City of San Francisco

Meeting the Smart City Challenge

Notice of Funding Opportunity
#DTFH6116RA00002:

SEAL OF THE CITY AND COUNTY OF SAN FRANCISCO

SFMTA
Municipal
Transportation
Agency

TABLE OF CONTENTS

TABLE OF FIGURES

EXECUTIVE SUMMARY

Goal: To expand and integrate shared mobility services across the City to incorporate Shared Connected Automated Vehicles (CAVs) using a community-driven approach.

San Francisco has been part of the international network of smart cities since 2011 and has been sharing best practices with our sister cities including Barcelona and Paris. We have used technology to make our building operations more efficient, reduce our energy use, streamline our waste management system, and expand our transportation system, all measure that have contributed to greening our city while making mobility easier. Our CAV goal is a timely next step forward and complements current City goals:

- Zero Waste by 2020 (at 90%), Zero Emissions by 2020, Vision Zero Traffic Fatalities by 2024;
- Reduce greenhouse gas emissions by 25 percent from 1990 levels by 2017, on track to meet;
- Transportation: 50% non-driving mode share by 2018, met in 2015.

Issue: Transportation modes are not coordinated or integrated and many options are not yet available across the City. The City is growing and too many people and businesses using their own vehicles congest streets, cause collisions, emissions and noise, and require more land for parking. Travel times and costs are increasing as is the affordability gap and social equity among transport choices.

Specific SF Challenges this grant is aiming to address:

- The city is growing faster than infrastructure can keep pace causing transit crowding and street congestion and serious traffic safety issues especially among vulnerable populations (low income, elderly, children, and the disabled).
- The lack of affordable housing supply with this rapid growth forces longer commutes for people with limited financial means.
- Growing number of shared mobility providers, with patchwork regulation and policy to deal with safety, accessibility, interoperability, availability, and sustainability of these services.
- Most people living in the outer areas have limited transport options especially for cross-town trips relying on private cars and needing to spend more for transportation.
- Growing late night economy is creating a more vibrant city, but most of the service workers have limited financial means and limited transit service after midnight.
- The city receives over 50,000 visitors a day, many of them regional. The lack of information and coordination of transport options means most drive causing neighborhood congestion and parking impacts.
- Commercial deliveries are growing in the city, incompatibly sized vehicles serving neighborhoods, inadequate loading zones is straining businesses ability to access their goods.
- These transportation challenges have helped to inform our four use case examples.

Opportunity: Linking shared mobility with CAV technology and transit to improve mobility, equity, access, safety and affordability for all:

- Shared mobility (carshare, bikeshare, scootershare, car-pooling, taxis, private transit) and public transit together give access to mobility, reducing the cost of travel and the need to own a vehicle and the associated hassles of ownership, saving money and time.
- CAV technology can meet multiple city goals including eliminating traffic fatalities, reducing

emissions, congestion, noise and personal, business and city operating costs.
- Combined, shared mobility, public transit and CAV technology can reduce demand for street space and parking so that public right of way can be repurposed over time for walking, cycling, open space and to create more affordable housing.

Key steps: To test and scale this concept, the City will challenge neighborhoods to participate and apply with participating residents, businesses and stakeholders. While several areas are technically promising, the challenge will be offered as an opportunity, not as a mandate. The City will work with an advisory group of community members, providers and technical partners to evaluate the strength, location and size of neighborhood applications. The conceptual schedule is to:

- Develop a robust community challenge resulting in at least one or more neighborhoods that is **selected as the City's first pilot area for these new services and technologies.**
- Develop and staff a community partners working group of stakeholders to provide input and guidance throughout the process.
- **Collaborate with qualified shared mobility providers to integrate routing, payment software for ease of use among users in parallel with fleet expansion efforts.**
- Use data-driven qualifying criteria to meet City goals then incentivize shared mobility expansion in the neighborhood with priority curbside access (including geo-fencing) and travel lanes.
- Invite CAV technology companies and researchers to participate in pilots in the area.
- Pilots could include but are not limited to: Wi-Fi, charging, smart signals, lanes, sensors **and beacons, fleet operations, first-last mile transit shuttles, flexible loading zones and open** space, delivery services, parking management, geo-fencing, demand management pricing and incentives, and bike/car/scooter/cargo share pods.
- Provide the working group and the public with ongoing data collection, information and analysis of the effectiveness and support for the new services and technologies.

As these services scale, the cost will come down so more people will utilize them and will become accustomed to the ease of travel without having to rely on their personal car for every trip. CAVs can offer:

- Connected and collision avoidance technology to greatly improve safety and by traveling closer together use less space on the road, reducing costs to the City and society.
- Combined, shared, connected vehicles with automation will reduce the need for parking and can reduce the number of cars in the City, saving costs and opening land for other uses.

This iterative, community supported process will include dashboards to track and monitor progress and outcomes, provide annual reports, processes and lessons learned to be shared among other neighborhoods, cities and interested parties.

1. SAN FRANCISCO'S SHARED TRANSPORTATION FUTURE

The San Francisco Bay Area has seen tremendous growth in the last few years and is expected to grow by an additional 25% in population and employment over the next two decades. The region's employment and output outpaced California's and the nation's. Here, employment is growing faster than population and the population faster than housing units. Growth has posed enormous transportation challenges as it relates to the safety, mobility, environment and economic productivity.

Figure 1. Travel Corridor Demand and Growth

Preparing San Francisco for Beyond Traffic through Smart City Deployment

Some of the key trends noted in the Beyond Traffic document include predictions of population growth, increase in number older citizens and shift of people to mega-regions. These challenges are now impacting the citizens of San Francisco. Travel in the City is very time-consuming and expensive. Problems will get worse because the current growth rate is projected to continue. Freight demand is also on the rise. Increased deliveries in San Francisco have created safety conflicts, double parking, and blocked access with large trucks that are incompatible on the roads of a city like San Francisco. Technological advances need to transform the way vehicles, infrastructure and services operate. Using the Transport Platform model, the City will measure the impacts using established and increasingly available data sources. We also recognize that the public investment alone is insufficient to fund the increasing costs of maintenance and expansion of the infrastructure.

Vision: San Francisco is an ever-evolving community of thinkers, doers, runners, bikers, activists, neighbors, babies, students, entrepreneurs, cooks, up-and-comers and a thousand other roles. The vision of San Francisco phasing out its reliance on single occupant vehicles by adopting a path toward Shared, Electric, Connected and Automated Vehicles (SECAV) deployment through the Smart City Challenge will be nothing short of transformational here and for cities across the world. We imagine our City having its public rights of way repurposed to spaces where people of all backgrounds and abilities will be able
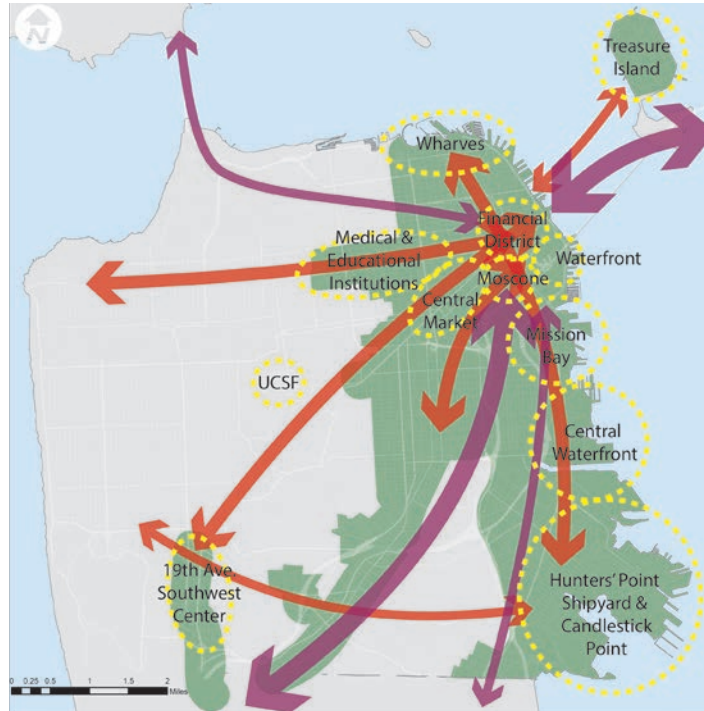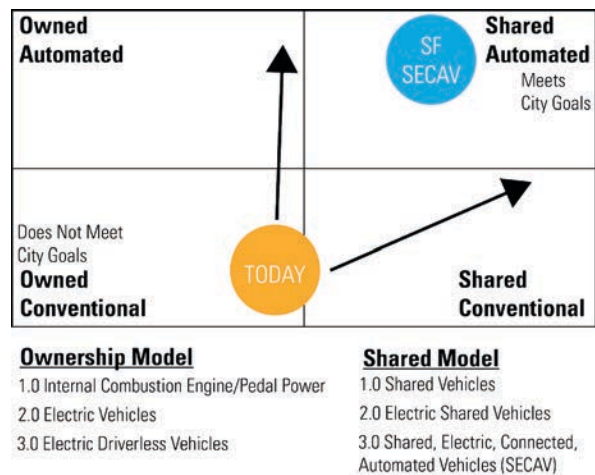

Figure 2. Potential Transportation Paths

to enjoy, explore and experience the City whether they are a resident, commuter, a visitor or delivering goods. People of all abilities and means will be able to afford to live, work and get around the City in ways that will soon achieve the shortest time with the least impact through a unique, phased approach of iterative changes:

- Expand technologies that reduce reliance on single occupant vehicle trips through the sharing model to create more affordable, accessible and integrated travel options, reduce congestion and emissions, and increase customer satisfaction.
- Incorporate Connected and Automated vehicle technology in phases through the shared model as it comes available, and is proven to be safe to further reduce travel costs, eliminate collisions and fatalities, and reduce parking demand sufficiently to re-purpose parking facilities into affordable housing and other city amenities.

Our vision is less about the technology (which we care about deeply) and more about people, community and culture change. Technology enables. But it is our belief that values shape technology – not the other way around. We cannot emphasize enough the profound global culture change that this grant is seeking. As the global capital of technological innovation, we know first-hand that technology is a tool to respond to our personal quality of life. In the world of transportation, we are no strangers to global firsts; San Francisco is a testbed of groundbreaking discoveries and trend-setting policies that get replicated globally, notably:

OUR VISION

Get the greenest, most affordable trip choice in 2 minutes and easily get anywhere in the city within 20 minutes.

- **SFpark:** With over $20 million of USDOT Urban Partnership Agreement funding, the SFMTA created the SFpark pilot program, now in Phase II. The outcomes of that pilot program (a 30% reduction in greenhouse gases and vehicles miles traveled, technological leaps and increased customer satisfaction) are being spread across a dozen of the world's cities.
- **San Francisco Parklets Program:** a more human-centered approach of repurposing on-street parking through a community business partnership to create open space and support economic development. This best practice has been replicated in over 50 cities globally.
- **Treasure Island Mobility Management Program:** innovative mobility solutions for the City's island community redevelopment.
- **California Road User Charge pilot:** a volunteer vehicle miles traveled pilot for drivers in exchange of the gas tax.

We know from our rich experiences with groundbreaking firsts and game-changing policies that the changes envisioned in the Smart City Challenge will require unprecedented partnerships and community engagement. For this to succeed, we need to understand the key challenges facing people in their daily lives and figure out the best way to reduce the friction points in how they get around the City. From there, we will know what matters most and what these technologies can enable and support to create the public opinion that is favorable to citywide, national and global adoption. The sharing economy model and connected and automated technology will succeed only with a deep engagement with our community of customers: our residents, commuters, visitors and our commercial delivery services.

Why San Francisco: We believe our history of trend-setting innovation; our culture of openness, inclusiveness and early adopters; our long-standing relationship with technology entrepreneurs from the City and Silicon Valley, with research institutions and design firms and our proven track record to deliver sets us apart. Our human capital resources (public, private, academic, civic) partnership is ready as the numerous letters of support demonstrate. Our size, varied topography, micro-climates, and urban form is ideal. Our approach to focus on the customer experience through human-centered design, and create a community and data-driven process centered on the sharing model, will truly create a "Smart San Francisco City" and begin the culture change that will set an example for other cities to replicate.

