to scale beyond a pilot project.

What is more certain are the levels of staff efforts associated with city-directed projects, primarily outlined in the Smart Mobility Traffic Management initiatives. With 20 city-directed Smart Mobility projects identified for the next 5 years, the City of Bellevue anticipates a project delivery approach that will include additional staff to carry out project management, planning, design, implementation, and integration activities. Starting in 2021, the plan determines the need for one additional ITS Technician and one additional ITS Engineer to advance initiatives identified in the Smart Mobility Plan.

POLICIES

Bellevue City Council recently adopted an Interest Statement for Smart Mobility (Appendix A), intended to encourage innovation and adoption of advanced transportation technologies.

The interest statement establishes a regulatory framework aimed at removing obstacles and supports early adoption of emerging transportation technologies through partnerships with the public and private sector. The eight components of the city's Interest Statement in Smart Mobility include:

1. Improve transportation safety by reducing the frequency and severity of vehicle collisions.

2. Enhance the quality of life for those who live and work in Bellevue.

3. Improve the efficiency of and establish measurable outcomes for the entire transportation system.

4. Ensure new technologies complement other travel options, including transit.

5. Participate in the development of a regulatory framework that provides a structure to ease the transition from current to smart mobility technologies.

6. Maintain user security and privacy.

7. Support and enhance Bellevue's leadership as a center for innovation and technology.

8. Promote environmental stewardship.

In addition to policy directions, Bellevue's Smart Mobility plan also aligns with other key transportation policies and plans that have already been adopted by City Council and championed by staff, including the city's Vison Zero program, Bellevue Smart initiative, 2015 Comprehensive Plan, and Environmental Stewardship Initiative.

Vision Zero Program

Bellevue's commitment towards Vision Zero means reaching zero fatalities by 2030. Projects in the Smart Mobility Plan such as AV pilot projects, video analytics technology, and weather information systems help to reduce the human factors related to driving, provide better information on roadway and safety concerns. These projects are all aimed at implementing technologies to make travel in Bellevue safer and help the city reach its Vision Zero goal.

Bellevue Smart

In 2017 the City of Bellevue published "Bellevue Smart: Planning for a Smarter City," which set the early foundation for this Smart Mobility Plan (then called the ITS Master Plan):

"Leverage the upcoming ITS Master Plan update to define the next set of advanced capabilities… to advance Bellevue's transportation system into proactive mode and ready the system for autonomous and connected vehicles." [24]

Bellevue Smart set forth an overall transportation goal:

"Moving people smarter, safer and faster, while providing more choices, better real-time information, lowering emissions and raising efficiencies." [25]

These goals and aspirations are accomplished through the implementation of this Smart Mobility Plan.

Bellevue 2015 Comprehensive Plan

The City's 2015 comprehensive plan identifies multimodal integration, transit enhancements, and enhancing mobility options as several key opportunities towards effective growth management in Bellevue. Smart mobility initiatives like TSP expansion, shared-use mobility projects, and traveler information enhancements are ways in which this plan supports the goals that were established through the city's comprehensive planning efforts.

Environmental Stewardship Initiative Strategic Plan

Reducing municipal emissions has been a key component of Bellevue's goals toward environmental stewardship. Traffic operations, commute trips, and the city's municipal fleet were identified as major opportunities to reduce greenhouse gas emissions. Bellevue's Smart Mobility Plan leverages the use of technologies to provide more EV options within the city and shared mobility services to support commute trip reduction efforts that align with the sustainability goals in the Environmental Stewardship Initiative Strategic Plan.

Other Regional Programs

Outside of the local programs and policies in Bellevue, the city also supports regional programs including partnerships with WSDOT, King County Metro, Seattle Department of Transportation, and neighboring cities of Kirkland and Redmond. The movement of people and goods does not stop at Bellevue's city limits and a partnership with Bellevue's neighboring cities is crucial to an effective smart mobility strategy.

SOCIETAL IMPACTS

It is generally known that many of the emerging ACES technologies discussed in the Bellevue Smart Mobility Plan are often referred to as "disruptive" technologies. They are referred to as disruptive because they transform the way that the greater population has been experiencing transportation since the invention of the automobile. They will ultimately transform our economics, workforce, land use, transportation mobility, transportation safety, and social equity. While many of the changes are positive, there are also unintended consequences as well. The City of Bellevue recognizes the potential impacts of smart mobility technology on Bellevue residents, commuters, and businesses and the important role of public policy. The following section provides abbreviated examples of some anticipated impacts from the emerging transportation technologies discussed but does not intend to address all consequences, because many are also unforeseen until more experience and wider adoption is observed.

Equity

ACES mobility are anticipated to increase accessibility for underserved groups, especially for individuals that are not capable of driving or owning a vehicle. It is believed that the arrival of AVs are mostly likely to enter the market under a TaaS model, and provide significant economic benefits that will allow travel to be more affordable and equitable for travelers.

