## Title
California Statewide Transit Strategic Plan: Recommendations Report



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STATEWIDE TRANSIT STRATEGIC PLAN

# Recommendations Report

*Final Report from*

UCLA ITS INSTITUTE OF TRANSPORTATION STUDIES

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# STSP Recommendations Report

## Caltrans Division of Rail and Mass Transportation Team

Joshua Pulverman
Jila Priebe (ret.)

The vision of the Caltrans' Division of Rail and Mass Transportation is to make public transportation a viable option for all. Our mission is to provide measurable improvements to California's integrated and sustainable public transportation system.

Contract #74A0884

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The UCLA Institute of Transportation Studies is a community of scholars studying transportation finance, public transit, and innovative mobility.

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## Abbreviations and Acronyms

| | |
|---|---|
| **AB** | Assembly Bill |
| **AHSC** | Affordable Housing and Sustainable Communities Program |
| **APTA** | American Public Transportation Association |
| **APTA-TCIP** | APTA Transit Communications Interface Profiles |
| **ATP** | Active Transportation Program |
| **BRT** | Bus rapid transit |
| **CalACT** | California Association for Coordinated Transportation |
| **CalSTA** | California State Transportation Agency |
| **Caltrans** | California Department of Transportation |
| **COA** | Comprehensive Operational Analysis |
| **CTC** | County Transportation Commission |
| **CTP** | California Transportation Plan |
| **FTA** | Federal Transit Administration |
| **FTP** | File transfer protocol |
| **GHG** | Greenhouse Gas |
| **GTFS** | General Transit Feed Specification |
| **GTFS-RT** | GTFS Real Time |
| **HOT** | High-occupancy toll |
| **HOV** | High Occupancy Vehicle |
| **HQTA** | High Quality Transit Area |
| **HSR** | High-speed rail |
| **ISO** | International Organization for Standardization |
| **ITS** | Intelligent Transportation Systems or Institute of Transportation Studies |
| **LCTOP** | Low Carbon Transit Operations Program |
| **LIDAR** | Light Detection and Ranging |
| **LRT** | Light rail transit |
| **MAP-21** | Moving Ahead for Progress in the 21st Century Federal Transportation Authorization |
| **MPO** | Metropolitan Planning Organization |

| | |
|---|---|
| **NACTO** | National Association of City Transportation Officials |
| **PMT** | Passenger miles traveled |
| **PUC** | Public Utilities Code |
| **RFP** | Request for proposals |
| **RMRA** | Road Maintenance and Rehabilitation Account |
| **RTP** | Regional Transportation Plan |
| **RTPA** | Regional Transportation Planning Agency |
| **SB** | Senate Bill |
| **SFMTA** | San Francisco Municipal Transportation Agency |
| **SGC** | Strategic Growth Council |
| **SMF** | Smart Mobility Framework |
| **SOV** | Single occupant vehicle |
| **SRTP** | Short Range Transit Plan |
| **STSP** | Statewide Transit Strategic Plan |
| **TIRCP** | Transit and Intercity Rail Capital Program |
| **TNC** | Transportation Network Company |
| **UPT** | Unlinked passenger trips (boardings) |
| **V2I** | vehicle-to-infrastructure |
| **V2V** | vehicle-to vehicle |
| **VMT** | Vehicle miles traveled |
| **VRM** | Vehicle revenue miles |

# Executive Summary

## Moving California

In the coming decades, California can become a national leader in mass transit. Just as the state's sprawling freeway network became a national symbol of freedom and mobility in the 20th century, so too can a robust, seamless, and comprehensive mass transit system become the State's fulfillment of a new, 21st century vision: enabling freedom and mobility, while improving sustainability, environmental protection, and social equity as well.

California has a uniquely favorable policy environment for the growth of public transit. The state's economy is the world's sixth-largest, and is expected to continue to grow along with its population. Caltrans' 2010 Smart Mobility Framework, the California Transportation Plan 2040, and other State policy documents have already underscored the importance of public transit in accommodating this growth without exacerbating pollution and congestion. Voters across the state have repeatedly shown their willingness to tax themselves for new transit infrastructure. Since 2006, California has committed itself to one of the world's most aggressive plans for greenhouse-gas emissions reductions. Finally, the State of California and a growing number of its local governments are seeking to add higher-density infill housing to address the state's affordable-housing crisis; in order for these neighborhoods to thrive, high-quality transit will be needed to connect residents to jobs and other destinations.

As one of the six modal plans mandated by the California Transportation Plan 2040, the Statewide Transit Strategic Plan (STSP) should give Caltrans, CalSTA, and other public agencies the tools, best practices, and data and identify the authority that they need to offer seamless public mobility, better coordinate with each other, and meet the State's public-interest shared mobility needs. In 2016, Caltrans engaged the UCLA Institute of Transportation Studies to support in the creation of the STSP, and this report contains UCLA ITS' recommendations to Caltrans and other major stakeholders regarding what the adopted Plan should address and include. Specifically, UCLA ITS recommends structuring the final STSP around four central goals for transit:

1. Effective, high-quality transit is integral to transforming California into a more thriving, just, and sustainable place.
2. A California transit passenger's multimodal experience should be seamless, safe, and affordable.

3. Transit agencies must become more innovative and agile to vigorously pursue their missions.
4. Use strategic investments to make transit more sustainable and resilient.

The STSP comes at a critical moment: Despite state-level targets and policies designed to increase transit ridership as part of California's climate-change solutions, transit ridership across the state has been in decline since 2014. Reversing this trend will require an innovative, resourceful, and comprehensive approach implemented by transit agencies, partner governments, transportation stakeholders, and statewide regulators and legislators.

## A New Vision for Transit

UCLA ITS recommends that California adopt a clear, compelling vision for the future of transit:


Such a vision sets the stage for future action and points to possibilities for a more central role for transit in the Golden State. The focus should not be on what transit is doing now — rather it should be on what transit can accomplish for California in the years ahead.

The above Vision Statement is rooted in a core set of values: Transit should be affordable, equitable, healthful, sustainable, and user-oriented.

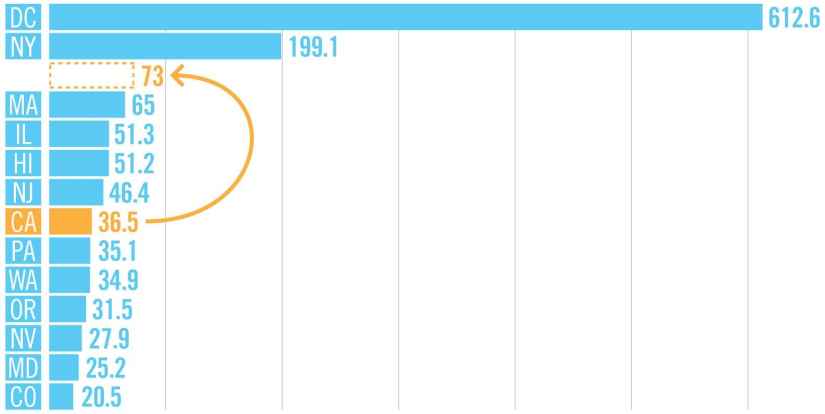
| | |
|---|---|
| **Affordable** | Transit fares are structured so as not to make riding transit burdensome for essential trips, while also providing for the most effective and efficient use of subsidies. |
| **Equitable** | The transportation system is a tool of empowerment for marginalized groups, and an enabler of opportunities for |

| | |
|---|---|
| | Californians. The public transit system is developed with public input for the benefit of all types of travelers, and with particular consideration for populations and areas with greatest mobility needs. Where transit operates, it is available and accessible to all people. |
| **Healthful** | Public transit systems, and the larger transportation systems within which they operate, are built, operated, and improved in conjunction with the development of land-efficient land uses that enable community well-being, economic security, and climate adaptation. |
| **Sustainable** | Transit supports state and local climate, environmental, and environmental-justice goals. |
| **User-Oriented** | Transit is frequent, safe, reliable, and easy to use for riders. Services are designed to be an attractive alternative to car travel, not simply a "last resort" for people who cannot rely on anything else. |

In pursuit of this vision, public transit must be successful in delivering its core competencies: 1) Providing public mobility for those with limited access to private mobility, such as the poor and those unable to drive, and 2) Enabling dense, highly productive urban districts to exist and thrive. The more transit becomes a viable option for people, and the more integral it becomes to everyday life in California, the greater its benefits will accrue to the entire population — even those who don't use it.

**Recommended Statewide Ridership Goal**

**Double the statewide number of transit boardings per-capita between 2015 and 2030.** Achieving this would put California's per-capita transit ridership third among all U.S. states and districts.



## What Public Transit Is, and What It Does

Because rapid changes in technology and transportation are blurring the line between public and private mobility, it is important to define what transit currently is and will be in the future as a prerequisite for planning. This plan defines "public transit" as "publicly-operated or subsidized shared-mobility services with the capacity to carry multiple passengers per vehicle," and "transit agencies" as the public entities that provide, organize, or subsidize these services. Unlike private providers of mobility services, transit agencies have the responsibility to operate in the public interest. This means they must fulfill important social-service goals such as guaranteeing service to targeted populations with limited mobility, including the elderly and disabled. The state also grants transit agencies authority not granted to private mobility providers, including the right to run service on highway shoulders and/or in restricted surface-street lanes, operate large vehicles, designate certain street locations as bus stops, and levy special transit district taxes.

Many of the factors that affect transit's performance are outside agencies' authority or operational control. Transit providers can decide what routes they run, the general locations of stops and stations, the frequency of service, forms of payment, and the availability of real-time trip data for passengers — and this report contains recommendations for improving all of these core functions. However, agencies have limited to no control over several crucial factors influencing transit ridership, including the out-of-vehicle passenger experience, travel times on mixed-traffic streets, the number of homes and jobs near transit, and the cost of and limitations on solo driving and parking. Thus, high-quality service is a necessary but not sufficient condition of increasing transit ridership. In order to reverse the current trend of declining ridership and realize the State's ambitions for public transit, *transformative changes* will be needed to the context of mobility in California.

## Transformative Changes for California

Many of the factors that inhibit transit's success in California require contextual, long-term solutions — transformative changes that multiple stakeholders and government agencies will have to make together. The recommendations in the "Transformative Change" chapter of this report represent best practices, but require buy-in from multiple agencies and stakeholders.

## Motor Vehicle Pricing

It will not be possible to achieve ambitious state goals to dramatically increase transit use without better managing private vehicle travel. Managing our road system by pricing motor vehicle use to reflect the marginal social costs of driving can make California's street and road system work much better, by making traffic more free-flowing, reducing emissions, and decreasing road damage. In addition to these benefits, managing roads through prices makes active and shared modes relatively more attractive, and can generate revenues to improve them and roadway infrastructure in the process. Evidence also indicates that better management of roads through motor vehicle pricing can help transit vehicles move more quickly and reliably, resulting in a positive ridership feedback loop. A statewide road-pricing system should meet some or all of the following goals:

- Remove transit vehicles from traffic congestion, thus increasing their speed and reliability.
- Increase the attractiveness of transit relative to private vehicles.
- Be technically feasible for widespread implementation.
- Be equitable for rural areas, which typically lack meaningful transit alternatives and whose residents typically drive longer distances to reach their destinations.

The three road pricing mechanisms that best meet these criteria are expanded Express Lanes, all-lane highway tolling, and cordon-area tolling.

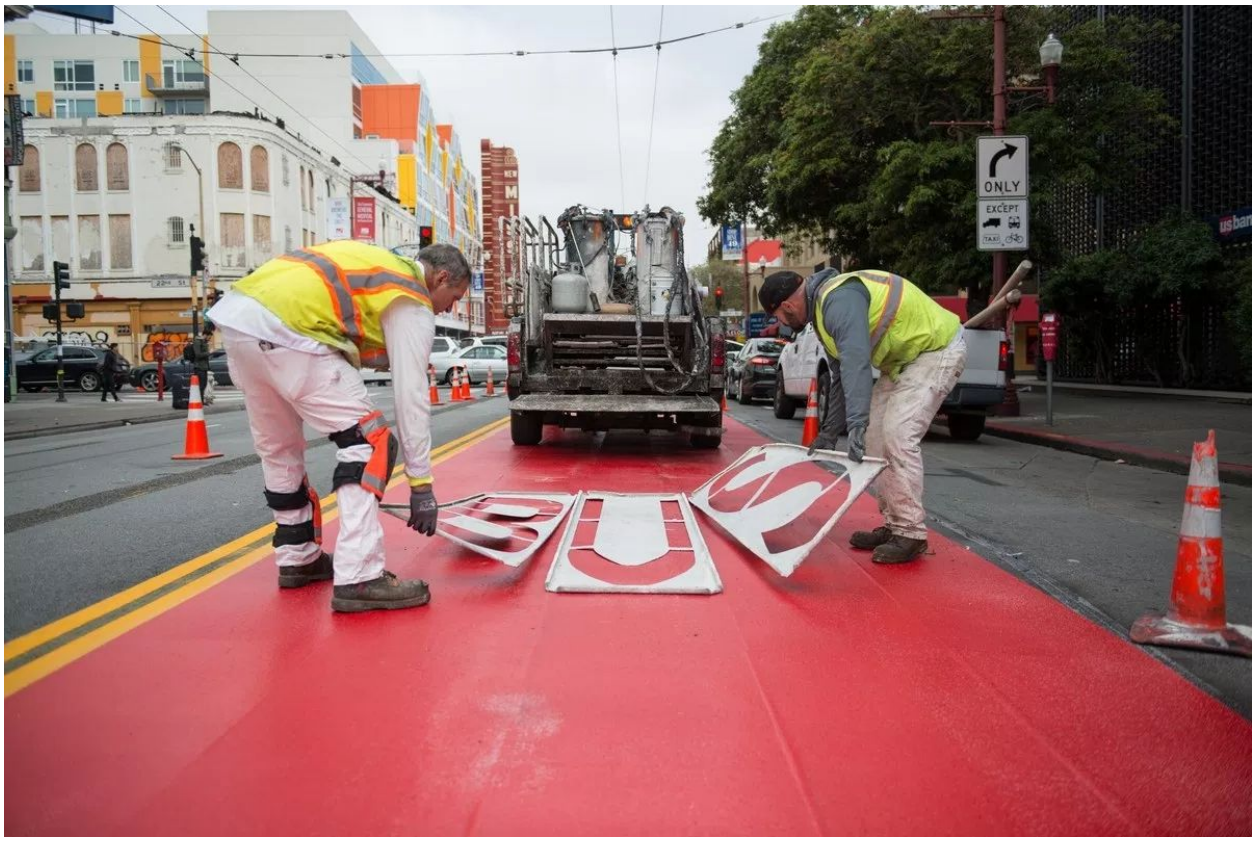

With respect to public transit, **expanded Express Lanes** would speed up important commuter-oriented transit services that operate on freeways, but do little to improve the

functioning of transit that operates on surface streets. All-lanes **highway congestion tolling**, which would take either the form of periodic electronic toll collection or distance-based tolling, could be designed in such a way that toll prices are adjusted in real-time to achieve a targeted free-flow traffic speed. In areas of the state where surface streets are the most congested, **cordon tolling** would price all roadways within a set geographic area, charging drivers to enter and/or exit that area in exchange for free-flow travel. Evidence from cities such as London, Stockholm, and Singapore has shown that cordon tolling in central areas has reduced traffic delays and increased flow, increased the number of people walking and biking, and substantially improved transit performance in terms of speed, reliability, and operating cost. Therefore, UCLA ITS recommends that the state promote cordon tolling in selected high-density areas to manage congested roadway networks, improve transit service, and increase transit ridership. The state should help to mitigate any potential regressive impacts of an automobile-pricing program by requiring revenues from pricing to be directed toward transit and other forms of transportation disproportionately used by low-income people, or to low-income travelers themselves.