City Preferred Path for Connected and Automated Vehicles (CAVs):

We are at a Y path with CAVs: there is the ownership model and the shared model paths. For cities, the shared model path is the preferred and most effective way forward because it will be able to meet multiple city and regional objectives. We further believe that the promise of the CAVs for a city is truly transformative. We will prioritize a Shared Electric Connected Automated Vehicles (SECAV) policy path in San Francisco to ensure a sustainable and equitable outcome.

Vision Zero and Equity: The SECAV potential to reduce people being severely or fatally injured from collisions, to decrease the cost of travel through new programs,and to reduce the need for car ownership allowing the re-purposing of public rights of way to public open spaces, affordable housing and other city amenities is quite attractive.

The City is excited to deploy SECAVs in a real-world environment and to accelerate the adoption across the globe. This will require unprecedented and innovative community engagement approaches to garner the **acceptance, desire and adoption for these technologies to fulfill their potential. Almost ten companies are** currently testing CAVs in the city limits. These companies are at various stages of ability and willingness to provide real-life opportunities for residents, workers and visitors to engage, provide input and feedback and test-ride these services. We can work with our policy makers to develop the authority for pilots, in partnership with local, regional and state policy bodies.

This is a bold vision with a bold goal. Imagine the possibility of all modes integrated and designed around personal preferences with their use being safe, convenient, enjoyable and incredibly affordable. The implementation of this vision is going to fuel its own success and will be the game-changer for people to make the switch from ownership to transport-as-a-service. This goal is consistent with a long list of City **ordinances, plans, and Mayoral directives. The City has several policy documents and goals that will benefit** from the SECAV deployment including:

- **Vision Zero Action Strategy:** Zero traffic fatalities by 2024 (Feb 2015)
- **Climate Action Strategy:** Zero waste, 50% sustainable trips mode share, 100% renewal energy (2011)
- **FY 2013-2018 SFMTA Strategic Plan:** 50% driving and 50% sustainable trips mode share by 2018. Goal 1 Safety, Goal 2 Mode shift, Goal 3 Efficiency and Goal 4 Customer service and dozens of action items. The 2018 mode share was reached in 2015 highlighting the changing pace in the City and how more needs to be done for the half that continue drive. There are dozens of reasons why people still drive for most of their trips in the City. The SECAV framework **through the four identified uses cases aims to provide mobility and access to those without the** hassle and costs of car ownership.

Key Outcomes:

Increased customer experience	The cost and time of travel has been reduced in the city opening up opportunities to spend more time with family and friends and more leisure time to enjoy the city.
Vision Zero and Active Transportation	The city has greatly improved the accessibility ,safety of streets, walking and biking options making it easier and healthier to get around by active transportation.
Affordability	SECAV adoption has reduced demand for parking and driving, reducing operating costs, repurposing land for affordable housing to greatly improving supply.
Sustainability	The City is more accessible, greener, more efficiently operated, more climate resilient and economically competitive.

How: The SECAV deployment will be focused on a phased approach to build upon our existing assets and successes, learned by applying and building the necessary tools to ensure its success. The path will be developed in a step-wise process with three focus areas:

- **Transportation as a Platform (TaaP):** City policy framework and partnership to enable the inclusion and integration of shared mobility providers working towards a safer, affordable, accessible, inter-operable, sustainable and resilient transportation network.
- **Transportation as a Service (TaaS):** A customer focused framework to virtually and physically integrate all mobility providers through a "data commons" that provides routing, booking and payment and through street operations and prioritization to create a seamless travel experience.
- **Smart Streets:** A policy and design framework to regulate curb space, manage demand, and prioritize travel lanes to grow the shared model and guide the connected and automated phases.

The City has strong track record with neighborhood engagement improvement programs. The process will be community centered, inclusive and iterative, and will include steps from creating policy and qualifying criteria, to engaging stakeholders and providers, to testing and evaluating and reporting outcomes.

What Success Looks Like: A Phased Approach

The transitional approach is designed to take full advantage of both the sharing culture and the connected and automated technologies. This requires all 12 Smart City Challenge Vision Elements to work together to succeed. The sharing culture is to the "software" as the CAV is to the "hardware." The shared mobility layer will provide the social connectivity "glue" for connecting customers to sharing trips. As the technologies converge, and the barriers to scale are reduced, the transition to CAV will be seamless, as the sharing culture has matured.

When: The City is eager to move forward with its Smart City vision effort and begin the process of partnerships and engagement now. Our ability to launch quickly builds on a maturing On-Demand Services culture. The City is home to more shared mobility services, ranging from carshare, bikeshare, scootershare, on-demand pooling, micro-transit and ride sourcing through taxis and transportation network companies (TNCs), than any city i. There are over a dozen companies operating shared mobility services, and almost a dozen testing connected and automated vehicles in the City.
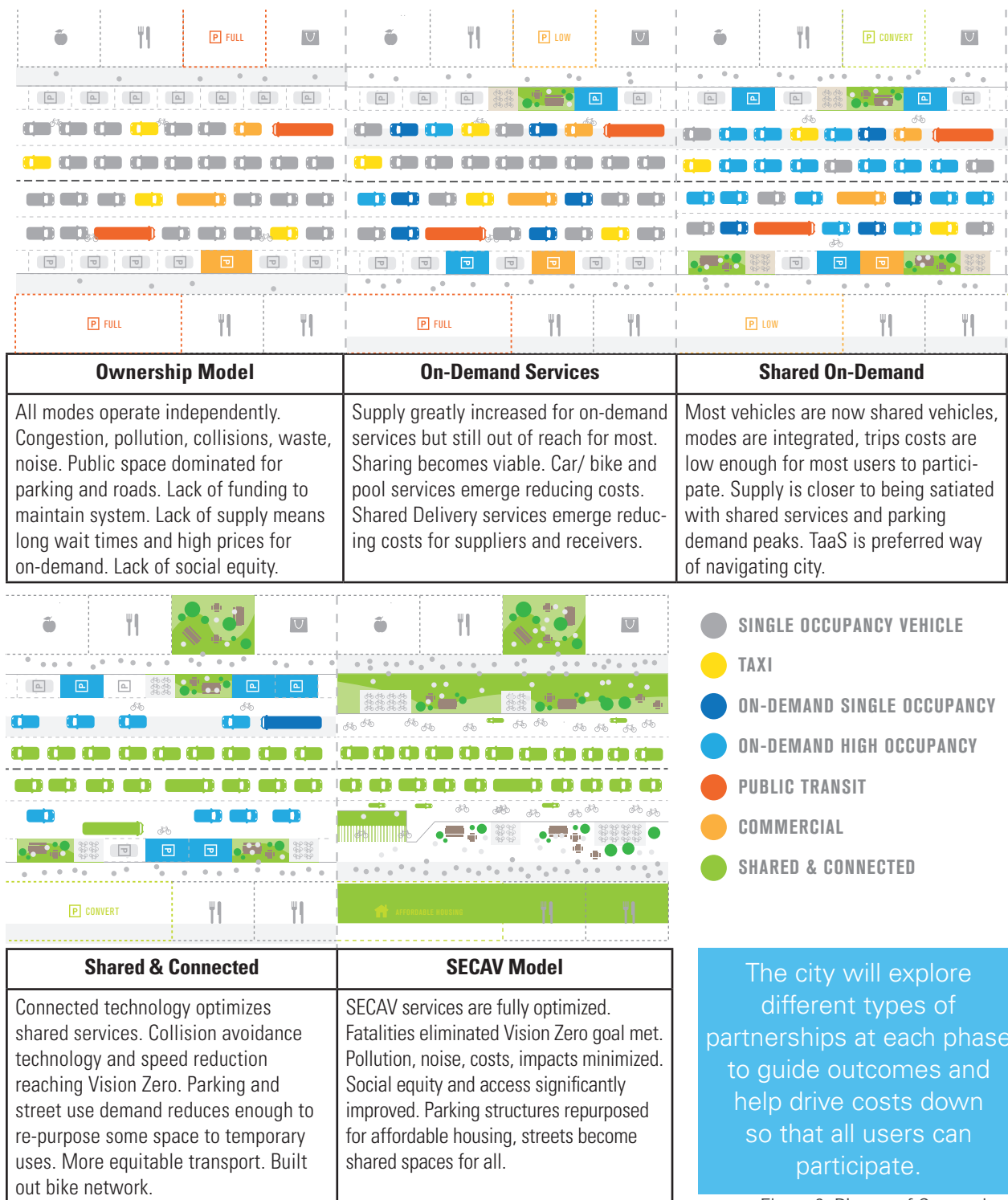
Ownership Model	On-Demand Services	Shared On-Demand
All modes operate independently. Congestion, pollution, collisions, waste, noise. Public space dominated for parking and roads. Lack of funding to maintain system. Lack of supply means long wait times and high prices for on-demand. Lack of social equity.	Supply greatly increased for on-demand services but still out of reach for most. Sharing becomes viable. Car/ bike and pool services emerge reducing costs. Shared Delivery services emerge reducing costs for suppliers and receivers.	Most vehicles are now shared vehicles, modes are integrated, trips costs are low enough for most users to participate. Supply is closer to being satiated with shared services and parking demand peaks. TaaS is preferred way of navigating city.

Legend:
- ⬤ SINGLE OCCUPANCY VEHICLE
- ⬤ TAXI
- ⬤ ON-DEMAND SINGLE OCCUPANCY
- ⬤ ON-DEMAND HIGH OCCUPANCY
- ⬤ PUBLIC TRANSIT
- ⬤ COMMERCIAL
- ⬤ SHARED & CONNECTED

Shared & Connected	SECAV Model
Connected technology optimizes shared services. Collision avoidance technology and speed reduction reaching Vision Zero. Parking and street use demand reduces enough to re-purpose some space to temporary uses. More equitable transport. Built out bike network.	SECAV services are fully optimized. Fatalities eliminated Vision Zero goal met. Pollution, noise, costs, impacts minimized. Social equity and access significantly improved. Parking structures repurposed for affordable housing, streets become shared spaces for all.

The city will explore different types of partnerships at each phase to guide outcomes and help drive costs down so that all users can participate.

Figure 3. Phases of Conversion to SECAV Model

Concept: Shifting from Owner to Experience Plan

- Test out the TaaP policy platform with the shared mobility providers. Once we see their services meet our goals we will qualify them to be eligible users of priority rights of way.
- Coordinate providers to opt-in to the TaaS platform to integrate routing and payments.
- Incremental access to dedicated lanes and priority curb space serve as incentives for providers.

- In parallel, work with SFMTA's CAV and Smart Street partners to begin testing vehicles in slow speed environments to ensure compliance with safety and performance goals.
- As the tests prove successful for public use, invite technology applications to the larger public transit and municipal fleets and commercial deliveries to evaluate performance benefits.
- Begin augmenting shared services with CAVs. Once the data shows that parking and street demand is being met, begin the community process of re-purposing street space to complete the active transportation networks and dedicated open space and then over time start to redevelop parking facilities for affordable housing and other urban amenities.

Where: The City is an urban laboratory that has several locations ideally suited to create demonstration sites. The community will jointly choose the top locations of the demonstration area between now and the award round of this program. It is prudent to engage our community of customers to help define the places and outcomes that matter most to them rather than arbitrarily choosing a location, predisposing the planning process. The City will engage the community to crowd source its priority ranking for the most optimal locations, some of which include but are not limited to:

- Priority Development Areas (Treasure Island, Park Merced, Hunters Point/Shipyard, Central Waterfront, Mission Bay, Balboa/Glen Park)- developing at various stages ideal for first-last mile, smart city technology elements, transit augmentation and new service model overlays.
- Late-night hubs (Mission, Castro,SoMa, Marina, Nob Hill/Union Square) high occupancy services.
- Regional transportation hubs (Transbay Center / High Speed Rail area, Caltrain/SF station area,
- BART stations, Ferry Terminals) First-last mile connections extensions to public transit reach.
- Shared mobility hubs (Cultural/Medical/Learning Facilities, Muni/BART Caltrain stations, Parks)
- Commercial delivery hubs (Central/Downtown Area, Neighborhood commercial areas).
- Vision Zero Smart Intersections: Corridors on the High Injury Network and hotspots around the freeway ramp touchdowns.