Regional Mobility and Land Development

FHWA's May 2018 forecast on Vehicle Miles Traveled (VMT) acknowledges uncertainty in the effects of AVs[26]. The fear is that AVs may result in an increase in VMT because travel is made easier. Travelers may also be more tolerant to longer travel distances as improved productivity can be achieved while riding in an AV. Uncertainties in these potential human factors suggest that AV and shared mobility technologies may lead to more congestion and urban sprawl but public policy will play a crucial role to mitigating these unintended outcomes.

Modal Displacement

An increase in accessible and affordable travel through emerging technology may cause a mode shift as travelers choose to use autonomous on-demand service instead of public transit. If not managed effectively, many high-capacity transit routes may be displaced by lower-capacity shared mobility modes. The balance between high-capacity transit availability, travel cost, and shared mobility efficiency will need to be carefully maintained to ensure that transit ridership is not displaced where it works effectively.

Affordability

Privatization and government subsidies are just a few transportation policy issues to consider and balance when evaluating affordability of the transportation network. As privatization becomes more commonplace, government subsidies could assist low-income residents or underserved areas in achieving last mile connections between origin/destination locations and major transit hubs.

Affordability is also affected by the travel distance between home and work. As distance increases so do fuel and vehicle maintenance costs. Use of shared, EVs and AVs for first and last mile connections may be a cost-effective solution that will complement fixed public transit routes well.

Productivity

According to a Harvard study, an average American spends approximately 100 minutes per day driving. Shared use mobility and AVs are technologies that provide an opportunity to reclaim time spent behind the wheel so that travelers can redirect their attention to other tasks. Both technologies provide travelers with safe options to work while on the road, connect with family and friends, and even use smart devices. By taking the responsibility of driving out of the equation, drivers will be able to gain over 600 hours of useful time back over the course of a year, which can help to improve overall quality of life.

Safety

The NHTSA estimates that 94 percent of vehicular accidents are caused by driver error. An autonomous transportation network, in theory, would eliminate driver error and ultimately help meet the City of Bellevue's Vision Zero goals. AVs are equipped with sensory and communication equipment that surpass those of a human driver.

One of the largest threats to AV safety is cybersecurity, particularly personal data hacking and vehicle operational disruptions. Automakers and federal policymakers are placing a heavy emphasis on security standardization to minimize this risk.

Workforce and Economy

A recent 2018 Massachusetts Institute of Technology study indicated that one of the most significant uncertainties for government is the impact that AVs will have on employment. AVs will have a noticeable effect on the professional driving industry (e.g., truck, taxi, and bus drivers) because drivers will no longer be required. For instance, advancements in technology are the reason elevator operators no longer exist; however, the magnitude of those impacted by the introduction of AVs will be much more widespread than this.

As EVs and AVs become more prevalent and vehicles in general have become more fuel efficient, Washington State has seen an exponential decline in transportation funding generated by the state's gas tax. In response, the State is now considering taxes based on vehicles miles traveled which is agnostic to the vehicle fuel type.

MOVING THE PLAN FORWARD

Ongoing implementation of Bellevue's Smart Mobility Plan will rely on close collaboration between the city and its public and private sector partners. The private sector has much to offer in terms of innovative products and services that can help the city reach its Smart Mobility vision and goals. Collaboration with the public sector will help to integrate these new technologies into a well-functioning, safe, equitable, and efficient regional transportation system.

In order for the City of Bellevue to accomplish the vision and goals outlined in this plan, a combined approach to establish policy, partnerships, data-driven solutions, and pilot projects is important.

- **Transportation policies** will help establish the City of Bellevue's position and interest in supporting transportation technologies and attracting economic development in Bellevue.

- **Partnerships** will be a key component to leverage the latest technological advancements from the private sector and deploying emerging technologies at a regional scale.

- **Data-driven solutions** enable the city to apply technology in a useful way that helps to meet our region's mobility, safety and environmental challenges, as opposed to deploying technology for the sake of deploying technology.

- **Piloting new technologies** is critical to providing the necessary experience to understand the benefits and issues associated with each deployment and will allow the City of Bellevue to adapt to change and learn from small scale implementation before scaling up.

The City of Bellevue is also prepared that some of the identified strategies will take time to implement. Public acceptance may also take time as well. However, we are living in a transformative time where trends in transportation are evolving day-by-day through technologies that provide promise for safer, smarter, and cleaner travel. For these reasons, the City of Bellevue is committed to the successful implementation of this plan to ensure that Bellevue offers a dynamic and high-performing transportation system which optimizes the use of technology.