## Transit First

Through the use of "Transit First" policies that encourage or even require local governments to prioritize transit service over the needs of private automobiles, cities like San Francisco and El Cerrito have been able to successfully promote the use of transit in places where transit has the greatest potential and private vehicles impose the greatest negative externalities. Adopting Transit First policies on a statewide level would simultaneously improve the quality of public transit in urban areas and reduce the relative attractiveness of driving. Examples of statewide Transit First policies could include:

- Funding incentives and other support for multimodal street planning, with exclusive and/or separated rights-of-way for transit vehicles and ample, safe, and quality mobility opportunities for pedestrians and cyclists, including those connecting with transit
- Requiring local governments to produce explanatory findings any time a roadway project in a Transit Priority Area does not adhere to National Association of City Transportation Officials (NACTO) design guidelines
- Converting mixed-flow lanes on major transit corridors into transit-only lanes
- Partnering with the California Office of Traffic Safety to promote and enforce laws that support pedestrian connections to transit
- Allowing transit agencies to enforce transit-only lanes and impose citations on motor-vehicle operators who violate them




## Land Use

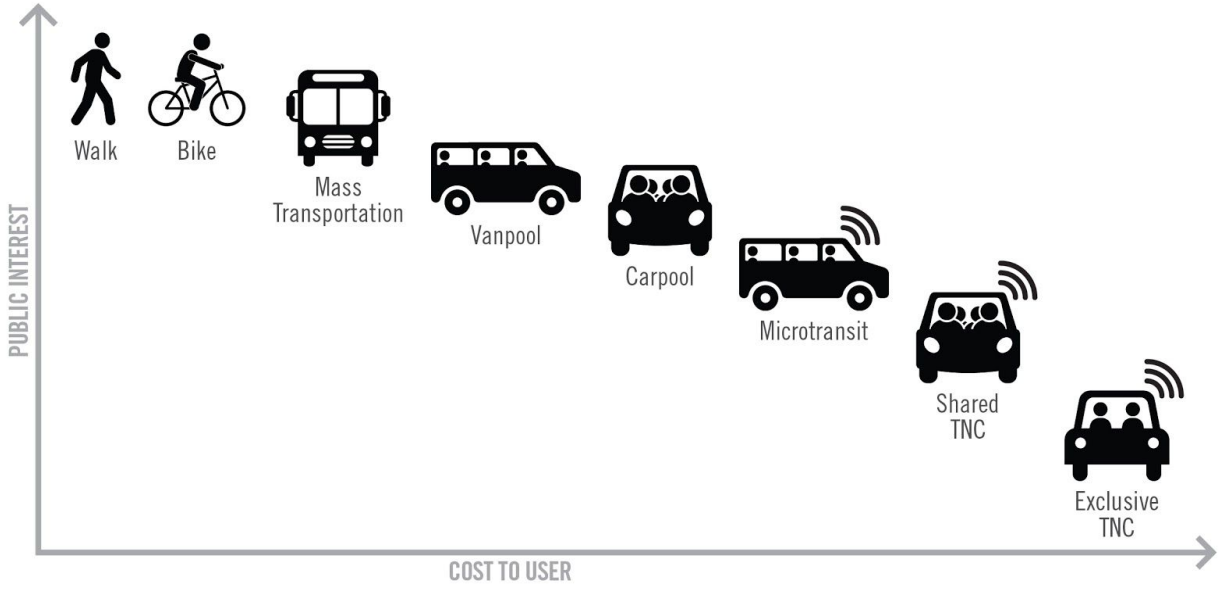
While most transit agencies cannot effect changes to land use, there is no doubt that land use policy is a crucial component of transit's success. Continued sprawl will increase transportation costs and emissions, and shift growing numbers of Californians to areas where alternatives to driving are few and transit is neither cost-effective nor convenient. Land-use policy is mostly set at the local level, though some recent housing laws passed during the 2017 legislative session promise to strengthen the state's oversight role. Thus, transit agencies should collaborate more regularly with local officials to promulgate transit-supportive land use policies and plans in their jurisdictions.[1]

## A New Operating Paradigm

For decades, most transit agencies have functioned as service providers. The UCLA ITS STSP Report recommends that they take on a broader role: that of a *mobility manager*. The American Public Transportation Association (APTA) defines mobility management for mass

[1] These policies vary widely depending on geographic context, as laid out in the Future Visions chapter of the STSP.

transportation as "a strategic approach to service coordination and customer service" that "will move transit agencies away from their roles as fixed-route service operators, and toward collaboration with other transportation providers."[2] Rather than a handful of discrete routes operated by a few agencies, a shift to managing for mobility will help to create a seamless, synchronized network that provides for whatever shared mobility needs riders may have. Agencies in this model shift their focus from operating transit vehicles to facilitating trips that are low-impact to both the public and low-cost to the user. For example, in rural areas, the development of a nonprofit, Transportation Network Company (TNC)-style mode may help agencies to more efficiently provide rural residents with the shared mobility they need to reach medical appointments, social-service agencies, courts, and grocery stores.




## Fare Reform

Transit fares contribute importantly to covering the costs of service provision and convey a sense of value to the purchaser. They can also be used to effectively manage transit system capacity. But fare policies also tend to vary widely from system to system, are often confusing to travelers, and can be expensive and cumbersome to collect. Currently, most transit fares are flat, meaning the passenger pays the same amount no matter when, where, or on which mode they travel. On many systems, revenues from fares cover a relatively small share of agencies' operating costs. Further, because fares do not typically vary to reflect the costs of providing

[2] American Public Transportation Association. (n.d.). *Mobility Management* . Retrieved from: http://www.apta.com/resources/mobility/Pages/default.aspx

service (for example, longer trips cost more to service than short trips), flat fares prevent systems from engaging in “yield management,” whereby fares vary to encourage more riders when excess capacity is available (such as during off-peak periods). Given this, fare reform is important to increasing transit ridership. Historically, limits in fare-collection systems prevented fares structures from being better designed, but technology has opened up new avenues for coordinated, smart fare systems.

Generally speaking, transit fares should be as low as possible for those who rely on transit service, and for so-called 'choice riders' they should present an attractive alternative to the cost of driving. Fares could even be free where possible (as suggested in California Transportation Plan 2040), particularly where the cost of fare collection is high relative to the amount of revenue collected. By rescinding a 20% minimum farebox-recovery requirement in the state’s Transportation Development Act, the state would allow agencies leeway to experiment with new fare rules and new types of passes. Where appropriate, charging passengers the marginal cost of their trip would encourage them to travel when the cost of providing service is lowest to the agency (i.e., at off-peak times, in off-peak directions, and where transit demand is already dense).

## Making Transit Excellent

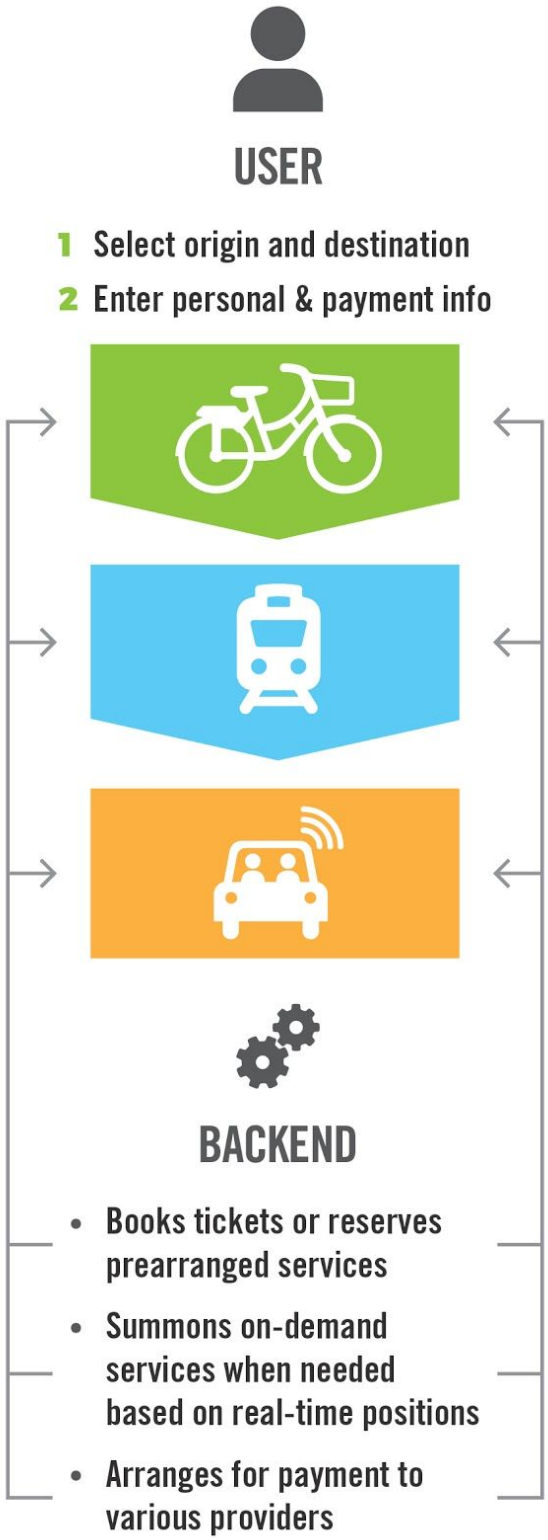

The “Making Transit Excellent” chapter of the STSP Report presents a variety of recommendations to help Caltrans and other public agencies provide the best possible service they can, given their particular operating context. Even if many of the dramatic policy changes described in the “Transforming California” chapter do not come to fruition, Caltrans still has an essential role to play in helping statewide stakeholders share knowledge and best practices. “Making Transit Excellent” highlights what can be done in the near future at multiple levels of government.

## Develop a Statewide Ticketing and Accounts System

The advent of statewide high-speed rail provides an opening to integrate all transit fare-payment media throughout the state. To manage individual payments and eligibility for certain transit discounts, as well as to distribute payment to actual transit providers, a **statewide accounts system** will eliminate the barriers from proprietary payment technology and make all major types of fare media interoperable. Concomitantly, a **statewide ticketing system** will allow passengers to book multi-leg, multi-provider trips at a single source, on a single ticket. A central server will coordinate information from transit providers across California to book multimodal trips.


Integrated Mobility Services Today

Integrated Mobility Services with Statewide Ticketing and Accounts




## Require Agencies to Complete Regional Comprehensive Operational Analyses

A Comprehensive Operational Analysis (COA) is a data-driven approach to reconfiguring a transit network in response to changes in ridership, urban and regional form, and other operating conditions. Completing a COA allows transit agencies to respond to new conditions in a systematic, proactive manner instead of incremental reaction to isolated factors. Regional COAs would allow local agencies to work together to set targets for transit ridership, find out where service is lacking and/or oversupplied, and plan service in the most equitable and cost-effective ways possible. They would be powered by a **Statewide Transit Data Warehouse** and advanced analytical tools.

## Apply New Approaches to Rural and Intercity Mobility

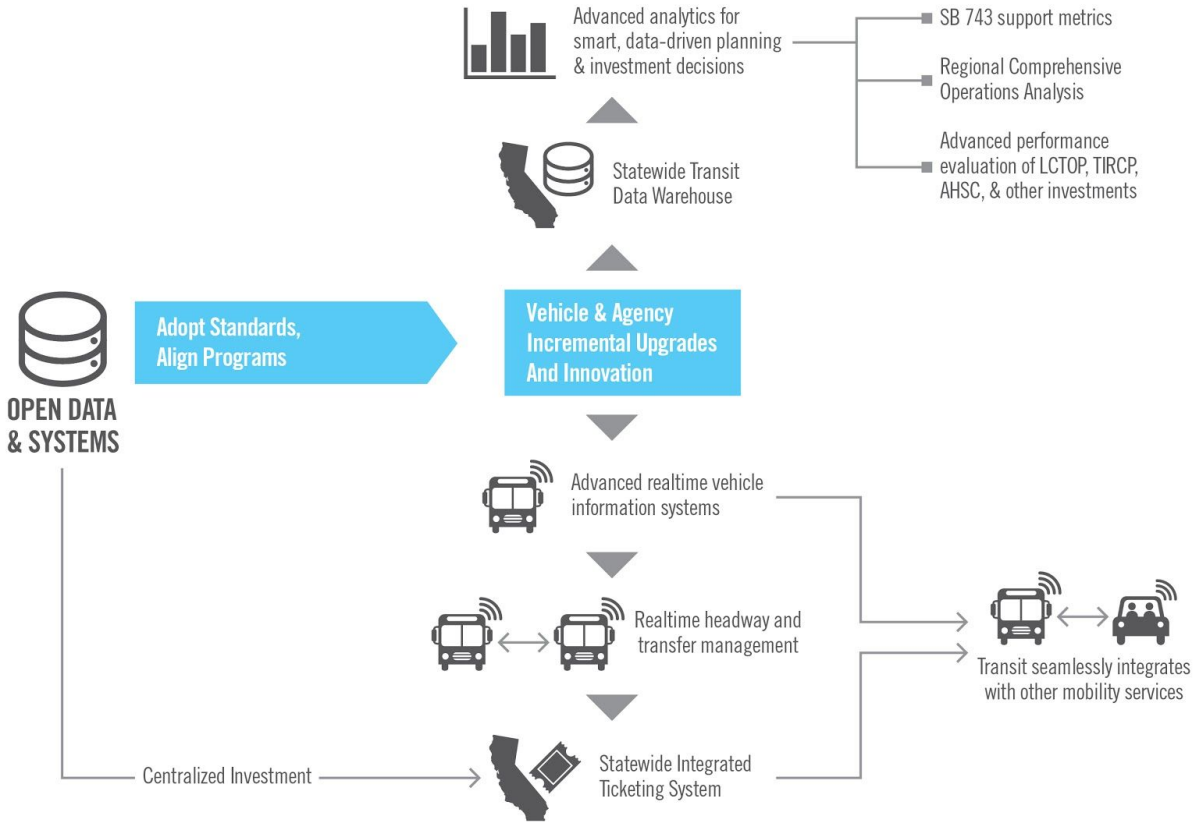
Rural areas do not have the population density necessary to sustain traditional fixed-route transit, but rural residents still have mobility needs that cannot always be met by private automobiles. Many rural residents are elderly and cannot drive, and otherwise isolated rural communities need to stay connected with each other and to larger metropolitan areas in the state. The State should establish a framework for nonprofit TNC services that provides basic mobility services (e.g., to grocery stores, medical appointments, social-services visits) to rural residents. Amtrak California could also allow

rural residents to book bus-only tickets on the Thruway service and expand intercity bus services to cities that do not have regional transit service.

### Adopt Open Data and Hardware Systems to Make Transit Smarter

The smart use of technology is essential to making transit more agile and innovative. However, non-technical barriers prevent transit agencies from upgrading and employing modern technologies used elsewhere in the world. The key remedy is enabling interoperability of hardware and software products from multiple vendors. Unfortunately, a 15-year effort by the American Public Transit Association (APTA) to encourage a common communications standard has yet to bear fruit.

Open Data & Systems: A Starting Point for Smarter, More Agile Transit




California can lead the nation in transit innovation by adopting data, hardware, and software interoperability standards, just as California made roadway tolling systems inter-compatible statewide (FasTrak). Adoption of a standard and implementation of compatible systems will

allow transit planners across California to analyze a wider array of transit data and make more informed decisions about statewide trends and needs.

### Use LCTOP Funding in Disadvantaged Communities

The Low Carbon Transit Operations Program (LCTOP) is an expanding source of statewide operating funding for transit. In an arrangement set up by SB 535 (2012), 50% of this funding must benefit disadvantaged communities. Projects funded with this money can be supply-side (new routes or enhanced services) or demand-side (fare discounts). The state should draw on future transit user data and accounts systems data to provide discounted fares to residents of disadvantaged communities. These demand-side subsidies can cause a virtuous cycle that increases ridership and improves services.

### Develop New Uses for Transportation Impact Mitigation Fees

In 2013, the Governor's Office of Planning and Research directed public agencies to begin using the metric of vehicle miles travelled (VMT) when evaluating the traffic impacts of proposed projects. As a result, cities and counties can reconfigure transportation impact mitigation fees to reduce VMT and fund alternative forms of transportation. The Office of Planning and Research has identified improved transit service and transit investments as examples of VMT mitigation measures. When cities and counties collect mitigation fees, they should consult transit agencies to ensure that these fees are effective at improving Californians' mobility alternatives.

### Conduct Surveys of Transit Users and Non-Users

It is common for transit agencies to survey their passengers. However, studies of current ridership declines have found that the fragmented nature of these surveys limits their usefulness in understanding multi-agency trends and necessitates a more coordinated and robust approach. Caltrans should assist in the creation of a comprehensive, consistent system for surveying both transit users and nonusers. Simple ratings of perceived overall performance, reliability, convenience, and safety can identify areas where improvement is needed. Non-user survey data, while more difficult to collect, are valuable for determining what aspects of service should be improved to attract greater ridership in specific areas. State support will help achieve the scale needed to make these surveys an efficient and regular occurrence throughout California.

### Establish a Statewide Data Warehouse

To enable more comprehensive statewide and regional analyses of transit, Caltrans should require all major transit agencies to participate in the creation of a statewide "big data" warehouse that can collect and archive new data for future use in advanced analytics and multi-agency analyses. Good data are essential to good policymaking, and a statewide warehouse provides certain benefits that agency and regional data repositories cannot. For example, using consistent methods to measure and store data will allow for the development of advanced statewide transit-performance metrics, and with a single warehouse, third-party consultants and software developers can more easily integrate into the system.

### Allow New and Emerging Technology to Support Transit and HOV Priority

With the advent of Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication systems, public-transit networks have the potential to become more connected and "smarter" than ever. Several types of already-existing visual and LIDAR systems can play a crucial role in enforcing HOV occupancy requirements and transit-only lanes. Transit-priority and HOV lanes are frequently occupied by single-occupancy vehicles, diminishing the speed and reliability benefits of those lanes to transit service. Giving transit vehicle operators across the state the technology to automatically report violators to be cited will enable a more consistent and reliable passenger experience. These technologies can also help facilitate queue jumps, signal priority, and other transit-first policies.

## Conclusion

Meeting the ambitious aspirations laid out in a wide array of state plans poses a significant, but achievable challenge for California's public-transit systems. For example, newly-adopted, aggressive greenhouse gas emissions goals will require the kind of multisector, pan-governmental approach that was absent from recommendations in the first STSP in 2012, which focused exclusively on actions that were directly within Caltrans' authority. In order to achieve the goals set out in this report, CalSTA, Caltrans, various MPOs, and transit agencies must all convene, find new ways to collaborate, and take on increased responsibilities for improving transit in California. The state legislature may also need to set clear expectations, policies, and benchmarks that transit operators can look to for guidance in the years ahead. All of this represents a new approach in a state where local transit agencies and operators have historically been given funding and then left to pursue their own agendas.

How and to what extent California chooses to manage motor-vehicle use will go a long way toward determining transit's future role in the state. Automobile pricing in particular carries great potential benefits for both the road system and transit, but transit agencies themselves must also rise to the occasion. Unless transit operators provide more and enhanced transit service to compensate for the higher price of driving in congested areas, Californians' overall mobility may be inhibited. But international experience shows that enhanced transit and roadway pricing can together create a "virtuous cycle" whereby pricing reduces the demand for solo driving, which allows transit to operate better and faster, thus attracting riders who can be served more efficiently and effectively.