Who: The deployment must show a benefit to our varied customer community. From the start and during this deployment, our key focus will be on safety, social equity and inclusion, affordability, accessibility, sustainability and customer satisfaction. We have developed four initial use-cases as representative of people who live, commute,visit and make deliveries in the City. While there are many other transportation user types, we are focusing on these four as they represent typical drivers. Each focuses on the Vision Elements by expanding the shared mobility services and transitioning to shared, electric, connected automated vehicles or SECAV.

Improving the lives of our customers: Four Use-Cases

Our guiding principle for implementing the vision is to take a user/customer focus and ensure that the experience of all users improves significantly in the future. We understand that there are many reasons why people drive for most of their trips and not utilize other modes. The city needs to continue to invest in its public transport system and active transportation networks. The following use-cases present today's real challenges faced by typical representatives of the City that through partnerships will address multiple city goals. This section provides our vision on how we will use the use-case scenarios to define the implementation/deployment plan through shared mobility and ultimately through SECAV.

Persona 1: Nicole, the Complex Commuter

Nicole, 35, is a teacher living in the Outer Sunset. She was a daily transit rider until she had a family. Every morning she drives north to drop off her daughter at Sunset Elementary, and then heads southeast to work at James Denman Middle School in Balboa Park and pays to park.
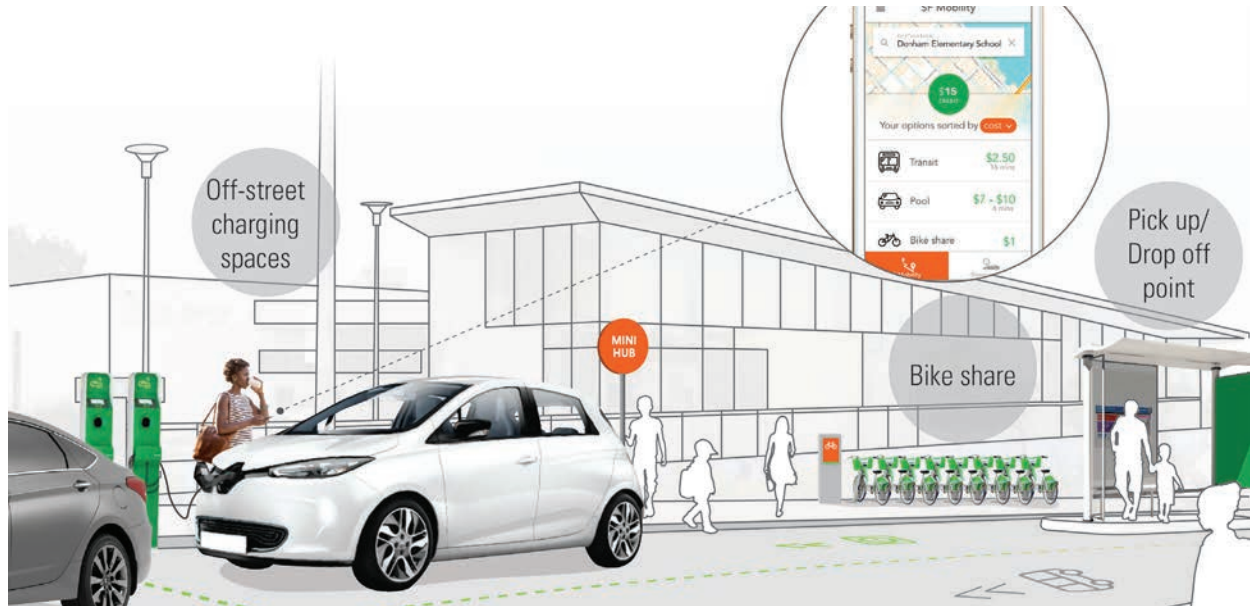

Figure 4. Shared Hub Model

Nicole's Transportation Challenges

- She lives in the west edge of the city and her work is across town in the southeast of the city
- She has a young daughter needing to be dropped off at school first and picked up
- She has multiple daily destinations with family, work and social life
- Her errands require carrying home goods, groceries and supplies for her child and for her work.

Nicole learns to use the city's new mobility app, and now uses her car only for necessary trips that include her family. She optimizes its use by placing it on a peer-to-peer sharing service earning her money when she's at work. A linchpin of her new routine is her daughter's school, which has become a sharing hub for shared and electric carshare drop off and pick up, bike & scooter sharing, and public transportation. She uses the app to pool + Muni some days, drive her car and bikeshare for her errands around her work and also send those groceries home through a new delivery service so she does not have to drive. The money she earns from renting out her car offsets the costs of the new and expanding sharing services. In the near future, she sees that there is a CAV delivery option and decides to try it out seeing it is so affordable.

A CAV microtransit provider hired by her weekly arts enrichment program brings Nicole's daughter home while she grabs a workout. Nicole can afford both the new multi-modal services, gym membership and the weekly arts enrichment program for her daughter with the money she earns from her car.

Persona 2: Juan, the Late Night Worker

Juan, 21, works at a Nob Hill hotel and lives with his family in East Oakland. He walks to BART regional rail and Muni bus to work to start the dinner shift at 6 PM, which takes **45-55 minutes but when he finishes** at 2 AM or later, there are very few transit options—his return is nearly two hours long and he does not feel safe walking home.
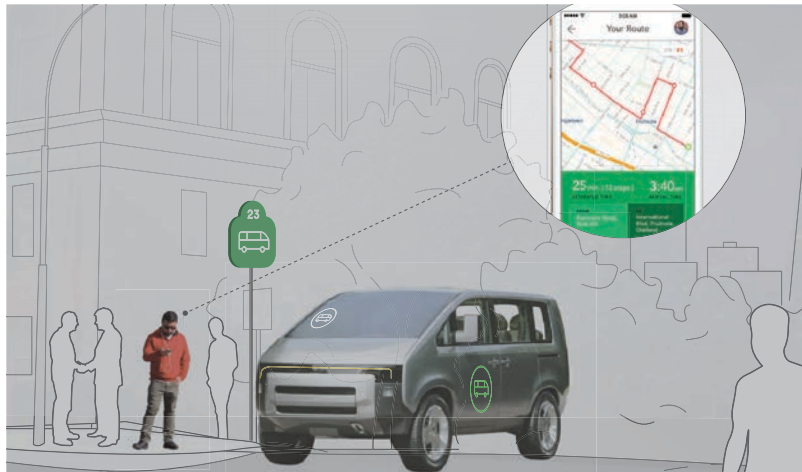

Figure 5. Late Night On-Demand Shuttle Model

Juan's Transportation Challenges

- Lives across the Bay with limited travel options late at night, after BART hours.
- **Limited financial means to operate a car and cannot afford housing closer to work.**

Juan learns about a new city/employer partnership with vanpool service. The smart data-responsive routing **options address the specific needs of late-night workers with more frequent and affordable high occupancy** van sized on-demand services that pick up in areas with clusters of late night workers headed to the East Bay. The system uses signal priority and gets a queue jump to the freeway on ramp every time. It drops off close to BART stations and locations crowd sourced from passengers.

When Juan finishes his shift, he catches a micro-shuttle two blocks from the hotel. The shuttle offers a direct cross-Bay commute and makes five stops in Oakland. As a member of the late night transport collective, he receives updates on locations and other information. His home commute is now less than 40 minutes door-to-door and due to the collective partnership is priced similar to his BART fare there. In the future, Juan is notified that due to demand a larger more affordable CAV option comes available and tries it out. With the time and money saved, Juan decides to enroll at community college to pursue his passion for hospitality services.

Vision Elements included: 1-9

Persona 3: Margo and Steve, Suburban Visitors

Margo and Steve, 57 and 59, have lived in San Mateo since they bought their first home and have two cars. Steve drives to the south bay daily while Margo rides Caltrain and transfers to Muni to her job in SF. They head to the city regularly for entertainment in the evenings and weekends but are not fond of the drive and parking situation.

Margo's and Steve's Transportation Challenges

- Regional taxi trips are expensive and pool options are not available from the South Bay to SF.
- Limited transit options to entertainment locations beyond the reach of regional rail stops.
- Parking is a hassle and driving in, means one has to be a designated driver for evening outings.

Figure 6. Pooling Model

The City partners with entertainment destinations (concert halls, sports events, theaters, exhibitions) to offer integrated transportation options with their tickets, and offer incentives for pooling and public transportation links. This reduces the number of cars heading into the City, which decreases congestion and prompts new behaviors for visitors from the suburbs.

Margo and Steve receive email newsletters about events, shows and restaurants in San Francisco. When they learn about an evening event they want to attend, they realize it is in Fort Mason, and they're not sure how to get there without driving. The email link shows them how to download an app to buy an integrated ticket for the event and a discount if they carpool or take public transit to the City. They decide on the carpool option as it says they get priority parking, so they convert their car into a peer-pool vehicle and pick up another couple in their neighborhood headed along the way. They use the smart routing app to get them there the easiest way, see that the freeway gives them priority queuing at the on-ramp, and on the way the routing app shows them the best route to get to Fort Mason. After dropping off their passengers at a virtual hotspot along commercial Chestnut Street, they get a credit earned for pooling and use that towards their pooled electric vehicle parking and plug on-site. The next time they use the app they switch to being passengers and save more money. In the near future, they subscribe to a CAV option that links them to and from Caltrain and realize they don't need both cars and sell one.

Vision Elements included: 1-9

Persona 4: Michael, Local Business Delivery in the City

Michael, 41, delivers coffee for a coffee roaster, "Local Roastery." He manages a fleet of three trucks that deliver coffee and supplies to a few dozen small businesses in San Francisco. Sarah, 27, is a freelancer who pieces together work doing short hop deliveries in her neighborhood and as a peer-pool driver.

Michael's Transportation Challenges

- Small business depends on low costs (smaller loads means higher costs while Amazon is close to zero cost delivery because its deliveries are so big)
- Vehicles too big for city
- Safety: blocking bicycle lanes and double parking
- Increasing traffic, especially in commute/rush hours
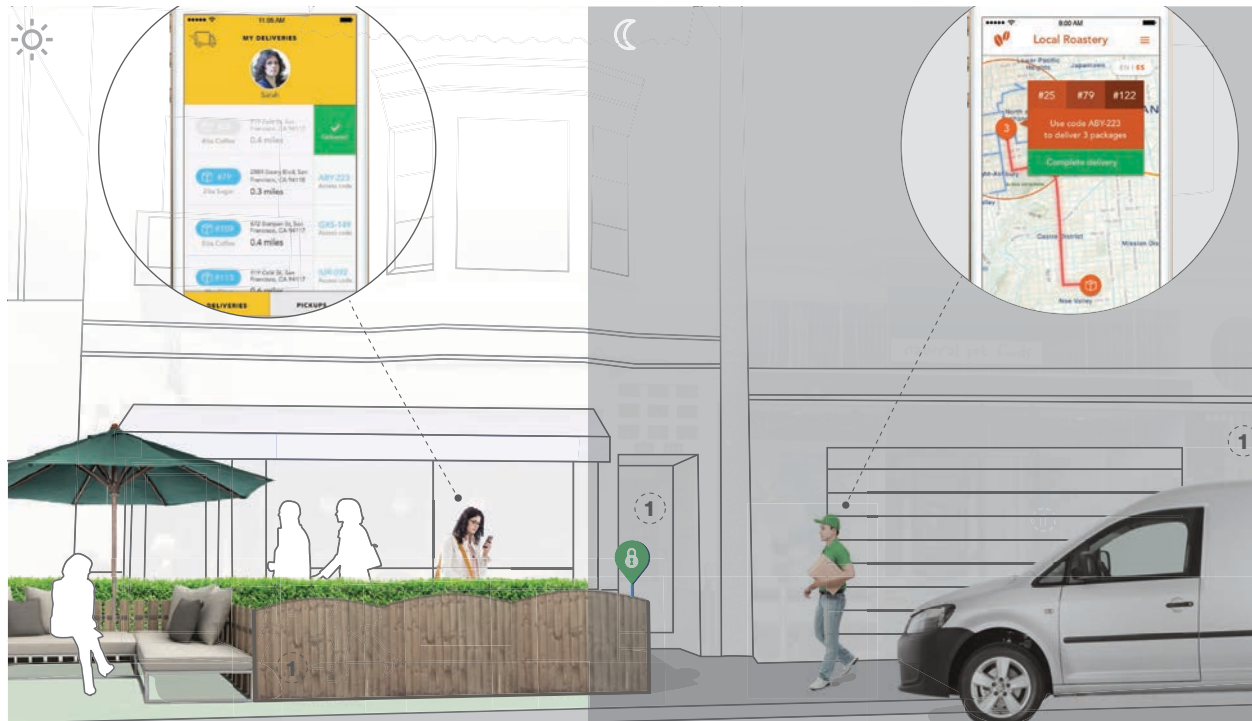- Trucks not used to capacity: space not optimized

Figure 7. Flexible Loading Space

Michael is part of San Francisco's "hub and foot" model that combines off-hour truck delivery to container-based hubs around the city within walking distance to the final delivery destination during work hours via foot delivery service. In the near future, he grows his company with the smart routing system and uses a CAV to make some deliveries outside of his work schedule.