As Bellevue's Smart Mobility Plan implementation advances, the City of Bellevue will also maintain awareness for the rapidly changing pace of technology and exercise flexibility to re-scope, add or remove projects as needed. New transportation technology press releases and pilot project announcements are revealed nearly on a weekly basis, some of which are positive and others that are negative. Most notable are the ones that reach headlines reporting major breakthrough or catastrophe. While

the projects identified in this plan have been evaluated for viability, reasons for change may be due to technology maturity, projected adoption rates, economic viability, risks, obsolescence, and so on. However, where managed in a prudent manner with the willingness to exercise flexibility, these projects have the capability to enhance transportation in the City of Bellevue.

Most importantly, successful implementation of this plan requires a broad partnership with the private sector and public stakeholders. The City of Bellevue seeks to partner with industry to bring new innovations in transportation technology to solve the regional mobility and safety challenges that we experience. The city also seeks partnerships with surrounding jurisdictions to build on innovations that cross city limits to maximize the potential mobility, safety, and environmental benefit across the region. Regional travel does not stop at the city limits and must be addressed from a regional standpoint. Lastly, the city will also build partnerships with the traveling public to integrate and adopt new technologies in ways that will enrich the experience of travel, enhance safety, and provide more accessibility and equitable options for transportation.

The City of Bellevue is ready to take on a leadership role in shaping a smart transportation system that includes supporting technology and innovation to provide for smarter travel and will lead the way to a smarter future.

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APPENDIX

BELLEVUE INTEREST STATEMENT
FOR SMART MOBILITY

Adopted October 1, 2018 by Bellevue City Council

The City Council Vision for Bellevue is to be a "Smart City," with a clean, high-quality environment and excellent, reliable infrastructure that supports our vibrant and growing city, including high technology connectivity. To achieve this vision, the city developed "Bellevue Smart: Planning for a Smarter City," a strategic plan that includes smart mobility technologies, including electric vehicles, autonomous vehicles and shared mobility options such as ridesharing and bikesharing.

As a leading technology innovation center, Bellevue recognizes that employing smart mobility technologies presents many opportunities that make Bellevue the place you want to be. In order to create an environment where the introduction of smart mobility technologies, including autonomous vehicles, can succeed, provide public benefits, improve the overall multi-modal regional transportation system, and foster economic growth opportunities, the Bellevue City Council supports the following principles:

1. Improve transportation safety by reducing the frequency and severity of collisions. Smart mobility technologies, including autonomous vehicle technology, can help substantially reduce serious injuries and fatalities related to human error or impaired driving.

2. Enhance the quality of life for those who live and work in Bellevue. Smart mobility technologies, including shared mobility options, should increase transportation choices and regional connectivity. By easing the burden of vehicle ownership and providing options for those unable to operate a vehicle, smart mobility technologies can provide greater mobility for all while maintaining personal choice and flexibility.

3. Ensure and strengthen user and system security and privacy. Users of smart mobility should not be required to sacrifice personal privacy and security to access these technologies. Sensitive personal information captured and maintained by smart mobility technologies must be safeguarded against identity theft and unauthorized use, commercial or otherwise, by third parties. Bellevue supports state and federal legislation exempting such personal information from public disclosure and requiring safeguarding of this data against unlawful access. Bellevue has incorporated the public disclosure protections within the City code and is developing privacy and security principles to further safeguard data and system infrastructure from unauthorized access and misuse.

4. Improve the efficiency of and establish measurable outcomes for the entire transportation system. Smart mobility technologies can improve the efficiency of the existing transportation infrastructure by moving more people in fewer vehicles and reducing collisions that exacerbate traffic congestion. These technologies also generate data that improve the predictability of travel times. Bellevue should use smart mobility data regarding transportation demand, travel patterns, and other information to identify where the City can make improvements in transportation infrastructure. Bellevue should use best practices and lessons learned from other smart mobility leaders.

5. Ensure new technologies complement other travel options, including transit. Smart mobility technologies should integrate with Bellevue's and the region's multi-modal transportation network, including connecting people to and from the frequent transit network envisioned in Bellevue's Transit Master Plan and in regional transit plans.

6. <u>Participate in the development of a regulatory framework that provides a structure to ease the transition from current to smart mobility technologies.</u> This should include, at a minimum, appropriate safety measures and levels of regulation for autonomous vehicles to enhance public safety and provide public benefit without erecting undue barriers on the industry.

7. <u>Support and enhance Bellevue's leadership as a center for innovation and technology.</u> To ensure Bellevue continues to be an attractive environment for technology businesses, Bellevue should partner with local, regional, state and federal agencies, transit providers, the private sector, local employers and educational institutions. These partnerships are essential to securing financial support, creating environments for the testing and deployment of new technologies, and providing information and education on new smart mobility solutions.

8. <u>Promote environmental stewardship.</u> Electric vehicles reduce harmful emissions and noise. Bellevue supports the deployment of electric vehicles and the installation of electric vehicle charging infrastructure. The City also supports public-private partnerships, incentives, and funding to expand electric vehicle charging infrastructure.