At the same time, the rapid rise of innovative and new-mobility services over the last five years has demonstrated that traditional public transit systems are vulnerable to disruption. Fixed-route, fixed-schedule public transit is expected to remain crucial in urban areas; while tech-enabled "new mobility" services such as TNCs can supplement these services, they cannot fully replace them. However, beyond these high-density districts and corridors, the future of shared mobility entails much that is uncertain. Therefore, UCLA ITS recommends that the 2018 STSP should set parameters for best practices in transit policy-making, while leaving transit agency managers much flexibility to decide how best to meet both state mandates and their constituents' needs.

# Part 1:

# **Shaping the Future of Transit**

# Chapter 1: Introduction

In the coming decades, California can become a national leader in mass transit. Our state has long been known for its extensive transportation infrastructure and proactive approach to facilitating mobility. However, as California pursues aggressive policies to reduce greenhouse gas emissions while continuing to address persistent challenges like its infamous traffic congestion, it has become clear that robust, transformative changes are necessary to supplement the automobile-centric model of the past decades. California already has extensive public-transit service; over 150 organizations throughout the state operate more than 25,000 vehicles and carry over 1.4 billion passenger trips per year, putting California at 6th nationwide for per-capita transit boardings. However, the service that is provided is often slow, unreliable, and infrequent; and too few agencies actively champion transit priority or have comprehensive plans to enhance services to attract market segments beyond so-called "captive riders." For the state to meet its environmental, population, job-growth, and mobility goals, agencies must provide current *and* potential riders with the robust services they need, and public transit must become more indispensable than ever.

## 1.1 Why Transit, Why Now?

California has a uniquely favorable policy environment for the growth of public transit. With nearly 40 million people and the world's sixth-largest economy, California has the scale and economic clout needed to be a major innovator and leader in this field. As the federal government reduces its role in funding and operating transit, California has the ability and need to pick up the baton from Washington, D.C. and become the new national leader in public-transit expansion, experimentation, and innovation.

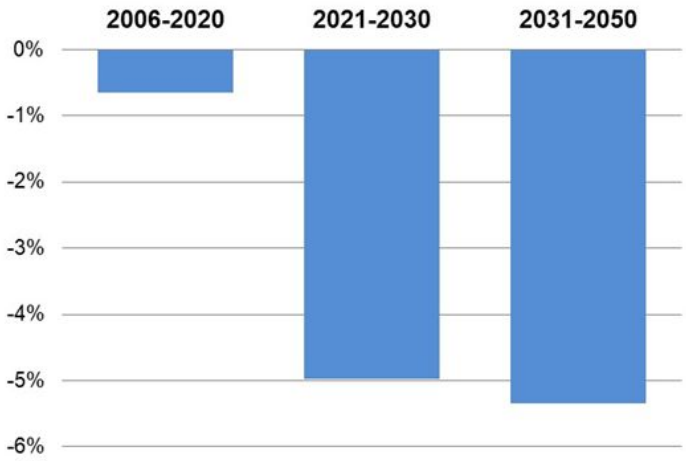
The state has one of the world's most aggressive mandates for greenhouse-gas reduction. Starting with the Global Warming Solutions Act in 2006 (AB 32), a series of laws and policies have been passed that require California to reduce greenhouse-gas emissions in three phases: down to 1990 levels by the year 2020, 40% below 1990 levels by the year 2030, and finally 80% below 1990 levels by 2050. Among these laws are SB 375 (2008), which requires transportation and land-use authorities to coordinate their efforts in an attempt to reduce GHG emissions, and SB 391 (2009), which mandates that Caltrans update the California Transportation Plan every five years to demonstrate consistency with the state's environmental goals. In short, the state is looking to the transportation sector to help California meet the strict emissions-reduction requirements set out in AB 32. Reducing the overall number of Vehicle-Miles Travelled (VMT) by shifting trips from personal automobiles onto public transit will be key to this effort.

What makes California's GHG reduction plans especially ambitious is that the state must achieve them during a period of projected population and economic growth. The California Department of Finance forecasts that the state population will be nearly 52 million by the year 2060 (up from 39 million today). Most of this population growth will occur in the state's four largest metropolitan areas (Los Angeles, San Francisco Bay, San Diego, and Sacramento). With a current unemployment rate of 5.1%, the state's economy is as robust as ever. In order to accommodate this projected growth and meet residents' mobility needs in a way that does not exacerbate pollution and congestion, and especially in light of the state's commitments to promoting climate-efficient and infill development, strong public-transit networks will be critical.

## 1.2 Public Transit Is a Statewide Concern

For most of California's history, public transit has been a local affair. In the early 20th century, private companies built and operated urban railway systems throughout the state, but after World War II, greater suburbanization and mass car ownership accelerated transit's ridership decline.[1] Transit networks were either disbanded or taken over by local governments. Since then, municipal or county governments have operated public transit as a social service, providing mobility to people who for whatever reason (poverty, disability, etc.) do not have cars. Under this paradigm, transit's benefits have traditionally been seen in terms of mobility (decreased congestion, rapid travel, etc). It is only in recent years that planners have focused on how transit can help the state meet a broader set of environmental goals.

**Figure 1-1: Average Annual GHG Reductions Needed to Meet State Targets**



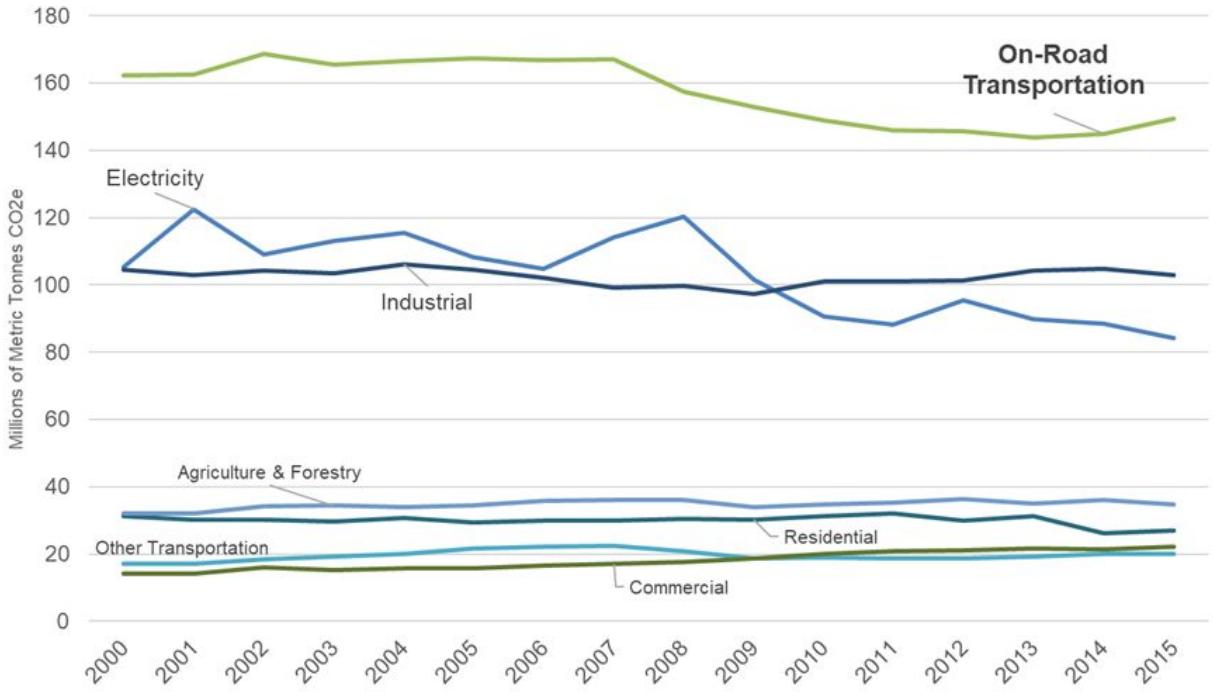

California's aggressive targets for GHG reductions mean that the state has a more active interest than ever in building, maintaining, and promoting a robust public-transit network. From 2006 (when AB 32 was enacted) to 2020, the first benchmark date, the state needs to achieve an average

[1] The City of San Francisco, which opened the Municipal Railway in 1912, is a notable exception.

annual GHG reduction of 0.7% per year. From 2020 to 2050, the second stage of California's emissions-reduction plan, the state must achieve an average annual GHG reduction of 5% per year (See Figure 1-1).

The State is aggressively removing fossil fuels from its electricity sector, which has resulted in declining GHGs. But transportation remains the single biggest source of carbon emissions in the state, with 91.9% of vehicles still running on gasoline or diesel fuel.[2] After over half a decade of declining GHG emissions from on-road transportation, emissions have been rising since 2013 as statewide transit ridership is declining (Figure 1-2).

Figure 1-2: Annual CA GHG Emissions by Economic Sector




The State's interest in improving public transit is also inextricably linked to its ongoing housing crisis. High housing costs in job-rich areas are making it harder than ever for people to live near their workplaces, leading to longer commutes, rising VMT, and unsustainable sprawl. If we are to build much-needed new housing near the state's existing job centers, public transit will have to play a major role in transporting workers; there is simply insufficient space for everyone to

[2] Roberts, D. (2017, August 22). *California has a climate problem, and its name is cars*. Retrieved from: https://www.vox.com/energy-and-environment/2017/8/22/16177820/california-transportation

commute by car. For Californians who live farther from work, affordable long-distance mobility options will make it possible to avoid spending hours each day driving alone.

## 1.3 A Need for Fresh Thinking

Transit in California sits at a crossroads: We will need it to accomplish a new, more multifaceted set of goals in the years ahead, but falling ridership means that it is not meeting the goals we have set out for it now. While research on the factors that may be causing declining ridership will be covered in Chapter 2 of this report, there is clear, consistent evidence that wherever they live, passengers most value safety, frequency, and reliability when choosing whether to take transit.[3] Improving user experience by focusing on the "nuts and bolts" aspects of transit service may seem unglamorous when compared to expensive new stations and rail lines, but recent evidence from Houston, Seattle, and Orange County shows that the best way to attract riders is to provide frequent service networks in high-density areas.[4] Transit agencies have often distinguished between so-called "captive riders" (who have no choice but to take transit) and "choice riders" (who have access to other means of mobility). To the extent that this dichotomy ever existed, it has become badly outdated.[5] In order to succeed, transit must become more resourceful, agile, flexible, and and responsive to the needs of *all* riders.

In short, accomplishing this set of goals will require officials to think strategically — not just in terms of a single entity's mandate, or a collection of 5- or 10-year capital plans, budgets, and multi-agency service planning, but rather how public entities at all levels can work together to improve transit in California. For example, legislative changes may be needed to give transit agencies more flexibility or hold them accountable in new ways. We can achieve scale efficiencies across regions by coordinating activities and operations among multiple agencies, or use the kind of specialized technical knowledge that many smaller local agencies simply don't have on staff. These efforts will require the sort of systematic, collaborative approach that has traditionally taken a backseat to local control.

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[3] "Thinking Outside the Bus," http://uctc.berkeley.edu/access/40/access40_outsidethebus.pdf
[4] Bliss, L. "A Year After a Radical Route Rethink, Houston's Transit Ridership Is Up." (2016). https://www.citylab.com/transportation/2016/08/houston-bus-system-ridership/496313/, Small, A. "How Seattle Bucked a National Trend and Got More People to Ride the Bus." (2017). https://www.citylab.com/transportation/2017/10/how-seattle-bucked-a-national-trend-and-got-more-people-to-ride-the-bus/542958/, Vo, T. "Ridership Up On OCTA's Improved Bus Routes." (2017). https://voiceofoc.org/2017/11/ridership-up-on-octas-improved-bus-routes/.
[5] Schmitt, A. "The 'Choice' vs. 'Captive' Transit Rider Dichotomy Is All Wrong." (2016). https://usa.streetsblog.org/2016/07/12/the-choice-vs-captive-transit-rider-dichotomy-is-all-wrong/.

## 1.4 What Is Public Transit?

Simply put, this report defines public transit as "publicly-operated or subsidized shared-mobility services with the capacity to carry multiple passengers per vehicle."[6]

Transit is defined by the provision of collective mobility in the public interest. The manner in which transit agencies apply this approach may change over time in response to new needs and opportunities. This includes changes in the types of vehicles employed to provide collective, public-interest mobility. For example, in the five decades since the passage of California's Transportation Development Act, which set the financial foundation for transit in the state, transit has evolved to include bus rapid transit, vanpools, and demand-responsive taxis.

In 2018, "transit" generally includes:

- Fixed-route buses, including circulator, local, rapid, and commuter buses
- Intra-city rail, including subways, light rail, commuter rail, streetcars, etc.
- Interregional rail, including Amtrak California[7]
- Ferries
- Demand-responsive paratransit services, including those provided by private taxi companies under contract with transit agencies
- Publicly-subsidized vanpools

As cities, suburbs, and technologies evolve in the years ahead, transit agencies may decide to manage or subsidize other service types, which would then be included in a widening definition of what constitutes "transit.[8]" Moreover, Even if a mobility service does not fit the definition of "transit," that service can still be *complementary* to transit. Indeed, many of the recommendations in this report are designed to allow such services to complement and integrate with transit when doing so would be in the public interest.

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[6]Definition adapted from Walker, J. (2011). *Human Transit: Hower Clearer Thinking about Public Transit Can Enrich Our Communities.* Island Press.
While the term shared mobility has recently been applied to services offered by Lyft and Uber, these services are but one element of the family of shared mobility services, including traditional fixed-route, fixed-schedule public transit.

[7] Intercity rail, commuter rail, and high-speed rail are included in the 2018 California State Rail Plan and California High Speed Rail Business Plan.

[8] For instance, they would be included in public data collection and ridership targets

Table 1-1: What Makes a Mobility Service "Transit"?

| | "Transit" includes... | "Transit" does not include... |
|---|---|---|
| **Type of Vehicle** | • Mass transportation: scheduled, fixed-route, general transportation services available to the public.<br>• Specialized transportation services provided to targeted populations, including the elderly, the disabled, and persons of limited means, usually in vehicles that can be shared by multiple passengers. | • Personal automobiles, whether owned, leased, or rented for a limited term.[9]<br>• Shared vehicles arranged on an ad-hoc basis, including carpools, taxis, Uber/Lyft, and charter-party carriers<br>• Employer-provided shuttles<br>• Shared bicycles or scooters available to the public[10] |
| **Service provider** | • Transit Districts<br>• Municipal Operators<br>• Consolidated Transportation Services Agencies<br>• Transportation Authorities<br>• State DOT (Caltrans)<br>• Cities operating dial-a-rides?<br>Referred to collectively as "Transit Agencies" | • Transportation Network Companies (Uber/Lyft)<br>• Taxi companies<br>• Transportation Management Organizations<br>• Providers of microtransit, such as Chariot and Bridj<br>• Employers<br>• Passenger Stage Corporations<br>• Charter-Party Carriers |

What differentiates public transit from private mobility? Primarily, it is that transit operates in the service of public-interest goals, as explained in the table below.

Table 1-2: What Differentiates Transit?

| Differentiating Factor | Why Transit is Different |
|---|---|
| **Public Oversight and Expectations** | Transit decisions are made with public oversight and should be responsive to public interests. Aside from the core goal of serving riders' mobility needs and providing them with high-quality service, transit agencies are also expected to operate with various social, |

[9] Includes rent-a-cars and all carshare services

[10] There are gray areas. For example, what if a city plans and subsidizes a bikeshare system: is that transit? This report is silent on these edge cases, and they are not included in targets and strategies for transit as it is difficult to measure the performance until entities report standardized data publicly-subsidized complementary mobility services.

| | |
|---|---|
| | environmental, and economic objectives in mind. In contrast, private mobility providers are mainly expected to earn returns on investment to private shareholders and interests. |
| **Authority** | The State grants transit agencies legal authority that private mobility services do not have, including the authority to operate on highway shoulders and in restricted surface-street lanes, issue limited citations, operate very large, high-capacity vehicles, and for Transit Districts, raise special taxes. |
| **Funding** | Transit involves a permanent, public appropriation that guarantees revenue from a source other than fares. This revenue stream enables transit to provide or contract to provide mobility services that are not profitable and unlikely to become profitable in the future. |

From these differentiating factors, transit derives its relative strengths and weaknesses.

Table 1-3: Transit's Strengths and Weaknesses

| Strengths | Weaknesses |
|---|---|
| • Unique authority<br>• Consistent funding stream<br>• A mission to provide mobility to the elderly, disabled, and persons of limited means<br>• Ability to offer mobility services at a price below cost to aggregate more demand from a greater proportion of the public; increasing vehicle occupancy, sizes, and service frequency | • Multiple, often competing goals and objectives<br>• A convoluted, long decision-making process<br>• The availability of permanent public funding demands less agility than private investments<br>• Multiple objectives (e.g. broad service coverage and serve low-income areas) can sometimes conflict<br>• Funding may be vulnerable to changes in political objectives |

# 1.5 What Is This Report?

## 1.5a Report Purpose and Organization

This report contains recommendations from the UCLA Institute of Transportation Studies (UCLA ITS) to Caltrans, CalSTA, transit agencies, the legislature, cities, counties, and a dozen

other types of entities. Caltrans engaged UCLA ITS in 2016 to support in the creation of a Statewide Transit Strategic Plan, and assembled an Executive Committee and Advisory Committee to advise ITS and provide feedback throughout the process. Those committees are the intended audience for this report. This report was researched and written in its entirety by UCLA ITS and has not been reviewed by, Caltrans, CalSTA, or members of the Executive and Advisory Committees.

Caltrans does not operate transit service, but recognizes local and regional transit as important for achieving broader statewide goals articulated in California Transportation Plan 2040 (CTP 2040), the Smart Mobility Framework, and other state-level planning documents. Therefore, the State recognizes the need for a strategic transit plan that will improve transit riders' experiences, increase ridership, pursue statewide VMT and GHG goals, and coordinate complex actions among public entities. Chief among these entities are the state (including but not limited to Caltrans), county and municipal governments, and local transit agencies.