Vision Elements included: 1-9

Step 1: Freight delivery to hubs

At 10:00 PM Sunday night Michael hops into his Automated van and rides through the empty streets of the Financial District checking his inventory and locations; At the first "foot hub", Michael pulls into a reserved space that, during the day is a parklet filled with chairs, tables, and charging stations. By late night, it is unused as people have gone home. He opens the locker in the parklet bench on the curb with a code from his phone and makes his delivery in under two minutes.

Step 2: Hand delivery to businesses from hubs

At 7:30 in the morning, Sarah, a 'gig' delivery person, uses a unique code on her phone to open the locker and then loads a hand truck to walk the coffee to the cafe that sponsors the parklet. Beacons at the parklet confirm she has completed the task and once they sense the locker doors closed, her phone logs her deliveries. And Sarah knows then exactly how much she is earning. She knocks off three deliveries by 8:00 and switches gears to provide pooling service for school kids. With a minimum of additional infrastructure and technology, Local Roastery lowers its delivery costs, reduces prime-time traffic, street level pollution, improves delivery time, increases customer satisfaction, and sees increased profits in its office coffee program.

VISION ELEMENTS: 1-12

Community-Guided Engagement Plan

Success in San Francisco is more than re-imagining a public space for community interaction. This is the first step in creating a scalable framework that can be leveraged nationally to develop smart cities anywhere.

Through an inclusive and data-driven community empowerment program, neighbors will work together to shape a new vision for the smart city that reflects the unique values that define all of us. From concept to implementation, the best decisions for a community are from the community. The City embraces a spirit of collaboration by providing all members of our community real opportunities to get involved, stay informed and stand up for an even stronger San Francisco.

This community guided process will be designed through cross-sector collaboration among the City, its convening partners and the mobility providers through a Community Mobility Challenge. This partnership will take advantage of the great depth of knowledge and know-how of the community organizations, design thinking firms, technology businesses, university research centers and non-government organizations actively engaging with the City.

The Community Mobility Challenge, administered by City of San Francisco through its Community Challenge Grant Program, will serve as a catalyst for the first phase of neighborhood outreach. The City will provide funding, technical and connectivity support to community groups, businesses, schools and non-profit organizations who can best propose an actionable plan to tackle mobility obstacles in their neighborhood, ranging from congestion caused by double parking to infrequent bus service. A panel of technical experts and community members appointed by the Mayor and Board of Supervisors will be responsible for recommending a grant recipient and developing the criteria by which applicants will be evaluated. Staff members can assist teams with planning capacity constraints to ensure inclusion.

The plan covers five main areas: Outreach, Mobilization, Grasstops Organizing, Partnerships and Community Oversight.

- **Outreach Goals:** Spark the dialogue between neighbors, collect feedback on implementation and provide ongoing support in the application process for the Community Mobility Challenge.
- Mobilization Goals: Create a ladder of engagement that empowers community members to voice their support for the Community Mobility Plan and influence policy decisions.
- **Grasstops Organizing Goals:** Sway decision-makers in favor of the Community Mobility Plan by

highlighting widespread public support and touting community benefits.
- **Partnership Goals:** Implementation of the winning Community Mobility Plan will require working with the best and brightest to address the identified needs and challenges. As much of the technology products and services are emerging or have not yet been created, a framework for experimentation, prototyping, and co-creation will be critical for creating real impact and value. The city's pioneering and proven Startup in Residence (STIR) program accelerates the commercialization of cutting edge innovations in technology services to the public sector. It does this by creating a collaborative pre-RFP (Request for Proposal) space to experiment, prototype and co-create with stakeholders. The program matches technology companies with government agencies to build or refine products and services across 16 weeks.
- **Community Oversight Goals:** Form an advisory committee of local stakeholders to oversee policy creation, implementation and performance.

Education Campaign Universe	Public opinion research	Engagement	Number of stakeholders[•] identified and engaged
Reach every household in the targeted neighborhood through a combination of mail, phone and door-to-door Communications as well as community meetings Determine contact goals per type of Communication	Hold focus groups to test assumptions and identify strengths and weaknesses of the plan Poll San Franciscans citywide to discern support at a district by district level	Stakeholders/supporters identified Turnout for community meetings Partner events Door knocks Phone conversations Surveys collected	Cultural, Housing Economic Development Neighborhood advocacy Labor, Education Elected Officials Merchants, Transit advocates Urban planning

Digital Organizing	Action Teams	Event Turnout	Partnerships
Email subscriptions and social media followers Online partnerships Petition signees Impressions per social media	Leaders identified Members identified Action events planned Delegation visits planned Postcards sent	Rallies Public Hearings Press events	Organizational endorsements Constituency/membership engagement Special events

2. SAN FRANCISCO, SFMTA AND CITY TRANSPORTATION FACTS AT A GLANCE

San Francisco is ideally suited for the Smart City Challenge and meets all the Smart City desired characteristics:

- A population of 805,235 people in the city limits (2010 Census).
- The city has a dense urban population of 17,818 people per square mile.
- The city's 2010 Census population represents almost 25% of the San Francisco-Oakland Census Urbanized Area's population of 3.28 million.

The Association of Bay Area Government (ABAG) recently conducted a major study to evaluate the population trends and understand the current economic conditions in the nine-county San Francisco Bay Area. Currently, people 65 and over represent 12 percent of the total population, but by 2040 the share will increase to 22 percent. Put another way, the number of seniors will more than double by 2040. We expect similar trends in the City of San Francisco.

3. OTHER CHARACTERISTICS OF SAN FRANCISCO

3.a. Existing Public Transportation System:

The SFMTA is one of few agencies in the world with a broad mandate to manage all modes (including public transport and taxis), parking and traffic signals in a city. The agency's vision of "excellent transportation choices" provides it with a big picture view to focus on all customers.

The SFMTA plans, designs, builds, operates, regulates and maintains one of the most comprehensive transportation networks in the world. For more than 100 years, it has kept people moving with the San Francisco Municipal Railway (Muni), the nation's eighth largest public transit system. The agency directly manages five types of public transit in San Francisco (motor coach, trolley coach, light rail, historic streetcar and cable car), in addition to overseeing paratransit services, serving individuals unable to use fixed-route transit service. SFMTA provides over 40 percent of all transit trips in the Bay Area carrying more than 225 million passengers annually. The SFMTA partners with regional transit operators that connect the City with the region using four additional transit modes: heavy rail [BART], commuter rail [Caltrain], bus [AC Transit, SamTrans and Golden Gate Transit] and ferry [Golden Gate, WETA]. The City and region need to continue to invest in transit as part of the SECAV strategy.

3.b. Environment that is conducive to demonstrating proposed strategies.

In 2012, the SFMTA Strategic Plan targeted a goal of 50% non-driving trips and 50% sustainable trips (walking, transit, bi-cycling, shared rides) by 2018. The City has achieved a remarkable **50% non-driving mode share** 3 years early even while seeing quick growth in its population and employment. As the City grows its needs to not only keep pace but also increase shared and active trips mode share as geometry and physics limit the number of people to move through constrained rights of way. SFMTA has a strong record for innovative delivery, pilots and demonstration projects. San Francisco has the know-how, the skills, and the strong relationships and partnerships to deliver on the goals of the Smart City Challenge. The SFMTA is ambitious and has delivered on its ambitions, through SF park, SFGo! transit signal prioritization, creating corporate shuttle partnerships, parklets across the City, and most recently developing smart land use partnership agreements with developers to include more travel demand management tools like transit passes and increased shared mobility options in new building developments. In addition, the City has adopted an ambitious vision in the Treasure Island mobility management program to meet multiple city goals. The City and region need to continue to invest in complete streets and active transportation as part of the SECAV strategy.

3.c. Continuity of committed leadership and capacity to carry out the demonstration throughout the period of performance

San Francisco leadership is highly committed to seeing this program become a reality. Time and again the City has evaluated its transportation needs and risen to the occasion by locally generating revenues to offset much of their costs. The Mayor's 2030 Transportation Task Force, comprised of representatives from the public, private, community and labor groups, quantified transportation infrastructures need in the City and identified potential measures to close that gap. As an outcome, the City's voters approved a $500 million streets bond with an overwhelming 71% vote in favor, underscoring their confidence.

By receiving this challenge grant the City can kick-start and accelerate the transformation already well

underway. We have received over a dozen letters of support from prominent shared mobility, CAV technology providers and other key stakeholders. The initiative will be led by the SFMTA and its partners. Together, we will be the first citywide entity in the world to develop a fully integrated shared, electric, connected and automated vehicle system, to all residents, commuter, visitors and commercial entities.