When adopted, the Statewide Transit Strategic Plan will be one of the six long-range modal plans required under the framework of the California Transportation Plan 2040 (CTP 2040). Taken together, these modal plans will provide the State with a cohesive, unified vision for improving its transportation infrastructure and ensuring Californians' mobility in the decades ahead. The six long-range modal plans in progress are:

- Statewide Transit Strategic Plan (the subject of this report)
- Freight Mobility Plan (2014)
- State Rail Plan (2018)
- Aviation Plan (2011)
- Bicycle and Pedestrian Plan (2017)
- Interregional Transportation Strategic Plan (2011)

This report aims to give Caltrans, CalSTA, and other public agencies the tools, best practices, and data and identify the authority that they need to offer seamless public mobility, better coordinate with each other, and meet the State's public-interest shared mobility needs. Recognizing that one-size-fits-all approaches are destined for failure in such a large and diverse state, this report aims to provide a framework flexible enough to allow agencies to both respond to changing needs, and effect transformative changes across the diverse communities of California.

The final STSP, therefore, should build on the recommendations in this report to define the State's vision and agenda for the future of public transit in a geographically diverse California; this vision should be deeply informed by the state's commitments to environmental sustainability, social equity, and efficient delivery of services. The details of how local agencies meet these goals — where and when service will operate, how much fares will be, etc. — are for

agencies themselves to decide. The strategies and action items in this report and the eventual plan will influence local decisions that support the State's vision.

Table 1-4: Organization of this STSP Recommendations Report

| | | |
|---|---|---|
| 1 | **Introduction** | An overview of the STSP project and report |
| 2 | **Transit Today** | Summarizing the current state of transit in California; describing the challenges and opportunities it faces |
| 3 | **Future Vision** | Imagining a future where convenient, seamless transit is available to all Californians — no matter what kind of community they live in |
| 4 | **Transforming California** | Changes to the overall land use and mobility context in California that will allow the state and transit to thrive |
| 5 | **Making Transit Excellent** | What transit planners and operators can do to pursue excellence in whichever context transit operates |
| | **Appendices** | Appendix A: Executive and Advisory Committee Membership<br>Appendix B: Matrix of Recommendations, including recommendations by responsible entity<br>Appendix C: Memoranda detailing recommended strategies and technical notes |

## 1.5b Defining and Categorizing Recommendations

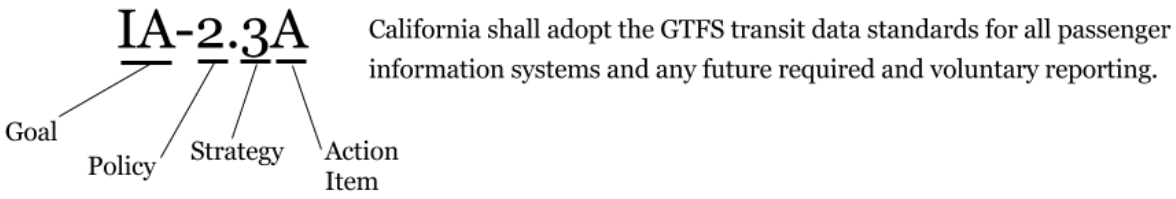
This report presents recommendations using the "Goal → Policy →Strategy →Action/Measure" approach used in CTP 2040. This method begins with establishing broad Goals, which are expressions of values. Policies and strategies then provide more specific direction on how to reach those goals. The Appendix B-2 Recommendations Matrix allows officials at various entities to see how the various proposals in this report fit together.

UCLA ITS recommends structuring the final STSP around four central Goals:

- **Effective, high-quality transit is integral to transforming California. (Code: TC)**
- **A California transit passenger's multimodal experience should be seamless, safe, and affordable. (Code: SE)**
- **Transit agencies must become more innovative and agile to vigorously**

**pursue their missions. (Code: IA)**
- **Use strategic investments to make transit more sustainable and resilient. (Code: SR)**

All recommendations made in the report fall under one of these broad Goals, and all recommendations also include a short code for easy reference.




**Goal IA:** Transit Agencies Must Become More Innovative and Agile to Vigorously Pursue Their Missions
**Policy IA-2:** Provide common data and tools for agencies to track, understand, and optimize their operations
**Strategy IA-2.3:** Adopt open data standards to improve service quality, planning and operating analytics, and multi-agency collaboration

A full list of all recommendations in this report is included in Appendix B.

## 1.5c STSP Project Approach

This report is the third and final component of the Statewide Transit Strategic Planning project, in which UCLA ITS makes recommendations based on our findings from Part 1 (the Baseline Conditions Report, published March 2017) and Part 2 (the Stakeholder Engagement Report, published August 2017).

### Part 1: Baseline Conditions Report

*Published March 2017*

The 237-page Baseline Conditions Report offers an encyclopedic overview of transit in California. Behemoths like Los Angeles Metro, BART, and San Francisco Muni, which collectively carry over half of all transit passengers in the state, tend to garner the most attention. However, the median California transit agency is about a $15 million annual enterprise with about 30 buses that serves a suburban area of a major region. In 2015, 42.2

million hours of public transit service were provisioned in California, 1.4 billion passenger trips were taken, and 8.5 billion passenger miles were traveled on transit. While these numbers are large, so is California. These 1.4 billion public transit trips account for only 4.1% of all of the person trips made in the state, and the 42.2 million hours of transit service are lower than several other states' on a per capita basis.

The final Baseline Conditions Report is available on the Caltrans website.

### Part 2: Stakeholder Engagement Report

*Published August 2017*

The STSP project team targeted three stakeholder groups between August 2016 and July 2017 with a mix of engagement activities. The findings from these efforts and activities are summarized in the Stakeholder Engagement Report. The membership of the Executive and Advisory Committees is detailed in Appendix A.

Table 1-5: Stakeholder Engagement Report

| Stakeholder Group | Perspective | Composition | Outreach Activities |
|---|---|---|---|
| **State Government** | Integrating transit into state goals and managing competing transportation objectives | Leadership from State Transportation Agency, Caltrans, High Speed Rail Authority, and Strategic Growth Council | • 3 Executive Committee meetings |
| **Local Transit Agencies** | Planners, managers, and operators of local and regional transit services | Executive officers and senior staff from transit operators and Metropolitan Planning Organizations | • 3 Advisory Committee meetings<br>• Industry conferences<br>• Online survey<br>• 2 webinars<br>• Interviews |
| **Public** | Users of transit and multi-modal mobility | Open participation | • 3 workshops<br>• Online survey<br>• Webinar |

The results of our Stakeholder Engagement process suggest that advancing transit agencies' ability to deliver good "on the road" service will have the greatest potential to improve the transit experience and increase ridership. However, some of these actions may garner opposition from agencies themselves due to a perceived administrative burden, an assumption

that mandated changes would require new training but not new funding, and/or a general wariness of technology suppliers and processes. Understanding stakeholders' objections and addressing them in proposed actions is essential for the stakeholders' buy-in and the actions' success. In addition, it will be important to develop effective communications strategies for explaining how initiatives such as a Statewide Transit Data Warehouse are essential for improving both transit's service and California's transportation landscape.

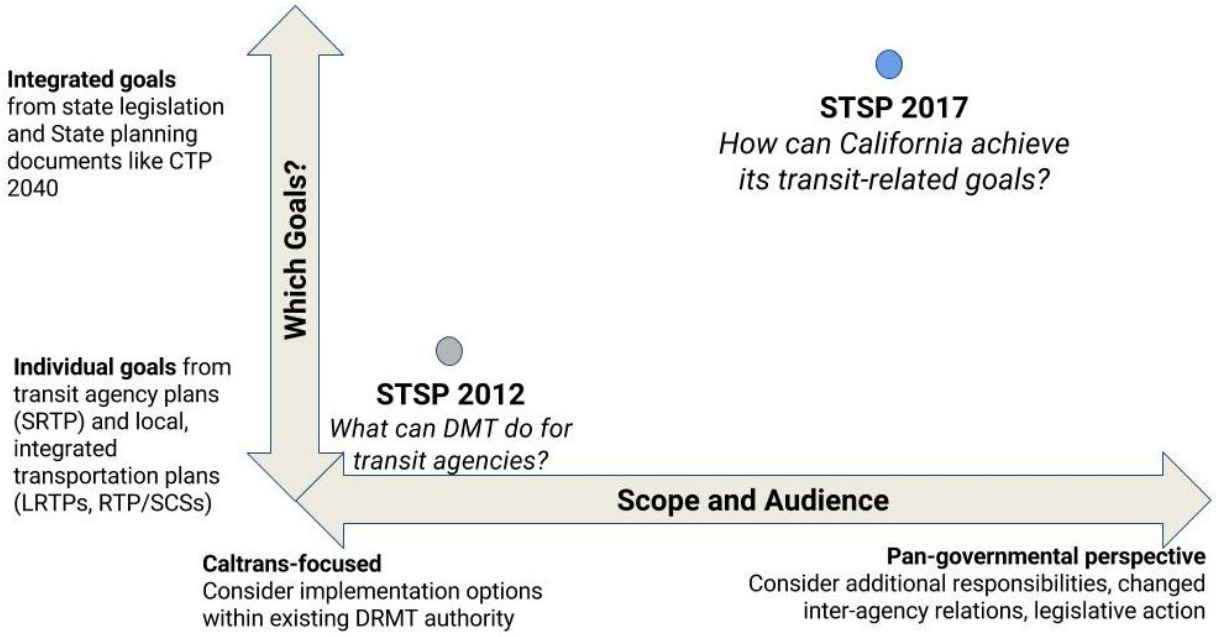
The full Stakeholder Engagement Report is available on the Caltrans website.

### Part 3: Statewide Transit Strategic Plan Recommendations Report

*Published February 2018 (this document)*

This report is the third and final component of the STSP project. It makes recommendations on pan-governmental actions from CalSTA, Caltrans, MPOs, and transit agencies, as well as legislative actions to expand authority or align incentives. Unlike the previous STSP, which was adopted in 2012 and focused only on recommendations within Caltrans's authority, this report prioritizes the achievement of state-level integrated transportation, environmental, social, and economic goals rather than agency-level goals (see figure 1-3).

Figure 1-3: 2017-18 Statewide Transit Strategic Plan Project Approach



# Chapter 2: Transit Today

## 2.1 The State's Role in Transit

Public transit is a decidedly local affair. At least 269 local agencies[1] provide publicly-funded transportation services in the state, ranging from single demand-response vehicles operating on rural tribal reservations to large urban operators whose service sees over one million boardings per day. Despite the large number of transit agencies in California, a mere 8% of agencies carry 90% of transit passengers. Collectively, California's transit agencies operate over 25,000 vehicles[2] and carry over 1.4 billion passenger trips per year. However, despite this strong culture of local control, the state plays a role in enabling, funding, and regulating public transit.

### 2.1a State Law Enabling Transit

California Public Utilities Code § 24501 *et seq*. establishes and grants authority to the State's transit districts. The legislature established funding for transit in 1971 with the Mills-Alquist-Deddeh Act (1971), also known as the Transportation Development Act. This Act (CPUC §99200 *et seq*) also created statewide regulations for transit districts and municipal operators. For example, PUC § 99280 governs relationships between operators and PUC § 99282 encourages "maximum coordination of public transportation services, fares, transfer privileges, and all other related matters for the overall improvement of public transportation" between agencies.

### 2.1b Caltrans' Role

Although it does not operate local or regional transit service, Caltrans plays a strong role in the state's transit system. Caltrans administers state and federal funding programs, with the most direct involvement in rural and intercity bus services and intercity rail and thruway connecting bus service. The Department also designs, builds, and operates the state highway system on which many transit vehicles operate.

[1] In 2015, 165 California entities reported information to the NTD and 269 reported to the SCO. This Statewide Transit Strategic Plan Baselines Report excludes intercity rail service provided by Amtrak California, including local or regional trips made on such services. These services are operated by Amtrak under contract with three Joint Powers Authorities (JPAs) with State support and funding by Caltrans and planned for as part of the State Rail Plan.
[2] 25,685 active vehicles, NTD Monthly. (2015).

## 2.1c State Transit Funding

The 2016-2017 STSP Baselines Report provides an in-depth view of federal, state, and local transit funding. Two key aforementioned developments since that report will increase the state's financial resources available to local transit: the passage of the Road Repair and Accountability Act of 2017 (SB 1) and a package to extend the state's greenhouse gas cap-and-trade system.

### Limits on accessing state funding

Agencies can access state operating funding if they meet two general constraints designed to encourage cost-effective operations: a minimum ratio of fares to total operating expenses, and a limit on the rate of increase in operating costs.

The state requires minimum farebox ratios of 10% for non-urbanized areas and 20% for urbanized areas. This farebox-ratio requirement has some exemptions, including the first two years of service on new routes or to new areas, and on service provided for elderly and disabled persons. There are also some exceptions to the rule; for example, agencies providing feeder service to rail can use a portion of the rail agency's revenues towards their farebox recovery calculation.

## 2.1d Factors Out of Caltrans' and Transit Agencies' Control

While California's transit agencies are responsible for serving transit trips, they have only a limited set of tools to intervene and reduce the trend of declining ridership. Successfully reversing the trend will require developments both within and beyond agency control.

Table 2-1: Control Over Factors That Influence Ridership

| Degree of Transit Agency Control | Factors that Influence Transit Ridership |
|---|---|
| **Transit agencies can control** | • In-vehicle passenger experience<br>• Routes and stop locations (reach of network)<br>• Service schedules and frequency (service levels)<br>• Acceptance of regional fare media<br>• The availability of commonly used digital information, including route information via GTFS and real-time information systems |

| | |
|---|---|
| **Transit agencies have limited influence** | • Vehicle reliability and travel times<br>• Out-of-vehicle passenger experience<br>• Passenger fares, subject to legislative farebox-recovery ratio constraint of 20% |
| **Transit agencies have little or no ability to influence** | • Whether an individual's origin or destination can be effectively served by transit<br>• Whether or not future population and employment growth in the service area is accommodated via transit-supportive land use<br>• The costs of mobility alternatives, such as vehicle access, operation, fuel maintenance, insurance, and the cost to use roads |

Cities and counties also play a large role by controlling housing production, parking policies, and the rights-of-way used by transit. Caltrans must enlist the support of Metropolitan Planning Organizations, cities, and counties to pursue transit-supportive land uses and transit-supportive transportation system management.

## 2.2 Unprecedented Challenges

### 2.2a Declining Transit Ridership

Statewide transit ridership has been declining since 2009. It declined by 12.5% between the first half of 2014 and the first half of 2017.[3] This trend is especially concerning because state policy seeks to promote transit ridership: In 2015, Caltrans adopted a performance target to double transit's modal share between 2010 and 2020.[4]

As a result of rising expenditures concomitant with the decline in ridership, California's transit productivity (passenger boardings per vehicle revenue hour) has fallen 5 percent between 2005 and 2016. Declining productivity over the long term requires either greater subsidies or reduced service.

[3] NTD Monthly. (2017).
[4] Caltrans Strategic Management Plan, 2015-20: http://www.dot.ca.gov/perf/library/pdf/Caltrans_Strategic_Mgmt_Plan_033015.pdf

The possible causes of declining ridership are the subject of ongoing research. A study of trends in transit service hours, gas prices, car ownership, and immigrant licensing reveals that increasing vehicle ownership and more driving by immigrants are likely to be the most significant and enduring factors that explain declining ridership. The most frequent transit riders tend to be people in households with no vehicles or with more drivers than vehicles. The number of such households in the SCAG region has declined dramatically between 2000 and 2015: There are 46% fewer households with no vehicles and 16% fewer with a "vehicle deficit." Declines among foreign-born households households are starker still, reflecting an auspicious rise in household incomes that also explains an erosion in transit use. At the same time, immigrants (particularly those newly-arrived) who constitute a large share of riders are arriving in fewer numbers[5] and have greater access to driver's licenses.[6]

Factors thought to be less significant contributors to ridership declines are: low gas prices (which are weakly correlated, with periods of high prices corresponding to continued ridership decline), and cuts in transit service (which have generally been increasing since 2011). The effects of new transportation alternatives such as Lyft and Uber are ambiguous; the services' ridership data is proprietary and generally unavailable for analysis. Lyft and Uber may be attracting riders from public transit, though ridership began falling before the services were widespread. The companies have begun partnering with transit operators to provide first-mile/last-mile services to transit, but the ridership benefits and net effects on ridership are not yet known.