3.d. A commitment to integrating with the sharing economy

The cross-functional team model created by the City team will deliver this complex program. We have strong leadership from the Mayor's Office, two key City Departments, SFMTA and the San Francisco Public Utilities Commission, UC Berkeley's Transportation Sustainability Research Center, as well as a number of academic community and civic innovation partners, who will help to leverage and foster our homegrown technologies and sharing economy talent for the benefit of all.
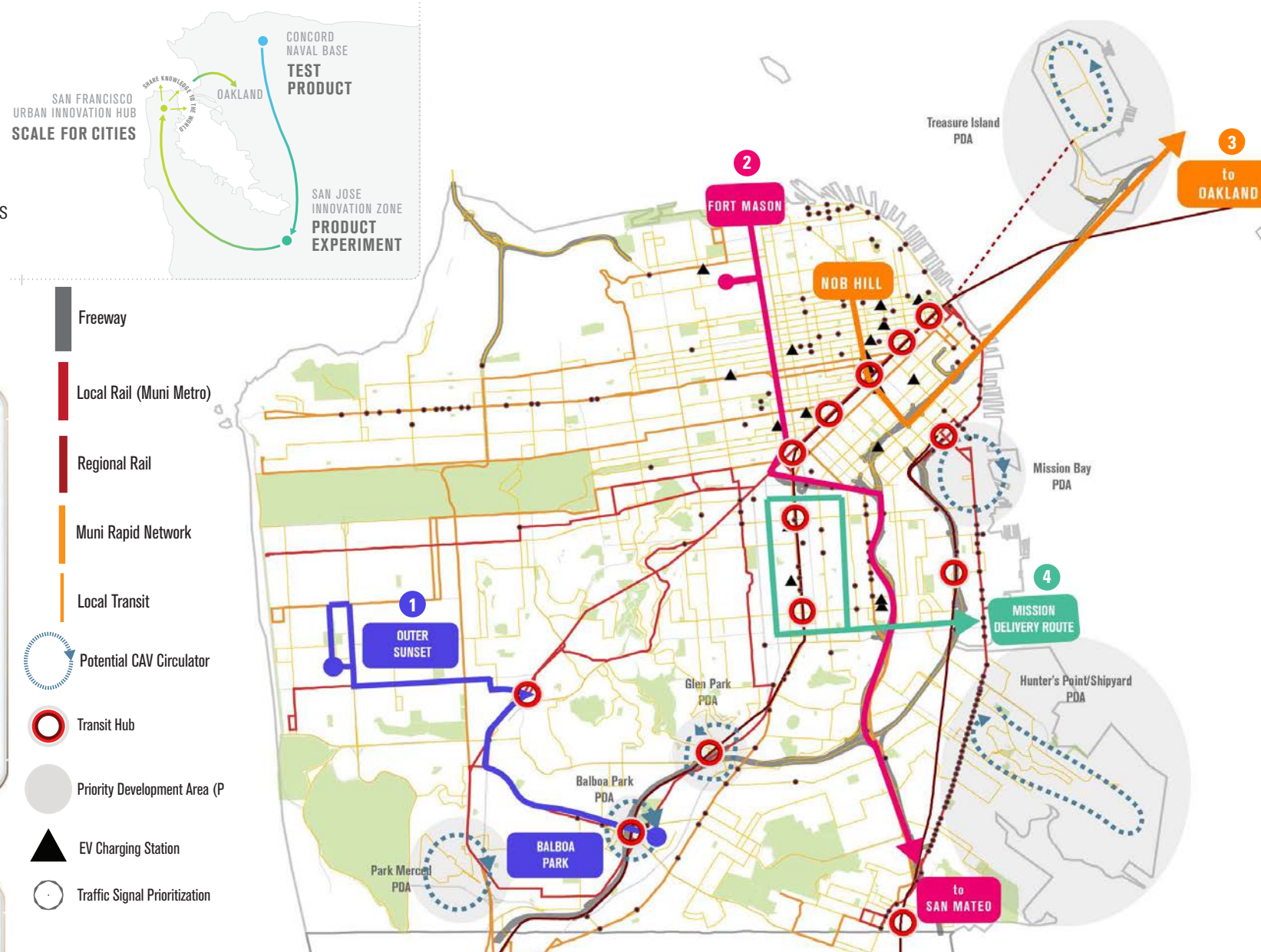
3.e. A clear commitment to making open, machine-readable data accessible, discoverable and usable by the public to fuel entrepreneurship and innovation.

San Francisco has a highly mature open data policy, being true to the innovation culture that breeds from San Francisco. SFOpenData (https://data.sfgov.org/) is an open data platform and a central clearinghouse for a wide range of data publishes by the City and County of San Francisco. This portal hosts more than 350 datasets across a wide range of industries and a number of innovative products have been built using the data. There are more than 30 transportation datasets (machine readable) already posted and made available to the public using this portal and we will host the data from shared, connected and automated vehicles once the relevant policies are established.

4. ANNOTATED PRELIMINARY SITE MAP

A City within an Innovation Region

This cycle of continuous regional innovation starts with CAV testing in Concord and Silicon Valley then scaled deployment in San Francisco, Oakland and San Jose. The SFMTA and its local and regional partners will work together to ensure our existing infrastructure and resources are leveraged to maximize the outcomes.

SAN FRANCISCO URBAN INNOVATION HUB
SCALE FOR CITIES

CONCORD NAVAL BASE
TEST PRODUCT

OAKLAND

SAN JOSE INNOVATION ZONE
PRODUCT EXPERIMENT

Use Cases-Local and Regional Connections

Travel is local and regional with great in/out-bound commutes from each direction. The city traffic system is managed with a traffic management center, CCTV traffic cameras, changeable message signs and other ITS elements. The city public transit network (local and regional rail, bus and ferry) includes corridors with transit signal priority. The four use-cases aim to highlight some of the local and regional transportation challenges we hope this grant can help solve.

Legend:
- Freeway
- Local Rail (Muni Metro)
- Regional Rail
- Muni Rapid Network
- Local Transit
- Potential CAV Circulator
- Transit Hub
- Priority Development Area (P
- EV Charging Station
- Traffic Signal Prioritization

1. CROSSTOWN COMMUTER

- NOW: Nicole school route via shared mobility app
- Carpool/shared parking hub
- Uses peer app to share car and earns money
- Muni Transit Signal Priority improves reliability to get to work
- Saves money and time
- FUTURE: Uses SECAV option to deliver groceries and do other errands
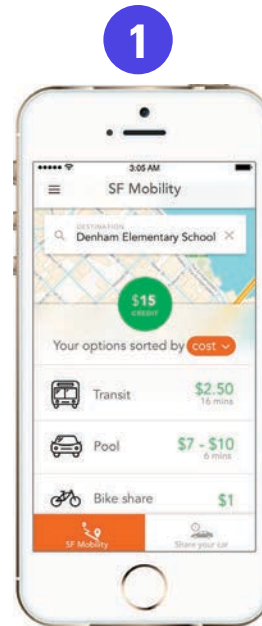
2. SUBURBAN VISITORS

- NOW: Margo and Steve use "Lifestyle" app to offer carpool ride to Fort Mason.
- Routing software links to ITS on freeway to create a "virtual pooling" lane.
- Queue priority on the highway, leave highway routed to smart street using Van Ness.
- Drop-offs passengers at hub.
- Use credit toward priority parking for shared vehicle.
- Drive home with another set of passengers.
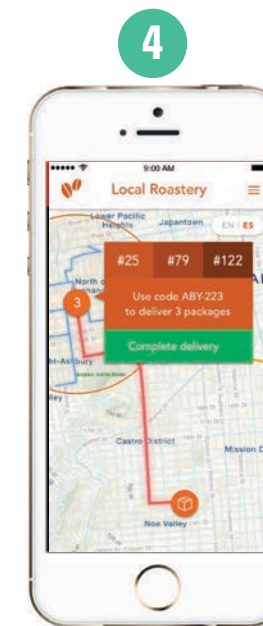- FUTURE: Trip is SECAV

3. LATE NIGHT TRANSPORTATION TO EAST BAY

- NOW: Juan uses app to get micro-transit stop and ticket to destination
- Route utilizes smart street ITS to get on the freeway ramp from Nob Hill to on-ramp in SoMa with priority access for shared vehicles
- FUTURE: trip is with SECAV, so price comes down
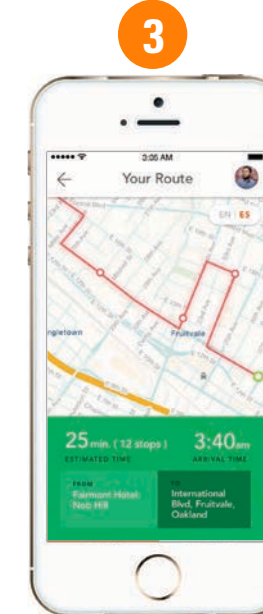
4. DELIVERY IN CITY

- NOW: Michael uses dynamic loading zones.
- Parklet sensors notify that space available to dock.
- Route uses smart streets to get to the locations.
- App routes Sarah with beacons and Wi-Fi understands topography to choose least inclines to deliver them.
- FUTURE: SECAV van is shared and it can deliver for him more place

Map labels: Treasure Island PDA, FORT MASON, NOB HILL, to OAKLAND, Mission Bay PDA, OUTER SUNSET, Glen Park PDA, MISSION DELIVERY ROUTE, Hunter's Point/Shipyard PDA, Balboa Park PDA, BALBOA PARK, Park Merced PDA, to SAN MATEO

PHASE PATH TO SECAV

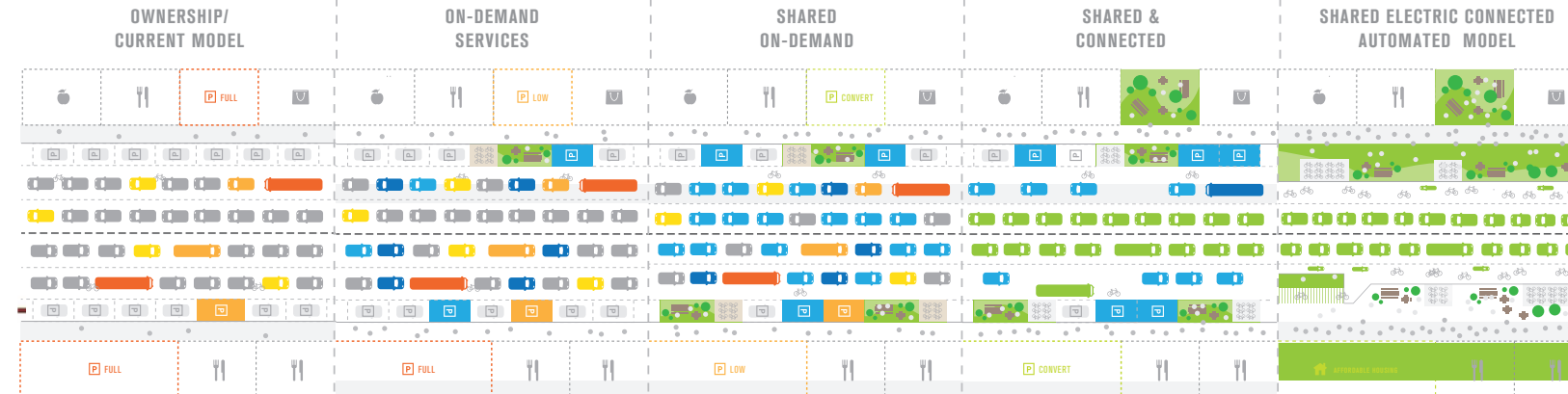| OWNERSHIP/ CURRENT MODEL	ON-DEMAND SERVICES	SHARED ON-DEMAND	SHARED & CONNECTED	SHARED ELECTRIC CONNECTED AUTOMATED MODEL

Figure 8. Annotated Preliminary Site Map

17

5. VISION ELEMENTS

The City envisions that a phased approach to Shared Electric Connected Automated Vehicles (SECAV) has the best chance of success as it is iterative and guided by the community. Each phase incorporates several Principle Elements of the Smart City Challenge in a holistic manner. The key goals outlined in the grant are mirrored for the City, too. During this phasing, the City expects to see congestion, greenhouse gas emissions and traffic collisions go down over time while affordability and reliability go up. There is a particular point in time when the demand for car space on the streets and in parking structures will decline enough so that the spaces can be repurposed. This is a path to affordability. This figure below provides an overview of the twelve USDOT Vision Elements collectively combining to support the SECAV implementation.
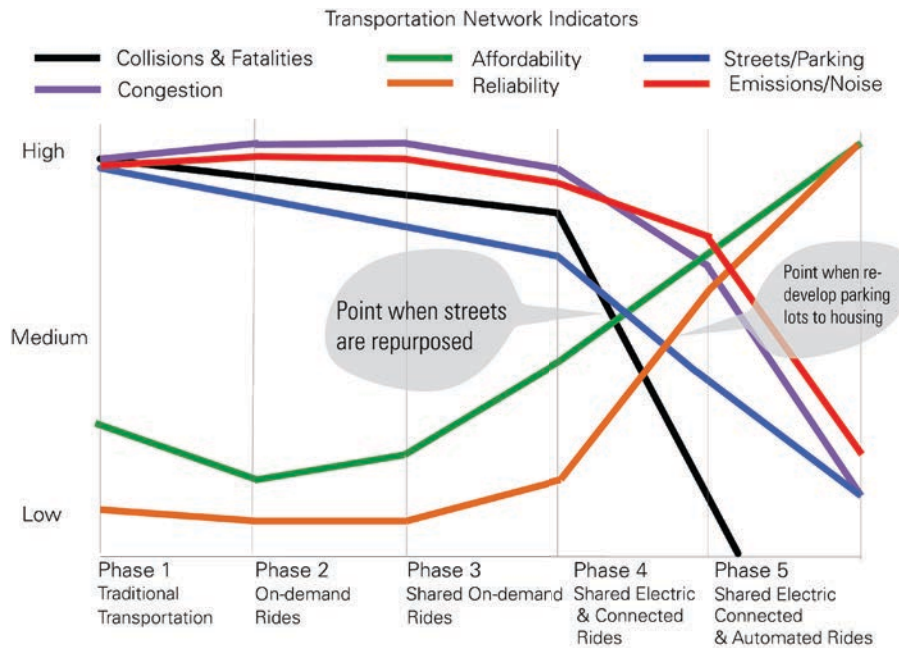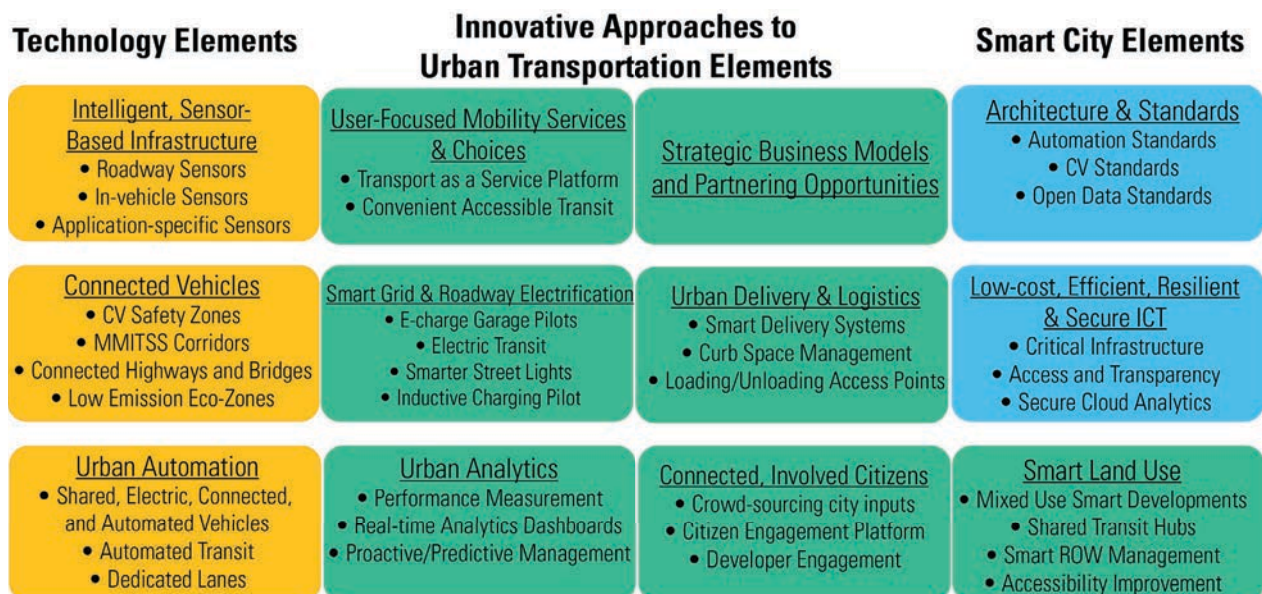

Figure 9. Potential Paths to SECAV

Figure 10. Holistic Approach to Implementing SECAV

TECHNOLOGY ELEMENTS

Vision Element #1: Urban Automation

The concept of SECAV aims at accelerating automated shared-use fleet deployment using a transitional path to encourage innovate and usage. The SECAV aims at minimizing single occupancy vehicles by providing convenient commute options to residents, workers and visitors. Autonomous Vehicles are happening now. "Easy Mile" buses are being deployed in San Ramon, California, all car manufacturers are developing and testing fully autonomous vehicles now, and many new cars have adaptive cruise control, self-parking and automatic lane control. San Francisco has 10 companies currently testing their technologies and they are looking to apply them to a specific urban environment to learn, test and improve. Provided below are some initial ideas for Urban Automation Implementation.

- **Automated Transit:** The City envisions that some of the controlled and guided type of transit fleet can be automated thereby enhancing safety and mobility. Light rail transit and streetcars that share the right of way with other vehicles would be good candidates for automation as they only need longitudinal guidance. Muni Metro light rail is automated underground-only below Market Street and through the Twin Peaks Tunnel. Increasing automation technologies over time could improve reliability on constrained rights-of-way.
- **Self-driving/Automated shuttles** operating at low speeds can address the first/last mile travel or fill gaps in particular neighborhoods that do not meet the high demand threshold for scheduled transit. These are also ideal for Priority Development Areas. The City's 50,000 daily visitors would receive an ideal opportunity to socialize with people from across the nation and the world to experience CAVs in major tourist areas and at special events.
- **Other Fleets:** The City's waste management and parking control are candidates for rising AV services. SFO Airport has an automated people mover and is one of the most extensive systems in the nation. AV ground transport for the airport has strong potential as does SECAV to and from the airport. SECAV ferry services are possible between Treasure Island and the Ferry Terminal and between new landings along San Francisco waterfront development areas.

Vision Element #2: Connected Vehicles (CV)

The City's CV goal goes beyond vehicles themselves and extends to connected infrastructure, vehicles, travelers, pedestrians and transportation applications. The City was also one of six initially selected for USDOT's Connected Vehicle Safety Pilot Driver Clinics. As a part of SECAV vision, the City will assay a portfolio of CV applications that address the City's mobility issues. Dedicated Short Range Communication (DSRC) Communication will be enabled to support applications that require high frequency Communication. Some initial CV applications considered include:

- **Connected Vehicle Safety Zones:** Specific locations in the city are prone to pedestrian, bicycle and vehicle collisions. The City has identified these locations that underlie the City's Vision Zero program. While the City works on improving the conditions in these areas through engineering countermeasures, the City will partner with companies (e.g., Waze and Zendrive) to provide alerts, re-routing and safe driving navigation to and from these areas. Applications for incident management such as Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE) and Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG) are also being considered.

- **Multi Modal Intelligent Traffic Signal System (MMITSS):** Some of the major corridors will be retrofitted with Intelligent Signal Controls that can communicate Signal Phasing and Timing (SPAT) information to vehicles to support applications such as Eco Approach and Eco Departure. The signals will also be designed and implemented to optimize green-time usage and minimize the stops using MMITSS applications that feature I-SIG and TSP. The City and its partners plans to add DSRC-equipped Road Side Equipment to several intersections including freeway access intersections.

- **Low Emission Eco-zones:** Geo-fenced eco-zones aim to reduce congestion and emissions by creating no-entry or limited entry zones of areas or roadways to avoid overuse of space and crowding. Eco-zone alerts will primarily reroute vehicles and traffic through areas that could potentially cause hazardous levels of emissions and high energy usage. The City will use AERIS concepts in developing and deploying these applications.

- **Eco-Approach and Departure Application:** reduce fuel consumption by providing eco-speed recommendations for vehicles approaching and departing intersections.

- **Pedestrian/Bike Safety Applications:** increase visibility and smart signals and sensors that can tell when people walking or cycling are approaching an intersection to warn people in vehicles.
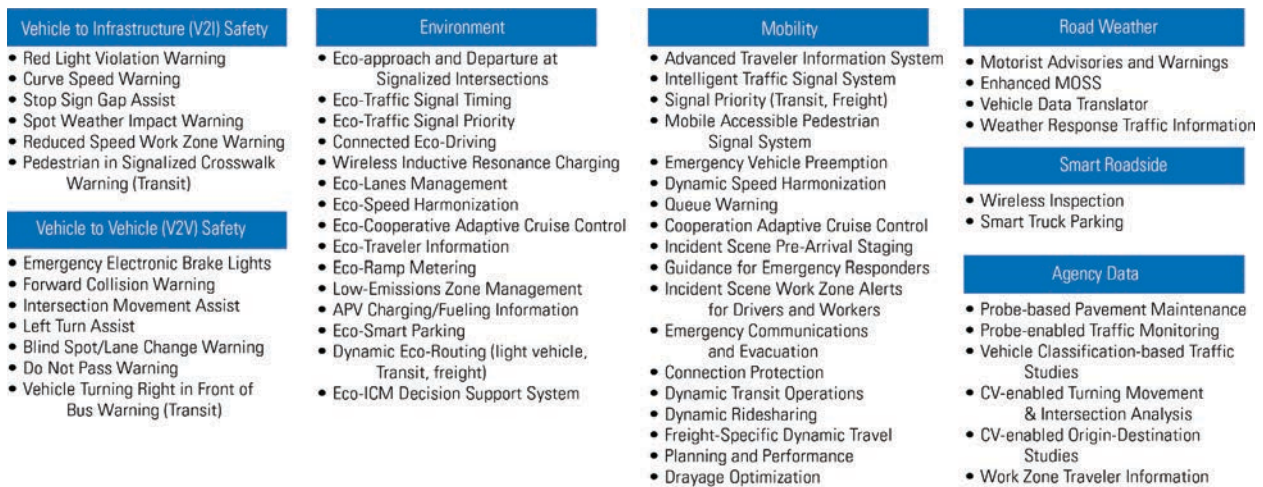

Figure 11. Connected Vehicle Elements

Vision Element #3: Intelligent, Sensor-Based Infrastructure

San Francisco uses a combination of conductive loops, magnetic sensors, radar, video cameras and overhead switches to collect data, detect vehicles, transit and bicycles. San Francisco has a Muni-wide high speed broadband wireless long-term evolution unlicensed spectrum (LTE-U) network that connects all of the intersections together so they can be remotely managed. These applications are supported today: (1) Transit Signal Priority for SFGo (2) Closed-Circuit Television (CCTV) Traffic Monitoring (3) Remote access to onboard Muni transit CCTV and audio. This same LTE-U network can support Wi-Fi service to Muni passengers as well as adjust signal timing. The City also has the first bicycle counters that collect bicycle trip data using loop detectors with data made available on SFMTA's website.

INNOVATIVE APPROACHES TO URBAN TRANSPORTATION ELEMENTS

Vision Element #4: Urban Analytics

With Urban Analytics being a key element of the Smart City, the open data portal will be opened to more real-time raw data from infrastructure elements such as roadside sensors, weather sensors, connected vehicle fleets so that the City can use the data in its performance assessment as well as operational decision making.

The City is an industry leader in using urban analytics to analyze data to address complex urban challenges, engage citizens and measure the performance of a transportation network. For example, SFMTA hosts a website **(https://www.sfmta. com/about-sfmta/reports/ performance-metrics)** that provides interactive performance dashboards that track the Agency's progress

Figure 12. Urban Analytics Framework

in meeting the goals and objectives outlined in the SFMTA's Strategic Plan. We envision creating a similar portal for the Smart City Challenge to track how the city is progressing towards meeting the SECAV vision. San Francisco's existing Open Data Policy will enable the developer community to localize innovative products such as cell-phone apps and information websites. Through urban analytics, the City intends to provide personalized travel recommendations while proactive management uses predictive analytics to predict the future state and make decisions to reduce negative impacts.

From a user perspective, the City will develop TaaP concept to integrate advanced analytics to its users in the form of personalized travel recommendations. The TaaP platform will support the TaaS in two ways by providing: (1) real-time decision support tools to the users in terms of routes, modes, and cost, and (2) personalized recommendations based on the user's location, selection history as well as other factors such as walkability, lighting score, crime rating, time of day.
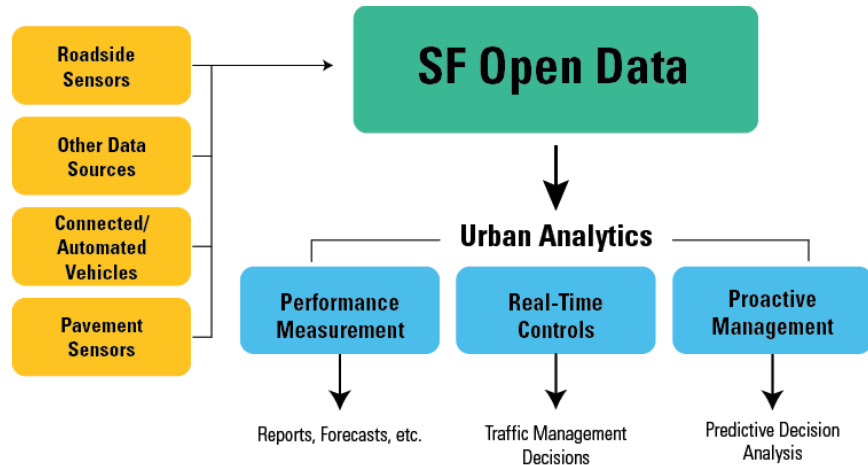
Vision Element #5: User-Focused Mobility Services and Choices

The focus on the customer shifting from the ownership model to the transportation-as-a-service model is a profound cultural change and calls into question how the current system of policy, regulation, provision and funding are able to meet this shifting trend. People are shifting their behavior from grabbing the car keys to summoning transportation from their smart phone. Balancing this demand and supply issue will provide a great opportunity to rethink our rights of way, reduce our parking supply and re-purpose newly realized excess capacity for things that are important to San Franciscans. The City is attuned to and working towards capturing this convergence into an iterative framework and governance.