**These causes are discussed in greater detail in Appendix C-13: "The Causes of Recent Declines in Transit Ridership."**

## 2.2b Slower Local Bus Service in Urban Areas

The table below shows that the average speed of local bus service has declined significantly between 2005 and 2015 in three of California's four major metropolitan areas. Reduced vehicle speeds are costly to agencies and result in lower service quality for riders and would-be riders. This decreasing speed trend is especially concerning considering that over the same period agencies deployed smart cards, transit signal priority, and other strategies aimed at reducing

[5] U.S. Department of Homeland Security (2000). 2000 Yearbook of Immigration Statistics. Washington, DC: Office of Immigration Statistics.; U.S. Department of Homeland Security (2015). 2015 Yearbook of Immigration Statistics. Washington, DC: Office of Immigration Statistics.
[6] National Conference of State Legislatures. (2016). States Offering Driver's Licenses to Immigrants. Available at http://www.ncsl.org/research/immigration/states-offering-driver-s-licenses-to-immigrants.aspx

dwell times and increasing vehicle speeds. Slower and more variable traffic conditions are likely the most significant contributing factors.[7]

Table 2-2: Average Speeds of Local Bus Service for California's Largest Agencies

| Agency Name | Average Speed (MPH, 2015) | Change in Average Speed (%, 2005-2015) | Additional Cost of Offering Service at Slower 2015 Speeds |
|---|---|---|---|
| **Los Angeles Metro (LACMTA)** | 10.70 | -13.0% | $126,147,055 |
| **San Francisco Muni** | 7.20 | -9.6% | $43,918,550 |
| **San Diego MTS** | 11.01 | -9.4% | $13,893,500 |
| **AC Transit** | 10.73 | -8.5% | $25,035,972 |
| **Orange County TA** | 11.99 | -6.1% | $11,637,658 |
| **Santa Clara VTA** | 11.70 | -8.1% | $19,451,20 |
| **Long Beach Transit** | 9.84 | -8.6% | $7,055,751 |
| **Sacramento RT** | 10.96 | -0.4% | $313,204 |
| **Los Angeles DOT** | 9.04 | -20.4% | $10,605,674 |
| **Santa Monica's Big Blue Bus** | 9.47 | -13.7% | $9,417,883 |

Slower vehicles means it takes more time to complete a bus route, and agencies must deploy additional service hours to maintain identical route and service levels. In 2015, the 10 largest agencies operating bus services spent an extra $267,476,455[8] on local bus service to compensate for declining average vehicle speeds versus a 2005 baseline. This suggests that successful state action to increase the speed of local bus vehicles could provide equivalent value to agencies as the entire $282,638,794 State Transit Allocation in 2015. It is clear that additional efforts are needed to reverse the decreasing average speed of local buses in urban areas.

## 2.2c California's Housing Crisis Affects Mobility

The State's ongoing housing crisis has entrenched auto dependency, inhibited the growth of transit ridership, and pushed population growth to job-poor, low-density areas of the state where transit is unreliable or nonexistent. California's major metropolitan areas have the highest-paying job opportunities, but they also have among the highest housing costs in the

[7] This report did not explore the cause of slower average speeds, which may include agencies responding to trip time variability by adding time to schedules to improve on-time performance metrics.
[8] Calculations based on analysis of data from National Transit Database

nation; the imbalance between where jobs are located and where affordable housing exists has led to longer commutes. High housing costs in urban areas mean that would-be residents, many of whom are low income or lower-middle income, instead choose to live in areas where the housing cost burden may be lower, but the transportation cost burden is often higher, as public-transit options are limited and long car commutes are necessary to reach jobs, a phenomenon called "over-commuting."[9] The increase in VMT from these longer commutes leads to even more traffic congestion, which is often cited as a reason to oppose new housing development — in short, a vicious cycle. High housing costs and high transit ridership tend to exist in the same areas, and even senior staff of some transit agencies have identified California's high housing costs as an impediment to their ability to recruit staff.[10]

## 2.2d Continued Funding Gap

The 2016-2017 STSP Baselines Report[11] summarized California's 10-year, $71.8 billion funding gap to maintain a state of good repair and expand service to serve more riders. Since that report was published, California enacted the Road Repair and Accountability Act of 2017 (SB 1), which will raise approximately $7.5 billion for transit operations and capital over 10 years. The State also enacted a package to extend California's greenhouse gas cap-and-trade system. Fifteen percent of that program's revenues are directed to transit capital and operations, estimated at $1.5 billion over 5 years.[12] Eight local ballot measures approved in 2016 will bring in an additional $13 billion over 10 years for transportation projects, including transit.

Even with this new funding, transit's unmet needs remain sizeable. Strategies to raise additional revenues and reduce the costs of transit service continue to be needed to maintain transit in a state of good repair while meeting the increases in statewide transit demand essential to the state's integrated transportation and land-use growth strategy.

## 2.2e Uncertainty Over the Federal Government's Role

The 2016-17 Baselines Report identified uncertainty about the federal role in mass transit as a risk to the future of transit in California. Transit agency stakeholders accentuated this sentiment during the stakeholder engagement phase.

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[9] California Department of Housing and Community Development. (2017). *California's Housing Future: Challenges and Opportunities*. Retrieved from: http://www.hcd.ca.gov/policy-research/plans-reports/docs/California%27s-Housing-Future-Full-Public-Draft.pdf

[10] Stakeholder Engagement Report

[11] Page 167

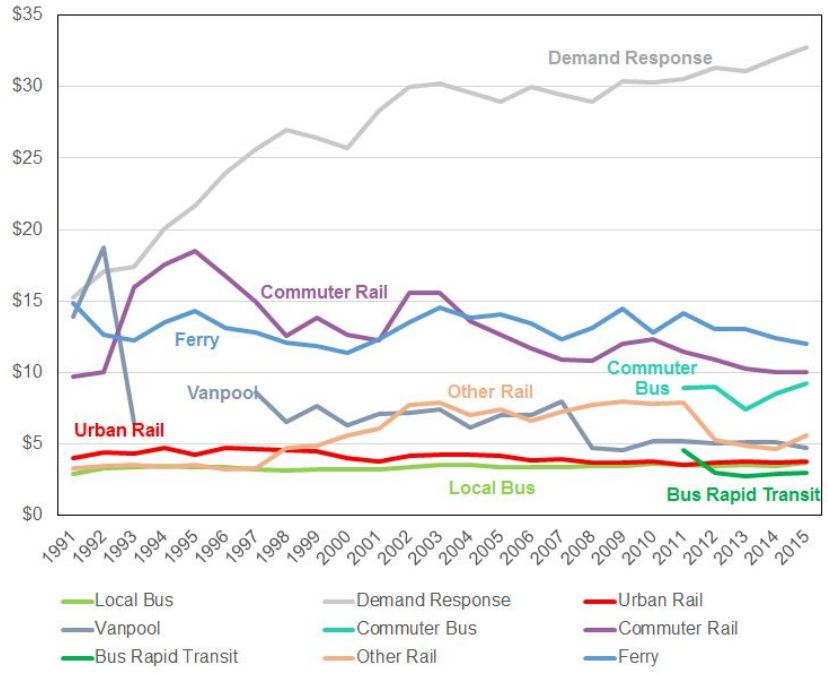
[12] Estimate based on projections in 2018 Transit And Intercity Rail Capital Program Guidelines (2017, October 13) (http://www.dot.ca.gov/drmt/docs/sptircp/2018finalgl.pdf)

Annual federal transit funds to California average[13] $1.9 billion per year, an amount greater than all statewide fare revenue. Federal funds are the main source of capital funding for small and mid-sized agencies and a significant capital funding source for large agencies. Federal funds make up roughly one-eighth of operating revenues statewide, but over one-quarter of operations revenues for rural transit agencies. Additionally, the 2017 state legislative session brought more than $1 billion in future annual transit funding, but achieving California's aspirations for transit require this new funding to be additional to the amounts historically received from federal commitments.

## 2.2f Demand-Responsive Services: Growing Costs and Needs

The cost of providing demand-responsive transit services, especially paratransit to senior and disabled populations, is of growing concern. The cost of serving California's demand-response needs has gone up by 50%, from an average of $21.70[14] per trip for 8.5 million trips in 1995 to an average of $32.72 per trip for 15 million trips in 2015. Transit agencies have a mandate to provide service for senior and disabled users, which is exempt from state regulations that limit increases in their annual costs.

Figure 2-1: Inflation-Adjusted Operating Cost per Passenger Trip




Increasing costs for demand-responsive services are of particular concern as the state grows and ages. The California Department of Finance forecasts that while the under-65 population will grow steadily over the next several decades (increasing by 17% between 2015 and 2060), the number of Californians over age 65 will increase rapidly, by 135% over the same timeframe. Senior-age Californians are forecast to make up about 24% of the population by 2060, up from

[13] Federal funds ebb and flow with major discretionary grants
[14] Figures in 2015 dollars

about 13% in 2015. California transit agencies will need to cater to this large elderly population while also serving the needs of growing working-age and child populations.

### 2.2g California's Rural/Urban Divide

Public transit is traditionally thought of as an urban service, but Caltrans has a responsibility to serve the mobility needs of all Californians across the state's many landscapes. Providing effective transit is certainly easiest in cities, where a high density of users allows agencies to provide busier, more cost-effective service on a large scale.

California's high-density urban areas are expected to continue growing demographically as well as economically, but housing costs in these areas are among the highest in the U.S. As long as these areas remain prohibitively expensive for many, migration to the urban periphery is likely to continue as commuters move in search of lower costs of housing. Unfortunately, as people move away from urban cores, they are less effectively served by traditional transit, leading to the car-dependent form seen in many suburbs today.

For the millions of Californians who live outside metropolitan areas entirely, transit agencies must find ways to offer cost-effective mobility management. The traditional ridership and cost metrics used to evaluate urban transit providers have limited applicability in rural areas where trip densities are often too low to justify fixed-route or even conventional demand-response transit. A new mobility approach is needed that retains urban transit's goal of providing basic mobility, improving job access, and connecting communities, but uses strategies that take into account rural communities' unique needs and context. One such strategy Caltrans should consider is to expand intercity bus service to rural communities in the form of an expanded Amtrak California Thruway service that reaches more areas and allows direct-ticket travel[15].

## 2.3 New Opportunities for Transit

### 2.3a Legislative Accomplishments in 2017

The 2017 legislative session brought new funding and policies to support transit in California. Most significantly, new funding from transportation-funding measure SB 1 and AB 398's extension of the cap-and-trade program provide a substantial down payment towards future transit funding needs. AB 398 also codifies California's 2030 target for greenhouse gas

[15] Washington State DOT's Travel Washington Intercity Bus Program is an excellent example of such a service that keeps otherwise-isolated rural communities connected to each other and to larger metropolitan areas by transit.

emissions at 40% below 1990 levels, putting the force of law behind California's climate-change mitigation aspirations.

In September 2017, the California Legislature passed a package of bills to address California's housing crisis. The package includes SB 2, a revenue measure expected to raise $200-300 million per year; SB 3, a $4 billion affordable housing bond; SB 35, a bill to streamline the approval of infill multifamily housing, and a dozen other bills intended to promote housing affordability. This package is a first step towards transforming land use in the state to become more transit-supportive.

## 2.3b A Thriving, Growing California

The California Department of Finance forecasts the state's population will increase by 17% from about 39 million in 2015 to nearly 52 million in 2060. Significant population increases will occur in planning regions that are already home to the largest populations — the areas overseen by the SCAG, MTC, SANDAG, and SACOG Metropolitan Planning Organizations (MPOs).

California is now the sixth[16] largest economy in world, a globally innovative place that will attract people and jobs for generations. For most of the 20th century, the state accommodated new growth by sprawling into the suburbs and planning for automobile travel first and foremost. By adopting a new, transit-supportive approach to growth, California can sustain population and job growth in a more sustainable and cost-effective way. There is already ample evidence that Californians themselves are enthusiastic about this new path; in 2016 alone voters across the state approved eight ballot measures that will raise money for transit.

## 2.3c Changing CEQA

SB 743 (2013) changed the criteria for how governments assess the environmental impacts of transportation and transit-supportive land use projects. The changes will especially benefit projects like bike lanes and transit priority lanes.

The state's old criteria allowed lead agencies to assess environmental impacts using estimated changes in the delay of vehicles. The new procedure requires local governments to assess impacts to vehicle miles traveled. Under the previous analytical method, interventions essential to increasing transit vehicle speed, reliability, and patronage, such as transit signal priority, queue jumps, and bus-only lanes, would be assessed as having a significant, negative environmental impact. Even though such proposals could increase the number of people moving

[16] Department of Finance State of California. (2017). *Gross State Product*. Retrieved September 26, 2017, from http://www.dof.ca.gov/Forecasting/Economics/Indicators/Gross_State_Product/

through a corridor, the analytical method only considered impacts to vehicle delay. With the new analytical method, such projects would likely be seen as having a beneficial impact.

New guidelines from the Governor's Office of Planning and Research assume that certain transit-supportive land use projects and efforts to prioritize transit vehicles will have a less-than-significant impact, allowing lead agencies to avoid extensive environmental review of such projects.[17]

## 2.4 Mixed Challenges and Opportunities

### 2.4a An Age of Transportation Innovation

"Innovative mobility" encompasses two sources of progress that both separately and together affect mobility options.

The first is innovation in business models. By integrating two or more existing technologies, firms can implement new business models or implement business models at smaller scales than previously technically possible or economically feasible.

Reduced scale and capital requirements mean that mobility can be serviced by a smaller, less-resourced startup. These new, agile, small private firms can respond quickly to changing market conditions and consumer preferences and can serve niche markets, not a forte of public transit.

Early-stage investors seeking high-growth opportunities have funded a surge in new passenger transportation and small-package logistics startups. Nine percent[18] of global startup companies with valuations of over $1 billion are involved in transportation. Investors effectively subsidize capital costs and operations as companies seek scale and network effects necessary to amortize costs and earn revenues sufficient to achieve a profit. However, unlike with public transit, this subsidy is not patient or permanent. Bridj, which provided microtransit service, is one example of an innovative mobility company that ceased operations after it ran out of subsidy. Transit agencies will need to be prepared to serve mobility gaps left by firms which exit the space.

The second source of innovation is advancements in vehicle technology, which can bring new capabilities or reduce costs and commercialize once-niche products. Research and development

[17] California, S. O. (2017, November 27). *Transportation Impacts (SB 743)*. Retrieved from: http://opr.ca.gov/ceqa/updates/sb-743/
[18] Crunchbase (2017). *The Crunchbase Unicorn Leaderboard*. Retrieved from: https://techcrunch.com/unicorn-leaderboard/

of this new technology is typically cost-intensive. Advancements are made by large, existing firms and well-financed startups, many of which are focused on components and systems needed for vehicle automation. Many of these advancements will have broader applications for transit and transportation. For instance, improvements to light detection and ranging (LIDAR) sensors may one day be used to enforce HOV restrictions.

Public transit has an immense growth opportunity to combine technological innovation with its comparative advantages: scale, public funding, regulatory authority, and pursuit of public interest. However, the a lack of strategic approach will lead to a growing gap in effectiveness between public and private mobility services. The need for a strategic approach motivates recommendations for statewide ticketing, open data and systems, and connected infrastructure.

## 2.4b The Mobility Landscape is Changing

The Baselines Report[19] documented the expansion of private Transportation Network Companies (TNCs) like Lyft and Uber. First offered in 2012, these services represent a significant change in passenger services available in the state. Stakeholders interviewed for the STSP consider TNCs to be both competitive threats and potential partners, and many agencies wish to take a "trust-but-verify" approach to potential collaborations. However, virtually no TNC data is available to transportation officials and transit agencies, and verifying that partnerships serve the public interest is difficult.

Statewide high-speed rail also looms on the horizon. The California High Speed Rail Authority expects[20]to open the San Jose to Bakersfield segment for passenger service in 2025. This is an exciting milestone, but also reinforces the need for local transit agencies to provide trips to and from the State's HSR backbone. Agencies will need to redesign their routes and schedules to accommodate this new system. The opening of HSR also provides an impetus to implement a statewide ticketing system, which will ease passengers' point-to-point journeys and foster collaboration between different transit agencies.

Finally, employer-sponsored commuter shuttles are proliferating[21] in the Bay Area, both in coordination with and in competition to publicly operated commuter transit service. For employers without large worksites, it is less feasible to provide large shuttle buses. However, both Lyft and Uber now offer commute-focused, shared-ride TNC products designed to qualify towards the IRS's $255 monthly tax-exempt transportation fringe benefit. This development can bring new competition to commuter transit markets throughout California.

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[19] Page 193-200
[20] California High Speed Rail Authority. (2016). *Connecting and Transforming California 2016 Business Plan*. Retrieved from: http://hsr.ca.gov/docs/about/business_plans/2016_BusinessPlan.pdf
[21] Page 200

# Chapter 3: Future Vision

## 3.1 Vision and Values

Public transit in California must offer a useful and attractive means of getting people where they need to go. Because transit service is provided not by the State but by over a hundred local transit agencies and 58 county transportation commissions, any State transit vision must be a shared one.

UCLA ITS proposes a vision for transit that imagines an integrated transit system that California does not yet have, but one that it must develop in order to accomplish its environmental, economic, and social ambitions.

Figure 3-1: Vision Statement for the Future of Transit in California


### California's Values for Transit

**Affordable** Transit fares are structured so as not to make riding transit burdensome for essential trips, while also providing for the most effective and efficient use of subsidies.

**Equitable** The transportation system is a tool of empowerment for marginalized groups, and an enabler of opportunities for Californians. The public transit system is developed with public input for the benefit of all types of travelers, and with particular consideration for populations and areas with greatest mobility

| | |
|---|---|
| | needs. Where transit operates, it is available and accessible to all people. |
| **Healthful** | Public transit systems, and the larger transportation systems within which they operate, are built, operated, and improved in conjunction with the development of land-efficient land uses that enable community well-being, economic security, and climate adaptation. |
| **Sustainable** | Transit deployment and use supports state and local climate, environmental, and environmental-justice goals. |
| **User-Oriented** | Transit is frequent, safe, reliable, and easy to use for riders. Services are designed to be an attractive alternative to car travel, not simply a "last resort" for people who cannot rely on anything else. |

In pursuit of this vision and values, public transit must be successful in delivering its core competencies: 1) Providing public mobility for those with limited access to private mobility, such as the poor and those unable to drive, and 2) Enabling dense, highly productive urban districts to exist and thrive. The more transit becomes a viable option for people, and the more integral it becomes to everyday life in California, the greater its benefits will accrue to the entire population — even those who don't use it.

## 3.2 Statewide Transit-Ridership Performance Target

Recommended Goal:

**Double transit boardings per capita in the state between 2015 and 2030.**

Transit will play a central role in achieving many important state goals, including California's low-carbon metamorphosis, but only to the extent that people actually use it. Ridership (transit boardings) serves as a critical corollary measure that mostly, if not perfectly, gauges transit's success or failure in providing seamless, sustainable, and affordable mobility.

The 2015-2020 Caltrans Strategic Management Plan adopted a goal to double transit's share of trips made in the state between the 2010-2012 California Household Travel Survey and the next

expected survey based on 2020. However, while transit ridership is fairly easy to measure annually, estimating transit's *share* of all trips in the state requires extensive, infrequently collected data on overall travel patterns. Household-travel surveys do not occur often enough for modal share to serve as a regularly monitored performance indicator.

UCLA ITS recommends that Caltrans adopt *Transit Boardings*[1] *per Capita* as a statewide transit performance measure. Transit boardings rise and fall in response to changes in both transit use and population. As the focus of this plan is on transit service provision and utilization, we propose adopting Transit Boardings per Capita as a primary performance metric, as it controls for population changes (both increases and declines), resulting in a measure that focuses directly on transit utilization.

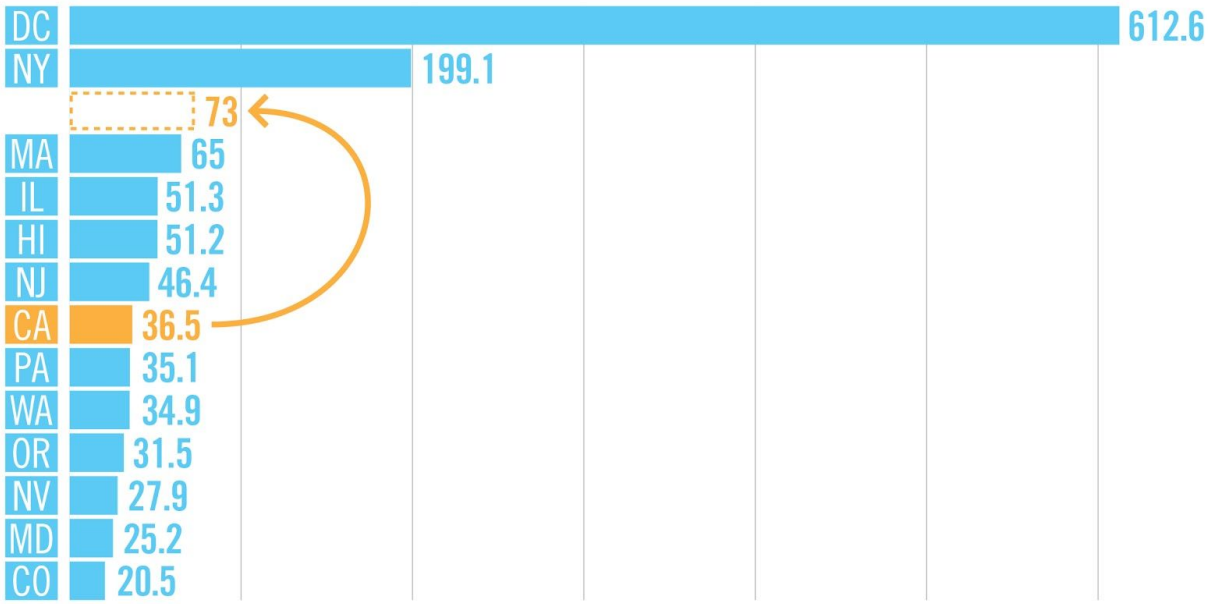
Using this measure has the following benefits:

- Transit boarding estimates are reported monthly for transit agencies representing roughly 98% of statewide ridership and annually for all transit agencies.
- Population estimates are reported annually by the U.S. Census Bureau and California Department of Finance, which also produces county-level population projections.
- Population and boardings estimates are available at a variety of geographic scales (city, county, region, and statewide), allowing the comparative assessment of performance at various scales.

UCLA ITS also recommends that Caltrans replace its current target of doubling the transit mode share by 2020, with a new target to **double transit boardings per capita in the state between 2015 and 2030, from 36.5 unlinked passenger trips (UPT)/person to 73.** Achieving this target would put California's per-capita transit ridership third among U.S. states and districts, as illustrated in Figure 3-2 below.

[1] Boardings and unlinked passenger trips are interchangeable terms. For the background on this recommendation, see Appendix C-14: Assessing Transit's Performance.

Figure 3-2: Transit Boardings per Capita by State, 2015




The above vision, values, and ridership performance target cannot realistically be achieved unless traffic congestion is better managed in the state's most gridlocked, economically productive areas so that transit service can be reliable, frequent, and useful where it is needed most. While there are many ways -- large and small -- to increase transit reliability, frequency, and usefulness, the research consensus suggests that dynamic motor-vehicle pricing is the most effective way to achieve and maintain congestion relief without encouraging more private vehicle travel. Thus, how and to what extent California chooses to price and manage motor-vehicle use will go a very long way toward determining not only transit's future role in the state, but also the future sustainability and livability of urban areas as well.

## 3.3 Place-Based Visions for California's Transformation

Rather than prescribing a single, one-size-fits-all vision for what transit should look like in California, public officials and transportation managers should think about the role transit should play in different types of neighborhoods and places. A "successful" transit service in a small town will look and operate differently from a traditional urban operator with line-haul service along busy, high-demand corridors. Understanding these different contexts is crucial to ensuring that transit reaches its full potential throughout California. This report further articulates transit's role in the different place types identified in Caltrans' 2010 Smart Mobility

Framework.[2] The Framework divides place types into "anchored" and "transitional" places, with the later places evolving over time to change place-type definition.

Table 3-1: Summary of Place-Based Transformations

| Place Type | Vision for Transit's Role | Present-Day Examples |
|---|---|---|
| **Inside Metropolitan Areas** | | |
| **Urban Cores and Centers**<br>High-density, mixed-use places including urban cores and transit-oriented activity centers | • Serve as a primary means of mobility for trips 1.5 to 5 miles in length, capturing 20-50% of all trips by 2040<br>• Provide everyday shared mobility for a range of urban residents<br>• Provide frequent, reliable, and affordable mass transportation services using high-capacity vehicles and transit-priority roadway treatments<br>• Develop strong links to all intercity/interregional travel hubs including train stations and airports<br>• Accommodate motorized mobility needs in support of transition to complete streets, pursuit of Vision Zero, and reducing auto dependency<br>• Integrate transit with walking and bicycling | • Downtowns of Long Beach, San Francisco, San Jose, Sacramento, Los Angeles, San Diego, and Oakland<br>• Transit-oriented, high-density neighborhoods outside of central cities, like Berkeley, Hollywood, Pasadena, and Santa Monica |
| **Close-in, Compact Communities**<br>Inner-ring suburbs with small-to-medium-sized downtowns or corridors, which regional and local land use planners target for future change. | • Capture 8-30% of all trips by 2040<br>• Provide excellent transit coverage with connections to high-capacity transit lines and regional centers<br>• Transit agencies provide infrastructure and mobility services to encourage strategic land-use changes<br>• Accommodate motorized mobility needs in support of transition to complete streets, pursuit of Vision Zero, and reducing auto dependency<br>• Transit is strongly integrated with walking and bicycling | • Downtowns of San Rafael, Carlsbad, and Uptown San Diego<br>• Westwood/Rancho Park (LA)<br>• Land Park (Sacramento)<br>• San Pablo Ave (East Bay)<br>• Vermont Ave (LA) |
| **Transitional Suburban Communities**<br>These are suburban areas further from the urban core or regional centers which regional and local land use planners target for future change | • Capture 10-20% of all trips by 2040<br>• Transform centers or corridors into more location-efficient places by creating "Town Center" mobility-hubs, which allow seamless connections between public and private mobility services<br>• Emphasis on express commuter-bus services, vanpools, and private shuttles that utilize extensive HOV networks to connect with regional employment centers | • Duarte<br>• Azusa<br>• Rancho Cordova<br>• Fremont/Warm Springs<br>• University Center (San Diego) |
| **Anchored Suburban Communities**<br>Urban form makes traditional fixed-route transit service more challenging in these areas | • Capture 5 - 15% of all trips by 2040<br>• Emphasis on express commuter-bus services, vanpools, and private shuttles that utilize extensive HOV networks to connect with regional employment centers<br>• Expansion of shared mobility options in areas where | • Chino<br>• Thousand Oaks<br>• Cupertino<br>• El Cajon |

[2] The Smart Mobility Framework describes archetypal place types and offers guidance on matching these place types to real places.

| | | |
|---|---|---|
| | traditional fixed-route services do not function effectively?<br>• Attempt to create "Town Center" mobility-hubs concept, as discussed above | |
| **Outside Metropolitan Areas** | | |
| **Compact Communities**<br>Historic cities and towns with walkable main street areas and newer places with transit-supportive community design | • Capture 5 - 20% of all trips by 2040<br>• Serve downtown area and major trip attractors (e.g. university, peripheral retail district) with moderately frequent fixed-route transit service<br>• Provide regularly scheduled intercity transit services that connect with major destinations such as hospitals and community colleges<br>• Encourage bicycling and provide secure bicycle-parking facilities for intercity transit passes | • Davis<br>• San Luis Obispo<br>• Eureka/Arcata<br>• Dinuba<br>• Red Bluff<br>• Healdsburg |
| **Rural Towns**<br>Small places with walkable main streets | • Capture 3 - 10% of all trips by 2040<br>• Provide nonprofit demand-responsive mobility services<br>• Provide regularly scheduled, if infrequent, intercity transit services that connect with major destinations such as hospitals and community colleges | • Hilmer<br>• St. Helena<br>• Ferndale<br>• Clearlake<br>• Los Osos |
| **Rural Settlements**<br>Scattered residences and commercial uses with minimal walkability | • Transit agencies provide demand-responsive mobility as a social service targeted at seniors, the disabled, and those of limited means<br>• Connect to Rural Towns and Compact Communities, as practical | |

See Appendix C-16: Place-based Visions for Transit in California for additional discussion for each place type.

## 3.3a Areas of Accelerated Change

Disadvantaged communities and those with planned high-speed rail stations are both slated to receive significant public investments to accelerate changes in the scope and scale of their transportation needs.

### Disadvantaged communities

Public transit provides a critical social service to disadvantaged and vulnerable populations, particularly those who cannot drive due to factors such as age, income, or disability. SB 535 (2012) and AB 1550 (2016) direct 25% of California's climate investments, including the TIRCP and LCTOP programs, to benefit CalEnviroScreen-designated disadvantaged communities. Because these communities will receive greater resources and have greater social-service mobility needs, the areas where they live need to be the focus of accelerated change to support transit's equity and affordability missions. Because mass transit and shared mobility benefit from network effects — a virtuous cycle of more users justifying more routes and more frequent

service which then attracts even more users — targeted actions to support transit can have a transformative effect in these neighborhoods.

### High-speed rail cities

The development of high-speed, interregional, and regional rail provides opportunities for accelerated land use and transportation changes that can greatly expand transit's role in these places. Cities with planned high-speed rail stations and regional and sub-regional rail hubs identified in the 2018 State Rail Plan should be targeted for improved transit service to enable a transition away from auto dependency.

# 3.4 Creating a Better Future for Riders

Creating a positive user experience is crucial to increasing per capita transit ridership in order to meet the State's environmental goals. The following vignettes describe how the policies, strategies, and action items we recommend for the STSP might combine to improve a Californian's trip.

## 3.4a Better Mobility in Action: Monica's Journey

Monica lives near the San Leandro BART station in the San Francisco Bay Area and typically enjoys a 27-minute commute to her job in Downtown Oakland. However, today Monica will spend h er day in downtown Redwood City. In 2018, Monica has 3 options for this trip:

Table 3-2: Monica's 2018 Mobility Options

| **Mode** | **Time** | **Personal Cost** with tolls & parking |
|---|---|---|
| Drive personal vehicle | 50 minutes | $26.45[3] |
| TNC (UberX or Lyft) | 46 minutes | $38[4] |
| Shared TNC (UberPool, LyftLine) | 57 minutes | $29[3] |
| Public Transit | 1 hour 57 minutes | $12.95 |

[3] The out-of-pocket cost of this trip would actually be $16 for tolls, parking, and gas. However, cars are depreciating assets that are expensive to own, insure, and maintain, so with these "hidden" costs included, the true cost of a car trip is closer to $26.45.
[4] Peak period estimate

If Monica does not have a private vehicle available for this trip or if she chooses not to drive, the trip made via a Transportation Network Company (TNC) as the sole passenger is convenient and straightforward, if costly. However, such a trip won't incrementally reduce road traffic or greenhouse gas emissions relative to driving. A greater public benefit accrues when Monica makes the trip matched with others: one or two fellow passengers in a shared TNC or rideshare, or dozens on public transit. These modes are also less costly to Monica, who shares her one private household vehicle due in part to a high rent burden.

Monica's 2018 public transit trip takes her on 3 transit services:

Table 3-3: Monica's 2018 Transit Trip

| Mode: | Walk | BART | Dumbarton Express | Caltrain | Walk | Total |
|---|---|---|---|---|---|---|
| **Trip segment** | Home → BART | San Leandro → Union City | Union City → Palo Alto Transit Center | Palo Alto → Redwood City | Station to work site | |
| **Minutes**[5] | 10 | 16 | 57 | 29 | 5 | 117 |
| **Cost** | $0 | $3.25 | $4.50 | $5.20 | $0 | $12.95 |

## Near-Future (2023): Using existing services for integrated mobility

A near-future Monica has a similar work situation, but a different travel experience. This five-year-older Monica walks her usual route from home to San Leandro BART, but then heads to Hayward. She walks two blocks from the Hayward BART station to Mission Boulevard, an arterial route for Amador Valley drivers going to the Peninsula. A third-party app that manages mobility as a service and syncs up with the Statewide Ticketing and Accounts System tracks Monica's route and progress in real time and provides her with options for the rest of her trip, including sharing a ride with someone going the same way. She goes to Peet's Coffee on the corner of Mission & B, where another app that integrates with her mobility app has arranged to have her usual morning coffee prepared and waiting at this atypical location.

Rohit, a rideshare driver with a 4.9 safety rating, picks her up from the curb on the way to his job near Stanford University. Sharing the ride adds 4 minutes to his trip time to drop Monica off near the Hayward Park Caltrain station, but he earns $10.90,[6] which covers his full costs while Monica is in the vehicle: vehicle operations, maintenance, depreciation, and the San Mateo bridge toll. His 46.3-mile single-occupancy vehicle trip from Livermore to Stanford typically

[5] including wait
[6] All amounts in 2018 dollars

costs him $29.77 (with the single-occupancy vehicle toll), but today his outlay is only $16.37 (with the reduced carpool toll).

Table 3-4: Monica's 2023 Trip

| Mode: | Walk | BART | Walk | Rideshare | Walk | Caltrain | Walk | Total |
|---|---|---|---|---|---|---|---|---|
| **Trip segment** | Home → BART | San Leandro → Hayward | Hayward BART to Mission Blvd | Hayward → Hayward Park Caltrain | Dropoff → platform | Hayward Park → Redwood City | Station to work site | |
| **Minutes**[5] | 10 | 8 | 5 | 33 | 3 | 25 | 5 | 89 |
| **Fare** | $0 | $1.95 | $0 | $10.90[7] | $0 | $3.20 | $0 | $16.05 |

Importantly, Monica didn't need to actively arrange her trip or worry about what to do if one of her usual mobility services was late or didn't show up. An algorithm made travel arrangements for her and seamlessly paid the fares based on the trip she took. In this case, Monica took Caltrain from Hayward Park to Redwood City, but depending on the driver's destination, she could have been routed on El Camino Real BRT. If no drivers offering carpools were making the transbay trip, the mobility service might have routed her on the Dumbarton Express or AC Transit Route M.

### Future (2028): Using future services for integrated mobility

With ample data from private mobility providers and strong political support for transit services to complement road and parking pricing implemented to manage congestion and emissions, planners at AC Transit and MTC have identified and responded to the growing demand for Transbay bus services. AC Transit now offers frequent express service from the Hayward BART station to the Hillsdale Caltrain station. Whereas in 2018 this service ran every 45 minutes during rush hours only, it now departs every 15 minutes during peak hours and runs all day, meeting most BART trains to allow for easy and time-efficient transfers. With only three intermediate stops, priority or dedicated lanes on all surface streets, and the use of a new congestion-free San Mateo Bridge Express Lane, the trip now takes 26 minutes instead of 48. Those who previously alighted at one of the nine AC Transit transbay service stops in Foster City are now served by a connection to demand-responsive microtransit.

As walkable, urban employment locations have grown in popularity, the Foster City Transportation Management Organization (TMO) and Chamber of Commerce have been eager to maintain the economic competitiveness of the city's large suburban office park. The TMO and CoC have funding commitments from property owners and businesses and have contracted with

[7] With reduced carpool toll

a private mobility service provider to facilitate access around the city. Eight vehicles now operate demand-responsive microtransit service, which has a small fare for local trips but is free to connecting public-transit passengers, employees at participating companies, and residents at participating housing complexes. The service is very popular with the lunch crowd due to its quick response times and destination flexibility.

To attract more riders on express Transbay trips from Hillsdale Caltrain to the East Bay, AC Transit worked with Caltrain and the new Foster City TMO. In 2017, Caltrain operated a single shuttle bus for 10 daily peak-period trips, but now at least one microtransit vehicle meets every east- and westbound AC Transit bus with passengers alighting in Foster City. The combination of Foster City microtransit and more frequent eastbound AC Transit transbay service allows Caltrain, enabled by capital and operations improvements, to increase its rail service frequency while serving increasing demand from those living near or connecting through the Hillsdale station. The station area has residential and job growth typical of Transitional Suburban[8] station areas throughout the state.

Similar arrangements throughout their service area allow Caltrain to offer higher-quality connecting services while focusing on their core competency of planning and operating reliable, efficient line-haul commuter rail services.