Vision Element #6: Urban Delivery and Logistics

As a part of SECAV vision, the City aims to bring smarter logistics and freight delivery systems on line. This includes concepts such as Smart Delivery Systems, Curb-space Management, loading/unloading access points and better optimization, routing and navigation for freight vehicles. Ultimately, the applications and deployments will help the City grow by moving and delivering essential goods in a efficient way.

1. **Smart Delivery Systems** aim at optimizing delivery trips that are multi-point to reduce travel time, fuel consumption and labor. This is done by integrating delivery routing algorithms with real-time traffic feeds. The City will work with developing APIs (Application Program Interface) to promote use of these feeds among private delivery companies.

2. **Curb Space Management** aims at reserving curb-space at precise delivery times, thereby enhancing land utilization. Smarter space management would mean use of reservation-based systems to optimize loading-parking shared use.

3. **Loading and Unloading Access Points** will be managed in a smarter way so that it takes place at predefined locations at predefined times. This system will also integrate the greater traffic data systems such that dynamic change requests can be made based on congestion.

Vision Element #7: Strategic Business Models and Partnering Opportunities

Implementing SECAV vision requires strong partnerships. The San Francisco County Transportation Authority (SFCTA), the State-designated Congestion Management Agency, will provide regional coordination with our agency partners and provide technical support. Team partners are provided in Section 7. The City is partnering with City Innovate, a not-for-profit organization developing a civic innovation lab in the city. City Innovate acts as a convener between public and private parties to gain mutual understanding of each other's needs and to develop win-win solutions for the City.

Vision Element #8: Smart Grid, Roadway Electrification, and Electric Vehicles

California has a long history of promoting alternative fuel usage as well as stringent emissions and energy efficiency guidelines. San Francisco also strongly supports this vision with its Zero Emissions and EV policies. A key incentive for this is prioritizing parking spaces in structures for shared/pool users as well as charging stations with partners in buildings throughout the city. ChargePoint, the world's largest network of EV charging points, provides real-time occupancy information through its apps and website. The City intends to enable the expansion of the current network for many more charging units. Additionally, car manufacturers such as Tesla, Nissan, BMW and Toyota are looking into building a network of e-charge stations on shared mobility fleets where the vehicle ownership is shared by a network of users.

Vision Element #9: Connected, Involved Citizens

San Francisco is at the forefront of citizen involvement taking advantage of new technologies and social media. Residents use a suite of smartphone applications to use different services. For example, the SFGov Mobile app lets citizens know the latest city and county related news while applications such as SF311 call-in service, SFpark, and StreetLightsSF aim at citizen reporting and feedback on services. The City already has free Wi-Fi networks along Market Street, at its libraries, and in 33 public parks and spaces. The City is building its existing data sharing capabilities to engage citizens to get and understand the data as well as

allow them to use them in application development through open APIs for developers. As San Francisco continues down the smart city path, the current data hub will be opened to more sources that can provide raw, source-fed data.

SMART CITY ELEMENTS

Vision Element #10: Architecture and Standards

The City's connected vehicle aspects of SECAV implementation will follow Connected Vehicle Reference Implementation Architecture (CVRIA) standards developed using the Systems Engineering Tool for Intelligent Transportation (SET-IT) that is expressly dedicated to producing a CVRIA-based Concept of Operations. We will use the CVRIA architecture to design physical, enterprise, and communications views. Our team members are familiar with SET-IT tool that generates several "Layers" of these Views and comprehensive versions, or lower Layers. DataSF pioneered integrating open data standards in its data hub. For example, restaurant health scores are developed using "LIVES Standard" developed for Yelp, so that the scores can be integrated directly into the app. Similarly, the City will work on developing and implementing open data standards for various other aspects of transportation for AVs, e.g., ISO 26262 and SAE On Road Automated Vehicle Committee, to flesh out frameworks, guidelines, and certification procedures.

Vision Element #11: Low-Cost, Efficient, Secure, and Resilient Information and Communications Technology (ICT).

San Francisco just initiated a five year Information and Communication Technology Plan to develop a secure low-cost and efficient ICT to support citywide goals:

1. Support and Maintain a Secure Critical Infrastructure - The City's ICT infrastructure is the basic set of systems that supports government operations. Investments are continually needed to ensure that the City's critical infrastructure is appropriately secured and supported.

2. Increase Efficiency and Effectiveness – to prioritize investments that support a more efficient and effective government.

3. Improve Access and Transparency - prioritizes ICT projects that improve access to City services and help make government more transparent. We will continue to improve and make the ICT resilient in support of the SECAV implementation.

Vision Element #12: Smart Land Use

San Francisco has a long history of smart land-use owing to its geography, street grid, parking restrictive and transit supportive policies. For example, the City was one of the top 12 sustainable cities in the US (Moyers and Company, 2013). The number of jobs is projected to grow from 568,720 in 2010 to nearly 760,000 in 2040. 4,600 housing units are under construction, with more than 43,000 in the pipeline. (Section 8's Existing Infrastructure table contains related information.)
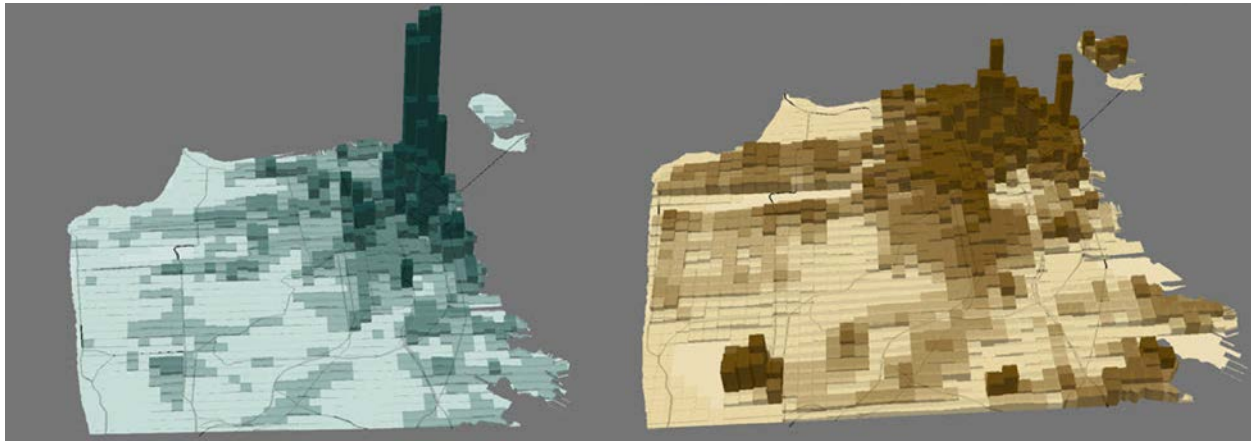

Figure 13. 2040 Jobs (left) and Housing (right) (SF Planning Department)

The City has designated growth in areas known as Priority Development Areas (PDAs) identified and approved for future growth. The City's development agreements have pioneered transit passes for new housing, shared mobility parking provisions, and contributed toward new infrastructure and rolling stock. In other words, the City has focused its energies on specific sites and surrounding neighborhoods that are good if not ideal candidates for the development of mobility innovation zones.

6. RISKS AND MITIGATION STRATEGY

The policy path to SECAV contains several layers converging and integrating to create a seamless door-to-door experience. These layers are:

- **Policy Layer:** Creates the framework to allow change to happen and grow over time
- **Social Layer:** Community adopts new service and tries it out and shares experience
- **Technology Layer:** New software that provides that layer of abstraction between user and the experience (no longer reaching for car keys, you tap your phone and access a ride separating the driving from the ride request)
- **Streets/Public Space Layer:** Streets are redesigned, and or repurposed to focus to increase people throughput, public space, traffic safety and/or active transportation.

San Francisco is well aware of the cultural and technological complexities of this effort and is committed to collaborate and work with our partners and stakeholders to solve each of these to work towards the path of an inclusive and livable city and region.

	Potential Risks	Mitigation
Community	Public opinion may not support technology and city streets to be used for deployment.	Community Engagement Plan work with community groups and District elected Board of Supervisors.
Technical	Passenger data from connected traveler and connected vehicles to be used for decision making and operations.	Work with federal government and companies to develop framework.
Policy	State operation policies for autonomous vehicles.	Work with state & federal partners to guide effort.
	Technical and policy issues related to cybersecurity and software bugs for connected and automated vehicles.	Work with policy makers to ensure policy requires addressing security.
	CV/AV for passenger and transit vehicles may have uncertain impacts on land use, either resulting in more sprawl or reinforcing compact growth patterns.	Create policy preference for shared model over the ownership model with incentives.
Institutional	Intergovernmental coordination to fully integrate technology at a local and then regional scale.	Continue building upon working relationships with local & regional partners.

7. PARTNERS AND KEY STAKEHOLDERS

San Francisco Municipal Transportation Agency (SFMTA) will lead the team and be responsible for legislation and governance process described below.

- **Legislation:** the implementation of changes to existing land uses will be led by SFMTA (for removal and reconfiguration of transportation features) in partnership with the Planning Department and Public Works.
- **Governance Process:** SFMTA's Office of Innovation will convene a Smart City Working Group led by the SFMTA. The agency is likely to foster partnerships with a lead Consultant and with City Innovate, a San Francisco-based non-profit entity. City Innovate is opening a civic innovation lab and will be organizing the public/private partnerships including private investment and data programs. The Smart City Working Group will meet to go over the three focus areas, TaaP, TaaS and Smart Streets. The City team will develop the policy, while the academic representatives (e.g., UC Berkeley's Transportation Sustainability Research Center) will provide research, and evaluation, and roadmaps to replicability.
- **Regional Partnership:** The Bay area is polycentric and city partnerships offer synergies that we feel would greatly leverage this grant opportunity. Working with MTC, the CAV research and development in Concord in the east bay, linked with the site testing in San Jose with the Silicon Valley partners, and then deployment in San Francisco then Oakland, San Jose and beyond creates a continuous cycle of innovation.

We have firm commitments from UC Berkeley's ITS teams, MIT's Media Lab and commitment in concept from our shared mobility and CAV/ICT providers as shown below. These partnerships will be codified upon being selected as a finalist. We will bring a "World-Class" team that includes innovators and globally recognized partners to support the deployment.

Building on Success: STIR (Startup in Residence) launched in 2014 with nearly 200 startups from 25 cities and countries applying to the program with six startups being selected. Each of the collaborations resulted in new products and services addressing real pain points. In March 2015, San Francisco was awarded a three-year, i6 innovation grant from the Department of Commerce to scale the program regionally. In January of 2016, San Francisco launched a multi-city collaborative with Oakland, San Leandro, and West Sacramento. The team will build upon these successes to create a replicable program.