Pedestrian network improvements have cut Monica's walk to the BART station from 10 to 7 minutes. Sensing that Monica has a tight connection at Hayward BART to the Transbay bus, her preferred mobility-as-a-service app arranges for her morning coffee to come from a vendor's kiosk at the Hillsdale Caltrain station. The cart is operated by a local nonprofit that has partnered with Caltrain to create job training and economic opportunities, all while enhancing passenger amenities and providing commuters with an increased sense of safety and stability.

Monica's 2028 trip takes her on three mass transit modes which exist today, but all of which have been optimized to better serve users.

[8] See Transitional Suburban place-based vision in Table 3-7.

Table 3-5: Monica's 2018 vs 2028 Mobility Options

| | **Time** (in minutes) | | **Cost**[9] (in 2018 dollars) | |
|---|---|---|---|---|
| | **2018** | **2028** | **2018** | **2028** |
| **Drive personal vehicle** | 50 | 50 | $26.45[10] | $34.39 |
| **TNC (UberX or Lyft)** | 46 | 46 | $38[11] | $49 |
| **Shared TNC (UberPool, LyftLine)** | 57 | 57 | $29[3] | $38 |
| **Shared, Automated TNC**[12] | 57 | 57 | Not available | $15 |
| **Public Transit** | 117 | 65 | $12.95 | $9.65 |

Table 3-6: Monica's 2028 Trip

| **Mode:** | **Walk** | **BART** | **Express Bus** | **Caltrain** | **Walk** | **Total** |
|---|---|---|---|---|---|---|
| **Trip segment** | Home → BART | San Leandro → Hayward | Hayward BART to Hillsdale Caltrain | Hillsdale → Redwood City | Station to Work site | |
| **Minutes**[5] | 7 | 8 | 28 | 17 | 5 | 65 |
| **Fare** | $0 | $1.95 | $4.50 | $3.20 | $0 | $9.65 |

[9] Assumes a real (after-inflation) 30% increase in automobile operation costs due to increases in tolls, parking charges and fuel expenses, presented in 2018 dollars.
[10] The out-of-pocket cost of this trip would actually be $16 for tolls, parking, and gas. However, cars are depreciating assets that are expensive to own, insure, and maintain, so with these "hidden" costs included, the true cost of a car trip is closer to $26.45.
[11] Peak period estimate
[12] Pricing and availability are uncertain; this mode is included to illustrate possible future options.

# 3.5 Goals, Policies, and Strategies for California Transit

Chapter 1 of this report introduced the "Goal, Policy, Strategy, Measure" hierarchy for categorizing recommendations. The table below lists all the recommendations in this report, sorted according to the GPSM typology. The remainder of this report (Chapter 4: Transforming California and Chapter 5: Making Transit Excellent) is dedicated to exploring these recommendations in detail.

These Goals, Policies, and Strategies have also been designed to leave planners and officials with room to evaluate future, unforeseen developments in the transit industry. While there is no way to know for sure what the future holds for transit in an area of transportation innovation, potential actions and measures can be evaluated against the Goals, Policies, and Strategies framework to ensure that those actions are consistent with the statewide vision and values for transit.

Table 3-7: Goals, Policies, and Strategies for California Transit

| | |
|---|---|
| **TC** | **Effective, high-quality transit is integral to transforming California** |
| TC-1 | Transit is necessary to enable dense, highly productive, low-carbon economic agglomerations to exist and thrive |
| TC-1.1 | Increase transit service availability, frequency, and reliability to complement dynamic pricing with meaningful travel choices |
| TC-1.2 | Promote transit investments and operations that significantly reduce the GHG impact of mobility |
| TC-2 | Implement transit-supportive land use strategies that also benefit biking and walking |
| TC-2.1 | Ensure that transit provides efficient mobility for urban and compact communities |
| TC-2.2 | Implement transit-supportive parking policies in areas with high-quality transit services |
| TC-2.3 | Pursue complete, mixed-use, and higher density neighborhoods near frequently-served transit stops and stations to enhance the accessibility of the transit network |
| TC-2.4 | Improve planning coordination between transit agencies and land use authorities |
| TC-3 | A Transit First policy advantages walking, bicycling and the use of public transit in places where these modes can best thrive |
| TC-3.1 | Support communities' transition to complete streets and pursuit of multimodal safety goals |
| TC-3.2 | Pursue transit-only lanes and transit priority to enhance comparative advantage in high-ridership, high-frequency, high-congestion transit corridors |

| | |
|---|---|
| TC-4 | Transit planning and operations promote healthy communities and social equity |
| TC-4.1 | Offer enhanced transit services in disadvantaged communities |
| TC-4.2 | Support local efforts to repurpose street space to enhance community well-being |
| TC-4.3 | Develop new approaches to enhance accessibility for seniors, the disabled, and persons of limited means |
| TC-4.4 | Encourage the use of comprehensive equity metrics and analyses |
| TC-5 | Pursue strategic opportunities for delivering transit outside of metropolitan California |
| TC-5.1 | Develop and support non-profit mobility services in rural areas and disadvantaged communities |
| TC-5.2 | Pursue new models for intercity mobility and connections with regional and statewide rail |
| **SE** | **A California transit passenger's multimodal experience should be seamless, safe, and affordable** |
| SE-1 | Take a user-centric approach to improving the passenger experience |
| SE-1.1 | Use technology to improve a user's experience, especially by offering reliable real-time arrival information for every vehicle in the state |
| SE-1.2 | Create Statewide Ticketing and Accounts Systems for seamless integrated mobility on transit and other transportation services |
| SE-1.3 | Support Regional Comprehensive Operational Analyses (RCOAs) to enable coordinated, seamless regional mobility |
| SE-2 | Reduce actual and perceived threats to safety to lower a key barrier to using transit |
| SE-2.1 | Provide users and agencies with resources to ensure consistently safe and secure on-board and out-of-vehicle experience |
| SE-2.2 | Work with law enforcement community to address transit's specific needs |
| SE-3 | Restructure and simplify fares to bolster transit ridership |
| SE-3.1 | Reduce non-financial barriers for agencies which wish to offer fare-free transit |
| SE-3.2 | Provide statewide guidance for a easy-to-understand, low-friction transit fare structure |
| SE-3.3 | Provide a platform for common verification of eligibility for discounted fares and passes |
| **IA** | **Transit agencies must become more innovative and agile to vigorously pursue their missions** |
| IA-1 | Transit agencies must be able to understand and respond to changing market and demographic conditions |
| IA-1.1 | Illuminate the effects and potential of private mobility services by publishing operational data |

| | |
|---|---|
| IA-1.2 | Provide resources for more frequent, robust surveys of transit users and nonusers |
| IA-1.3 | Improve transit's efficiency through better regional planning and coordination |
| IA-1.4 | Use statewide marketing guidance, tools, and campaigns to enhance transit's perceived attractiveness |
| IA-1.5 | Collaborate strategically with employers and Transportation Management Organizations (TMOs) on shared mobility efforts |
| IA-2 | Provide common data and tools for agencies to track, understand, and optimize their operations |
| IA-2.1 | Establish a Statewide Transit Data Warehouse to support advanced performance analysis and multi-agency collaborations |
| IA-2.2 | Implement a statewide, web-based platform for required reporting and funding applications |
| IA-2.3 | Adopt open data standards to improve service quality, planning and operating analytics, and multi-agency collaboration |
| IA-3 | Understand and respond proactively to technological innovations which affect transportation |
| IA-3.1 | Coordinate preparations for connected and automated vehicles |
| IA-3.2 | Adopt technology systems standards to improve transit's technological agility |
| IA-3.3 | Partner with private mobility services that can increase use of transit, bicycling, and walking |
| IA-4 | Foster innovation by transit agencies and individuals |
| IA-4.1 | Provide transit agencies with tools and support for a transition from transit operator to mobility manager |
| IA-4.2 | Expand and enhance transit's professional development opportunities to empower innovators |
| **SR** | **Use strategic investments to make transit more sustainable and resilient** |
| SR-1 | Create more resilient, adaptive transit infrastructure |
| SR-1.1 | Conduct research and disseminate best design practices for adaptive transit infrastructure |
| SR-1.2 | Encourage transit agencies' participation in local climate adaptation and resilience planning |
| SR-2 | Use state transit funding programs for strategic capital investments |
| SR-2.1 | Allocate capital funding to agencies that prioritize investments in state of good repair |
| SR-2.2 | Help to lead California's transition to clean and energy-efficient heavy duty vehicles |

| | |
|---|---|
| SR-2.3 | Pursue transit-supportive street design through roadway construction, maintenance, and operations |
| SR-2.4 | Prioritize funds for updated technology systems that enable more innovative infrastructure and vehicles |
| SR-2.5 | Encourage and prioritize investments in bus rapid transit |
| SR-3 | Pursue new state and local sources of transit funding |
| SR-3.1 | Create statewide guidance for use of new and emerging local revenue mechanisms |
| SR-3.2 | Enhance mass transit services with revenues from congestion pricing systems |

# Part 2:
# **Implementation**

# Chapter 4: Transformative Changes

Achieving California's vision for transit and achieving the State's transit-related goals and performance targets requires transformative change: to transportation and land-use systems in ways that support transit, and to transit agencies themselves in ways that better support Californians' mobility needs.

## 4.1 Transforming California to Support Transit

### 4.1a Encourage Transit-Supportive Congestion Pricing in California's Most Gridlocked Areas

When deciding which mode of transportation to use for a given trip, travelers generally compare the time, monetary, and uncertainty costs that each mode would incur for that particular trip. Travelers who choose to drive their car usually focus on the travel time and variability, fuel, and any tolls or parking costs, while paying less attention to the fixed and sunk costs of auto purchase, insurance, and maintenance. When travelers live in a place with reliable transit, they typically weigh the costs of fares and the uncertainty of transfers and waiting, along with the time spent inside the vehicle.[1] Auto owners therefore tend to view the time, monetary, and uncertainty costs of auto travel as lower than those of transit travel, even if their total costs of vehicle ownership and use are much higher in the long run.[2] The result of these lower out-of-pocket costs is to make personal auto travel appear more attractive.

This is important because private vehicle usage produces extensive negative externalities; that is, costs imposed on others that are not borne by the driver. Some of the most significant externalities produced by vehicle usage include roadway congestion, the risk of crashes, the cost of building and maintaining roadway infrastructure, greenhouse gas emissions, and air, soil and water pollution. However, it is possible to mostly internalize external costs through the use of pricing, which has been shown to significantly influence driving and transit use.[3]

Among these externalities, traffic congestion is especially acute because millions of people experience it daily. The aim of vehicle pricing is not punitive, but rather to increase the efficiency, efficacy, and equity of the road network. Pricing roadway use increases efficiency and

[1] Iseki, H., Smart, M., Taylor, B. D., & Yoh, A. (2012). Thinking outside the bus. *Access Magazine*, *1*(40).
[2] Harvey, G. W. (1994). Transportation pricing and travel behavior. Transportation Research Board Special Report, (242). Chicago
[3] Anas, A., & Lindsey, R. (2011). Reducing urban road transportation externalities: Road pricing in theory and in practice. *Review of Environmental Economics and Policy*, *5*(1), 66-88.

smooths traffic flows by shifting when, where, and how people travel. Pricing fuel increases efficacy by encouraging the use of cleaner vehicles and other modes that reduce emissions per mile traveled. From an equity perspective, pricing the use of roadways and parking spaces charges people in proportion to the social and environmental costs their choices impose on society, encouraging them to make choices that have fewer societal impacts.[4] Managed properly, pricing can actually move *more* people, and in some cases more vehicles, but with less wasted time and lower emissions.[5]

Pricing can help travelers identify the costs of their private automobile use and weigh those costs against the benefits. This, in turn, reduces many of the external costs that private automobile use currently imposes on common infrastructure. In particular, the congestion caused by private vehicles limits the effectiveness of transit service.[6] Consequently, a transit-supportive roadway pricing program could make transit travel more reliable and attractive. London, Singapore, and Stockholm have used pricing to achieve success with reduced congestion, better transit-schedule adherence, and increased transit ridership. As to the potential regressive impacts of a program to price motor-vehicle use, the State could require revenues from pricing to be directed toward transit and other forms of transportation disproportionately used by low-income people.

### 4.1a.i Complementing Motor Vehicle Pricing with Better Transit

Pricing motor-vehicle use has important benefits to, and implications for, transit. In general, pricing the use of roadway facilities at peak hours will moderate demand; when prices exceed the value of a car trip to the user, the would-be driver will choose different routes, different travel times, and/or different modes of travel. The benefit to transit is that the consequent reduction in roadway congestion means transit vehicles can operate more quickly and more reliably adhere to their schedules.

While pricing provides an impetus for travelers to consider their travel options more carefully, pricing roadway use on its own is not enough to manage overall travel demand. More and enhanced transit service (as well as other modal options) will be needed to provide a meaningful travel choice to travelers who have opted not to drive alone, so as not to inhibit Californians' mobility. To capture rising demand and serve as a viable alternative to car travel, transit service needs to be enhanced and expanded, especially in areas that have been targeted for congestion relief. With enhanced transit and roadway pricing in place, a "virtuous cycle" will emerge whereby pricing reduces the demand for driving and allows for better and faster transit

[4] Schweitzer, L., & Taylor, B. D. (2010). Just road pricing. ACCESS Magazine, 1(36).
[5] Verhoef, E. T. (2005). Speed-flow relations and cost functions for congested traffic: Theory and empirical analysis. Transportation Research Part A: Policy and Practice, 39(7), 792-812.
[6] Costly bottleneck expansion projects in built-out urban areas command an increasing share of state and local transportation funding, with increasing revenues coming from general taxes rather than transportation user fees

operations. With greater reliability and faster speed, transit will then be able to attract more riders and serve them more efficiently.

Transit agencies, regional planners, and State officials will need to pay careful attention to take full advantage of the opportunities afforded to transit by motor-vehicle pricing. The State should encourage any congestion pricing systems (on highways or in cordoned areas) to be dynamically priced so that congestion can be more effectively managed through prices that correspond to real-time demand and provide better, more reliable travel times for toll-payers (and transit users). In order to fund needed improvements in public transit in these tolled areas, State and regional officials should also ensure that a share of vehicle-pricing revenues is allocated to transit agencies that serve the priced and complementary corridors.

### 4.1a.ii Motor-Vehicle Pricing Options

The STSP Project Executive Committee requested an assessment of transit-supportive pricing options that do not penalize those who live in areas without transit options. Table 4-1, below, assesses whether each of eight identified mechanisms to price motor-vehicle use can:

- Remove transit from traffic congestion and increase vehicle speeds and reliability.
- Increase the attractiveness of transit relative to car travel.
- Be technically feasible for widespread implementation.
- Be equitable for rural areas, which typically lack meaningful transit alternatives.

Table 4-1: California's Options for Pricing Motor-Vehicle Use

| Pricing Mechanism | Removes transit from congestion? | Encourages transit ridership? | Technically feasible? | Equitable for rural areas? |
|---|---|---|---|---|
| Gas tax increases | ✘ | ✔ | ✔ | ✘ |
| VMT charges | ✘ | ✔ | ✔ | ✘[7] |
| Vehicle-hours-traveled charges | ✘ | ✔ | ✘ | ✘ |
| **Expanded Express Lanes program** | ◑[8] | ◑[9] | ✔ | ✔ |
| **Local cordon-area tolling** | ✔ | ✔ | ✔ | ✔ |
| **All-lane highway tolling** | ◑[8] | ✔ | ✔ | ✔ |
| **Comprehensive congestion tolling** | ✔ | ✔ | ? | ✔ |
| **Demand-based on-street parking pricing** | ◑[10] | ✔ | ✔ | ✔ |

**See Appendix C-12: Transit-Supportive Motor-Vehicle Pricing for an extended discussion of these options.**

[7] Assumes a mileage charge is additional to motor vehicle fuel taxes. Rural travelers are better off than urban travelers when motor vehicle fuel taxes are replaced by VMT fees that use the same rate in urban and rural areas. Rural drivers drive more miles than urban drivers, but typically in vehicles which are older and less fuel efficient (because they are larger). Weatherford, B. (2011). Distributional implications of replacing the federal fuel tax with per mile user charges. *Transportation Research Record: Journal of the Transportation Research Board*, (2221), 19-26.

[8] Only 13.5% of California's transit vehicle revenue miles traveled are on commuter buses and vanpools which could use managed lanes.

[9] Only 1.4% of California's transit trips and 7.5% of passenger miles traveled are on long-distance commuter bus and vanpool services which might utilize managed lanes.

[10] Demand-based parking pricing like SFPark and LA Express Park can reduce surface street congestion and a desire to avoid the charge can increase demand for alternatives to private automobile travel (including transit). However, these are both second-order effects, would not be universal, and are limited by the impacts of a vast off-street private parking supply.