SAN FRANCISCO SMART CITY CHALLENGE SECAV TEAM **SFMTA OFFICE OF INNOVATION: PROGRAM LEAD** SFPUC Lighting: Smart Lights & Utilities lead Mayor's Office: Transportation Policy & Civic Innovation Offices Metropolitan Transportation Commission (MTC): Regional Connected Vehicle Coordination SFCTA: Technical Support and Treasure Island Mobility Management Association Coordination Consultant: Project Management				
Agency Partners	**Community & Business Partners**	**Research & Data**	**Shared Mobility Providers**	**Connected & Automated Vehicle**
City Departments Regional Transit Operators Bay Area Rapid Transit District Caltrans Metropolitan Transportation Commission (Bay Area Metropolitan Planning Organization)	**Community Engagement:** Community Partners through the Community Mobility Challenge City Innovate (Public-Private Partnerships), TaaS Pilots, Smart City Infrastructure	ITS UC Berkeley, PATH: Partners for Advanced Transportation, Technology Transportation Sustainability & Research Center, MIT Media Lab Waze, Zen Drive	**Carshare:** Zipcar & Carma (City Carshare) **Bikeshare:** Motivate Bay Area Bikeshare **Transportation Network Companies:** Uber, Lyft, Shuddle **Scootershare:** Scoot **Pooling:** Carma **e-Hail Taxi:** Flywheel **Microtransit:** Chariot	**CAVs:** Adelphi, BMW, GoogleX, Zoox, Cruise, GM, Ford, Tesla. **ICT:** Systems Integrated, Bosch, Siemens, Technology

8. EXISTING INFRASTRUCTURE

Community	Infrastructure	Shared Mobility Services
2010 Population: 805,235 **2010 Density**: 17,180/sq mile **2010 Employment:** 586,720 **2040 Population:** 1,085,641 **2040 Density:** 23,163/sq mile **2040 Employment:** 759,470 Source: Plan Bay Area (2013 MTC)	**Arterial Miles:** 1029 (includes unaccepted mileage: park (65), military (12), and private (6) **Freeway Miles:** 59 **Transit Services** Local Transit Service: Muni (SFMTA) • Bus: 59 lines • Trolley Bus: 17 lines • Streetcar: 2 Lines • Light Rail: 5 Lines • Cable Car: 2 Lines Regional Transit Service: • Bus Lines: AC Transit, Golden Gate, SamTrans • Heavy Rail: BART • Commuter Rail: Caltrain • Ferry: Golden Gate, WETA	**Carshare:** • Zipcar • Enterprise • City CarShare **Scootershare:** Scoot **Bikeshare:** Bay Area BikeShare 350 bikes expanding to 4,000 in SF 7,000 in Bay Area **Micro Transit:** Chariot **Carpool:** • Carma • Ridewith • Uberpool • Lyftline, • Shuddle **Taxi:** • Flywheel • City Taxis

9. DATA COLLECTION

The City's data infrastructure is ready to support SECAV deployment. A suite of sensors currently provide real-time information to several sub-systems including the California's Performance Measurement System (PeMS) and Bay Area 511. The City intends to expand its current sensor deployments to more roadways citywide. San Francisco recently announced creating a large Internet-of-Things platform that aims at bringing in data from a variety of urban sensors including energy and transportation sensors to the open data platform. We will build off this initiative for the Smart City Challenge. DataSF will eventually be an integrated data clearing house that serves as:

1. A one-stop place where all the data is accessible to users without registration and in a machine readable format.

2. A developer portal that provides real-time, queryable methods to build applications. Rather than providing CSV or other "log" format data, the system will also expand the scope of analytic tools to anything that the developer community can think of.

3. A portal for assessment and evaluation logs for interested citizens to conduct independent analyses.

The open data hub will contain only data devoid of any personally identifiable information. The data hub will also only hold aggregate data from certain sensors to improve privacy and security. For example information logs and will be provided in the Open Data Hub.

City Data Informs Transportation Operations: Land use, development, demographics, economic development			
Public Safety	**Human Services**	**Transit**	**Public Works**
Vision Zero High Injury Network Transbase Public Health Database	SF General Data SFPD Collisions Data	GTFS Routing Passenger Counts Transit Signal Priority **Waze Traffic Data** Routing of Services	Pavement Database Construction Updates Street Closures
Transportation Data Integrates with City Data: SFpark parking management system (including meters and parking garages), transit fare systems, transit passenger counting, bicycle and traffic counters, incident management and a variety of GPS vehicle tracking including transit vehicles, non-revenue vehicles, taxis, and commuter shuttles.			

The SFMTA collects a multi-modal data set to create a total picture of travel with the city's right-of-way, including transit and parking demand, vehicle velocity, and multi-mode travel origin and destinations, as well as safety measures including collision analysis. These datasets form the basis of a citywide and public **sharing data network including partnerships with the Mayors Office of Civic Innovation's public data sharing** platform and the Department of Public Health's TransBase system, which offers analysis of health and safety impacts of transportation in an open geospatial data portal.

An integrated intelligent transportation system (ITS) could improve transit and traffic operations through real-time dynamic scheduling and real-time incident routing. The data system and platforms can leverage and further the goals of the SFMTA's Transportation Management Center, a state of the art facility poised for dynamic monitoring and management of the transportation network. The SFpark program's public data sets and evaluation forms a template for the way Municipal data can further academic research and

empower development of private sector applications. The program followed the City's lead as one of the first to pass an open data law, which continues to serve both academic research and the City as a hotbed of civic innovation. An ITS program will follow these leads in open data to further the goals of the city and help create innovative solutions for our transportation system.

10. STANDARDS/ARCHITECTURES

The City's current ITS infrastructure relies on Caltrans and Bay Area Regional ITS Architecture (BARA) and Standards which are based off of National ITS Architecture 7.1. The BARA standards combine some of the best state-of-the-practice standards to achieve seamless interoperability for multiple agencies contributing to the region's ITS infrastructure including Bay Area Rapid Transit (BART), Caltrans, San Francisco, Golden Gate Bridge Highway and Transportation District, among others. These will be expanded to include the Connected Vehicle implementation standards based off of CVRIA, which is currently the most comprehensive system architecture repository for Connected Vehicle Applications.

Regional Standards

- Toll and Roadway Administration
- Commercial Vehicle & Transit Vehicles
- Emergency Vehicle & Management
- Parking, Roadway, Traffic Management
- Data Management & Information Service
- Maintenance and Fleet
- Smart Card and Mobile Payment Integration

Architecture Layers

- Communications
- Transportation
- Institutional

Figure 14. Architecture Layers and Standards

In addition, the City will follow Open Standards in implementing Open Data repository and developer API standards. All the new architecture and standards would be communicated to the USDOT and the user community to act as an enabler for future deployments. For example, the City will use new architecture and standards in three key areas such as:

1. **Infrastructure and Sensor Deployment:** Most of this is covered under the ITS Architecture 7.1 and would be used for new deployments. Any changes or new developments will be documented. Additionally, SAE standards such as J3016 could help vehicle-based architecture development.

2. **Communication and Data Exchange:** IEEE 1609 (WAVE), 802.11 (IT), SAE J2735 (DSRC), etc., form key standards for Communication and data exchange. Additionally, open data standards have been developed over decades to be used in developing secure, open data sharing means.

3. **Application Deployment and Data Usage:** Most of the application deployment standards for Connected Vehicles have been scoped under CVRIA. Additional standards as well as automated vehicle standards will be scoped from corresponding SAE documents. Additional standards would also be developed for new deployments to serve as a platform to support future deployments in similar cities.

11. PERFORMANCE MEASURES

The City will build upon its data driven approach guided by key performance measures to demonstrate the outcomes and benefits of the "Smart City" deployment. Some initial performance measures to collect include: Number of collisions, fatalities, tail-pipe emissions (GHG/NOx/SOx), waste and noise, mode shift, travel behavior (# trips, trip length, time of day), HOV adoption, SECAV adoption, fleet conversion turnover, parking usage, travel speeds, vehicle occupancy, collisions, costs per trip, average trip and length.

Goals	Safety	Accessibility	Affordability	Availability	Interoperability	Sustainability
Objectives	Vision Zero	Universal Design CAVs	All income groups	All neighborhoods	Physical modal integration	0 Emissions, 0 Noise
	Safe Vehicles	Equal Access options	Small Businesses	Small businesses	Virtual modal integration	60% mode share
	Safe Drivers	Travel time reliability	Visitors	Ubiquitous connectivity	Payment integration	Carbon neutral electrification

12. ABILITY TO PERFORM AND DELIVER

The City has a strong track record to deliver innovative and high profile projects that have improved the lives of so many people in San Francisco and added to the body of knowledge for our peer cities. The City is at the leading edge of the sharing economy that began here. Thanks to our shared mobility partners, we have crossed over the cultural trust barrier of getting into a shared ride with a stranger. We will now embark this similar effort by linking all the modes together to work as one transportation system and test people's willingness and openness to use CAVs.

The most notable project with a similar flavor and scale was the SFpark pilot program. By all accounts the project has been deemed a success. The pilot changed many things about how we manage, operate and provide parking including:

- Travel behavior, improved parking accessibly, reduced circling and time to park
- Reduced vehicle miles traveled and GHGs by 30%
- Changed SFMTA's own view on parking from limited access to customer focused
- Real time parking availability, parking demand management through pricing
- Payment by mobile phone and credit card and a back-end data warehouse

The following milestones and tasks for this program include:

Milestone	Tasks
Community Design Challenge	Launch crowdsourcing platform, select locations, develop policy guidelines, create pilot tests, and provide evaluations, update City dashboard.
Transport as a Platform	Adopt guidelines, formalize working group, engage providers to reach inclusion targets, augment data partnership program with UC Berkeley to verify data.
Transport as a Service	Develop architecture for data commons, incorporate GTFSSum, develop integration platform, incorporate providers, integrate routing, booking and payment APIs, launch pilot incorporate retailers to create rewards/incentives. Initiate late-night pilot, evaluate pilots.
Smart Streets	Create guidelines for design of streets, develop thresholds for repurposing street space & parking, work with SFpark 2.0 team, develop key ITS infrastructure architecture with SFMTA/SFPUC team, pilot city street carpool lanes and curbspace for high occupancy pooling/shared mobility, launch test of CAVs on key routes.

13. OPPORTUNITIES TO LEVERAGE FEDERAL RESOURCES

The SFMTA anticipates a broad portfolio of bond and grants revenues worth $2.8 billion dedicated to sustaining and expanding its entire transportation network: transit and accessible transit services, pedestrian and bicycle improvements, signals, parking infrastructure. Using these funds we have partnered often and effectively with public and private entities to achieve the Agency's Strategic Plan goals. With regard to DOT, two recent examples of SFMTA's partnering are worth highlighting:

- TIGER Grant for Mission Bay: the SFMTA's partnering with FOCIL, a private entity, to finish street and transit elements in this now-burgeoning part of San Francisco. The $10 million award is being used to complete a new street grid and a rail turnaround loop to support short-turn light rail service for SFMTA.
- Value Pilot Pricing Program grant for Linked Priced Electric Bikesharing ("e-Bike") for $1,504,221. This innovative project is a partnership between SFMTA, City CarShare of San Francisco and UC Berkeley's Transportation Sustainability Research Center. Funds will be used to buy electric bicycles and storage pods (City CarShare), and their usage, distribution and impacts will be monitored and analyzed by the TSRC.

Similarly, but on a larger scale, the federal funds that SFMTA is poised to receive from the Smart City Challenge will leverage other complementary and enhancing investments with an array of potential partners - please see numerous letters of support. Relationships with partners will be codified during the development of the full grant application, and will be memorialized and made compliant with DOT provisions upon grant award. A number of vendors and consultants are quite aware of SFMTA's work thus far and we are confident that a strong and compelling grant application will materialize as a result.

Most recently, the City voted for a $500 million streets bond, and change to a funding formula for transportation based on population, approved a $2.4 billion budget to improve transportation citywide, and the SFMTA's credit rating of AA and Aa2 are the highest ratings for a transit agency in the nation.

Concluding Statement:

We are at the dawn of the internet of services for transportation in connecting everything to everything and everyone to everyone. Transportation is just seeing the beginning of massive changes ahead with the recent introduction of on-demand transportation. TNC companies and demand responsive micro-transit van services fit a niche between passenger vehicles and larger capacity public transit but also raise questions about governance, equity, emissions, and accessibility. The City is the hub and home to more shared mobility and technology companies representing the sharing economy, connected and automated vehicle space than anywhere else on the planet. It is deeply committed to move this discussion forward with community-supported and mutually agreed upon actionable deliverables. The City of San Francisco greatly appreciates this opportunity and looks forward to your response in the coming month.