Table 4-2: Summary of Transit-Supportive Pricing Options

| | Expanded ExpressLanes | All-lanes Highway Congestion Tolling | Cordon-area Tolling |
|---|---|---|---|
| **System Design** | • Add HOT lanes to existing freeways<br>• Toll single- occupant vehicles in HOT lanes with variable congestion- and distance-based charges.<br>• Adjust prices dynamically to achieve reliable 45+ mph speeds. | • In congested regions, price all freeways and highways with variable congestion- and distance-based charges.<br>• Adjust prices dynamically to achieve reliable 45+ mph speeds. | • Establish cordon tolling in high-congestion areas<br>• Levy tolls for entry, exit, and/or daily driving privileges within designated cordoned areas, neighborhoods and downtowns |
| **Transit Performance Improvement** | • Significant for transit routes operating on HOT lanes for long, uninterrupted distances.<br>• No improvement for other services. | • Significant performance improvement and cost reduction in transit operations on tolled highways.<br>• More modest improvements on nearby streets. | • Substantial performance and cost reduction in transit operations within cordon pricing zones.<br>• More modest improvements for operations on corridors leading to/from cordon areas. |
| **Transit Ridership Benefit** | • Largely limited to services utilizing HOT lanes during peak demand periods. | • Increased medium- and long-distance transit ridership due to toll avoidance. | • Increased transit ridership to, from, and within cordon pricing zones due to toll avoidance. |
| **Transit Funding Benefit** | • Revenues may fund transit service utilizing HOT lanes. | • Revenues may fund increased transit service. | • Revenues may fund increased transit service. |
| **Effects on complementary modes** | • Expanded highway facilities and direct access ramps may decrease attractiveness of walking and bicycling. | • Increased demand for shorter trips that may be feasible by walking or bicycling.<br>• Revenues can fund improvements to pedestrian and bicycle infrastructure. | • Increased walking and bicycling in cordon areas.<br>• May catalyze road diets and improvement of pedestrian and bicycle infrastructure in and around cordon areas.<br>• Revenues can fund improvements to pedestrian and bicycle infrastructure. |

## 4.1a.iii Cordon-Area Tolling

UCLA ITS recommends that the state promote cordon tolling in selected high-density areas to manage congested roadway networks, improve transit service, and increase transit ridership.

### About cordon tolling

In contrast to freeway tolling, cordon-area tolling programs price all roadways in a geographic area. Once a tolled area is defined (its borders are the "cordon"), vehicles must pay either:

1. once for every entry into the tolled area;
2. once for every crossing of the cordon, whether entry or exit; or
3. a single daily fee for the right to drive in and out of the cordon area.

Due to this structure, cordon-area pricing works best when cordons encompass single or multiple adjacent neighborhoods rather than entire large cities or county subregions. However, multiple, adjacent or nearby cordon areas could also be established. Tolls could be adjusted to achieve a target maximum number of vehicles within the cordon area, a target free-flow speed on select surface streets within the cordon area, or target queue lengths or vehicle wait times at select intersections within the cordon area.


While forms of cordon pricing have been established in cities around the world, such as London, Stockholm and Singapore, efforts to implement cordon pricing in the United States have met with significant political resistance.[11] Cordon pricing will likely be most attractive in areas of

[11] http://articles.latimes.com/2008/dec/30/local/me-sanfrancisco-traffic30
http://roadpricing.blogspot.com/2010/12/san-francisco-congestion-pricing-debate.html
Wachs, M. (1994). Will congestion pricing ever be adopted?. ACCESS Magazine, 1(4).; Roth, M. (2010). Congestion Pricing Fracas Shows Lamentable Ignorance of Facts. Streetsblog San Francisco http://sf.streetsblog.org/2010/12/03/congestion-pricing-fracas-shows-lamentable-ignorance-of-facts; Snyder, T.(2013). Confronted with Congestion Pricing, People Clamor for Transit, Gas Tax. Streetsblog USA usa.streetsblog.org/2013/01/24/confronted-with-congestion-pricing-people-clamor-for-transit-gas-tax/

California with the greatest congestion on surface streets where walking, bicycling, and transit are robust mobility options. [12]

Recommendations for Caltrans:

TC-1.1B Caltrans should support local governments that wish to initiate cordon pricing systems:

- Provide planning and technical support for local and regional authorities considering cordon-area pricing to address traffic congestion.
- Prioritize planning grants for proposals that include studies of cordon areas and other congestion pricing.
- Require locally-initiated congestion pricing programs to use electronic toll collection platforms that are compatible with the State's FasTrak system.

TC-1.1D Support the state's first cordon-tolled areas with additional funding and technical assistance.

- Once one or more tolled cordon areas have been established in California, Caltrans should facilitate inter-regional knowledge transfer on experiences and best practices.
- Caltrans should also prioritize discretionary funding (e.g. Active Transportation Program) for sustainable mobility projects and programs in the state's first cordon-tolled areas.

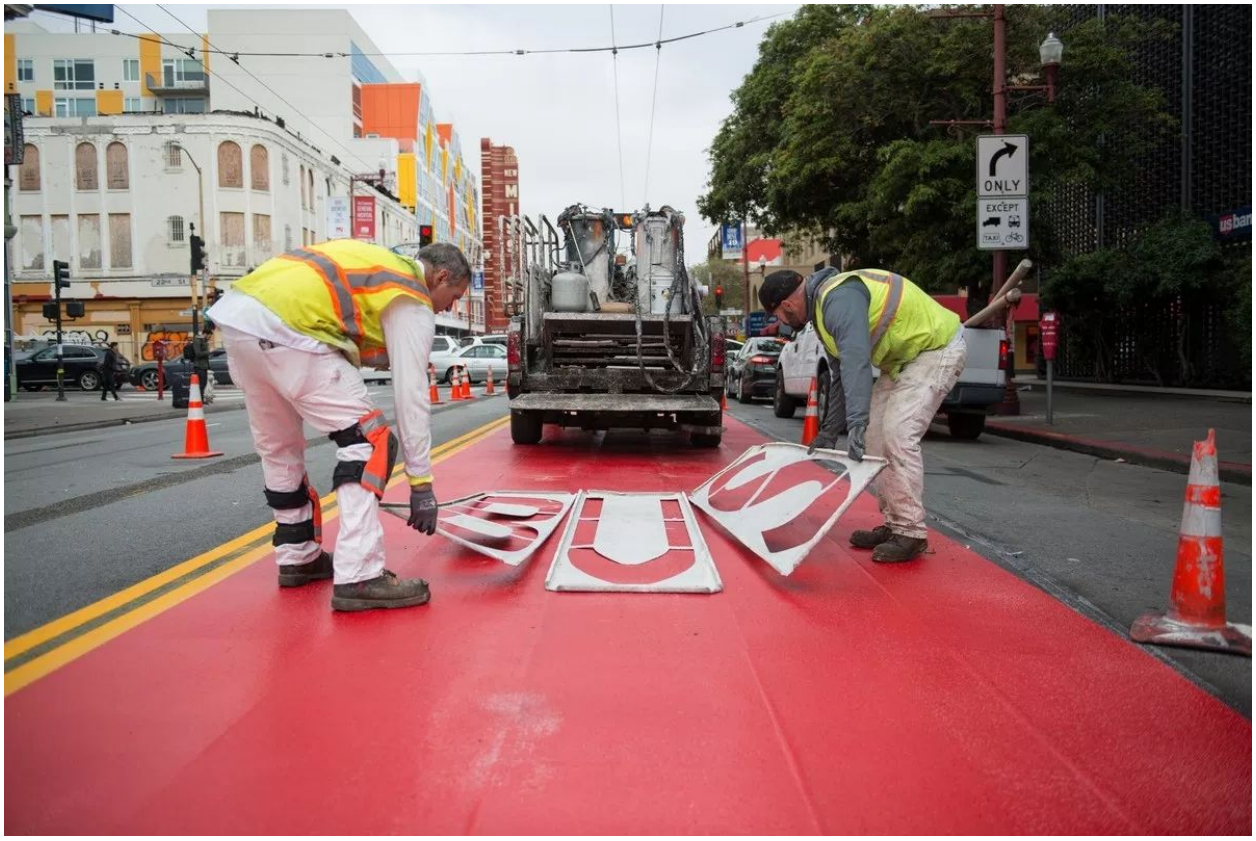
Recommendations for others:

TC-1.1A The Legislature should grant local governments authority to establish transit-supportive cordon pricing systems, i.e., they improve the speed and reliability of existing transit services and provide transit with revenues needed to expand capacity to meet increased demand.

TC-1.1C The Legislature should require that a share of revenues generated by all locally- and regionally-established tolling programs is dedicated to complementary transit, walking, and bicycling programs; and that a share of revenues is dedicated to transportation allowances for disadvantaged groups.

[12] See SCAG's Express Travel Choices Study Phases 1 and 2. Available at http://transfin.scag.ca.gov/Lists/Express%20Travel%20Tabs/AllItems.aspx

## 4.1b Statewide Transit-First Policy




A number of cities around the country have adopted "Transit First" policies that give transit preferential treatment in planning streets and signal operations. These policies are particularly useful in areas where high travel demand calls for efficient and fast transit, and where private vehicles impose the greatest externalities (such as city centers and dense boulevards). Transit First policies also prioritize walking and bicycling, and can be designed to prioritize taxis and shared-ride services as needed. In California, San Francisco and El Cerrito have adopted such Transit First policies.

A notable example outside California is the City of Seattle, whose "Move Seattle" strategic vision was developed to integrate systems planning around specific and mobility goals, such as providing "72% of Seattle residents with 10-minute all-day transit service within a 10-minute walk of their homes."[13] Move Seattle generated enough voter support to win passage in 2015 for a nine-year, $930 million property-tax levy to fund its envisioned projects. The city and county transit operator (King County Metro) have partnered on implementing "Always on Time" bus

[13] Seattle Department of Transportation. (2015). Move Seattle: Mayor Edward B. Murray's 10-Year Strategic Vision for Transportation. Retrieved from: (http://www.seattle.gov/Documents/Departments/SDOT/About/DocumentLibrary/MoveSeatte-FinalDraft-2-25-Online.pdf

routes (focusing capital improvements on the routes that serve the most residents), installing red bus-only lanes and transit priority improvements (such as signal pre-emption) at "pinch points," and stepping up targeted enforcement of bus-only lanes. Move Seattle is connected to, and provides partial funding for, the expansion of King County Metro's "RapidRide" bus-only lanes, which seek to increase transit speeds by 10-15 percent and increase ridership 50% within 5 years.[14] If successful, these programs would build on strong transit use that has increased 8% between 2014 and 2017 in the Seattle MSA.[15]

Adopting statewide Transit First would make it the policy of the State of California to give preference to walking, bicycling, and the use of public transit over the use of private automobiles. This would have the greatest effect in and around urban areas, where efforts to improve public transit could also reduce the attractiveness of driving.

**See Appendix C-15 for more details on transit-priority projects in Seattle and in other North American cities.**

Recommendations for Caltrans:

TC-3 Work with CalSTA and the Legislature to adopt a Statewide Transit First policy that advantages walking, bicycling, and the use of public transit in places where they can be most successful.

## 4.1b.i Multi-Modal Streets and Networks

The state should encourage the development of streets and public spaces that facilitate movement by transit, bicycle and walking, and that place less emphasis on the throughput of private vehicles. Such an approach moves beyond "complete streets," which seek to balance the needs of all road users within a single right of way, towards an emphasis on "complete networks," a paradigm in which certain routes advantage transit, bicycling, or walking over other modes.

Recommendations for Caltrans:

TC-3.1A Prioritize discretionary funding for projects that comply with the NACTO Transit Street Design Guide, including bus lanes; pedestrian paths, crossing and wayfinding improvements; and vehicle lane reductions.

[14] Seattle Department of Transportation. (2017). Seattle RapidRide Expansion Program Report. Retrieved from: http://www.seattle.gov/Documents/Departments/SDOT/TransitProgram/RREP_Plan_FINAL_062217_WEB.PDF

[15] Authors' calculations from FTA National Transit Database.

| | |
|---|---|
| TC-3.1B | Prioritize funding for transit, pedestrian, and bicycle improvements near major transit facilities such as transfer centers or rail stations, especially pedestrian and bicycle improvements which close network gaps and significantly reduce distances required for safe station ingress and egress. |
| TC-3.1D | Work with the Legislature to re-introduce vehicle code regulations that prioritize transit, pedestrians, and bicyclists. For example, Vehicle Code § 21810 required that drivers of vehicles overtaking transit buses yield to buses re-entering traffic, but sunsetted in 2004. |
| TC-3.1E | Partner with the Office of Traffic Safety to promote the enforcement of new and existing rules which support pedestrian connections to transit, such as those requiring vehicles to stop completely at stop signs or red lights (Vehicle Code § 22450). |
| TC-4.2A | Fund planning efforts to identify transit priority networks, including major corridors that could be converted to transit-only streets or linear parks. |
| TC-4.2B | Provide post-SB 743 guidance for reducing the proportion of the public right-of-way dedicated to automobile uses. |

<u>Recommendations for others:</u>

| | |
|---|---|
| TC-3.1C/ SR-2.3A | To implement SB 1's reasonable and feasible objectives for complete streets[16], local governments should produce findings to explain why roadway projects in HQTAs and Transit Priority Areas do not adhere to NACTO design guidelines. |

## 4.1b.ii Transit-Only Lanes

The state should promote transit-only lanes on high-frequency, high-congestion transit corridors, and advocate for specific projects in the state's highest-ridership corridors. Transit-only lane restrictions may be peak-period or 24-hours based on frequency, ridership, and congestion patterns. Transit-only lanes should preferably be converted from general-purpose lanes, although peak-period lanes may be converted from parking lanes. Roadway expansion to accommodate transit-only lanes is generally counter to other state and local goals and objectives.

[16] Streets and Highways Code § 2030(F)

Recommendations for Caltrans:

| | |
|---|---|
| TC-3.2A | Lead by example and implement transit priority treatments, including HOV-only, transit-only, bulbouts, and boarding platforms, on state-managed facilities with recurrent congestion and high[17] bus ridership. High priority segments include State Routes 2 in Los Angeles and State Route 123 in Alameda and Contra Costa Counties. Fund planning studies and implementation on facilities managed by others. |
| TC-3.2B / SR-2.5A | Develop guidance for post-SB 743 expedited environmental review for bus-only lane projects. |
| TC-3.2C / SR-2.5B | Share best-practice bus-only lane case studies as models for local replication, and fund related education for agency staff as needed. |

## 4.1c Transit-Supportive Land Use Reform

The success of transit and California's land-use growth strategy are interdependent — one cannot succeed without the other. As the state's population grows, land-use decisions must support the provision and use of transit. These decisions influence where and how people travel, and can support or hinder transit. When transit and land-use decisions are comprehensive and balanced, the result is high-ridership, low-cost transit service.[18]

Characteristics of the built environment strongly influence transit ridership. Research suggests that destination, distance, density, diversity, design, and demand management (6 Ds) have a significant influence on vehicle-miles traveled and transit, bicycling, and walking mode share.[19] Transit agencies can help shape land-use decisions by understanding the impact of the 6 Ds on VMT and mode choice. Among the 6 Ds, distance to transit is the most important factor influencing transit ridership, while design is second.

The state's shortage of housing near jobs exacerbates its mobility challenges. Other state-level plans and policy documents seek to address this deficiency.

[17] A possible standard for high ridership is those facilities where the bus route(s) using the facility have ridership in the top 20% of all facilities in the county, Caltrans district, or MPO region.
[18] National Academies of Sciences, Engineering, and Medicine. (2015). *Linking Transit Agencies and Land Use Decision Making: Guidebook for Transit Agencies*. Washington, DC: The National Academies Press. Retrieved from: https://doi.org/10.17226/24629.
[19] Ewing, R. & Cervero, R. (2010). *Travel and the Built Environment*, Journal of the American Planning Association, 76:3, 265-294. Retrieved from: http://dx.doi.org/10.1080/01944361003766766.

The **Statewide Housing Assessment 2025**[20] concedes that ongoing sprawl will decrease housing affordability, increase transportation costs, and as a consequence diminish quality of life for California residents. The housing assessment asserts that well executed land-use planning can "translate into the ability for families to access neighborhoods of opportunity, with high-performing schools, greater availability of jobs that afford entry to the middle-class, and convenient access to transit and services."[21]

The **Governor's Environmental Goals and Policy Report**, which envisions that a low-carbon, resilient California will be home to 50 million residents, calls for streamlining incentives for infill development in order to accomplish that vision.[22] Providing easy access to destinations through infill development can reduce a household's transportation time and cost burden and support the state's transit, equity, and climate-change goals. However, achieving these goals requires planning and zoning action at the local level, along with sufficiently responsive real-estate markets. A 2017 report from the **California Legislative Analyst's Office**, titled ***Do Communities Adequately Plan for Housing?***, finds that most do not.[23]

**Legislative Progress on Housing**

In September 2017, Governor Brown signed into law 15 bills that aim to increase the supply and affordability of housing in California.[24] The bills provide additional opportunities for funding for affordable housing through a new fee on real estate transaction documents (SB 2) and $4 million in bonds for affordable housing and a veteran's home ownership program (SB 3). The bills also call for streamlining for environmental review (SB 540) and infill development projects with affordable housing (SB 35 and AB 73). SB 166, SB 167 (also AB 678), and AB 72 strengthen existing housing laws by increasing local governments' accountability in meeting regional housing goals.

[20] California Department of Housing and Community Development. (2017). *California's Housing Future: Challenges and Opportunities*. Retrieved from: http://www.hcd.ca.gov/policy-research/plans-reports/docs/California's-Housing-Future-Full-Public-Draft.pdf
[21] California Department of Housing and Community Development. (2017). *California's Housing Future: Challenges and Opportunities*. Retrieved from: http://www.hcd.ca.gov/policy-research/plans-reports/docs/California's-Housing-Future-Full-Public-Draft.pdf
[22] Governor's Office of Planning and Research. (2015). *2015 Environmental Goals and Policy Report (EGPR).* Retrieved from: http://www.opr.ca.gov/docs/EGPR_Nov_2015.pdf
[23] Legislative Analyst's Office. (2017). *Do Communities Adequately Plan for Housing? Retrieved from: http://www.lao.ca.gov/reports/2017/3605/plan-for-housing-030817.pdf*
[24] Office of Governor Edmund G. Brown Jr. Newsroom. (2017). *Governor Brown Signs Comprehensive Legislative Package to Increase State's Housing Supply and Affordability.* Retrieved from: https://www.gov.ca.gov/news.php?id=19979

## Recommendations for transit-supportive land use

Statewide Recommendations:

TC-2A The state should continue to establish policies that facilitate infill development, use of transit and active transportation, and an increase in housing near employment.

- Provide incentives (such as ministerial permitting, density bonuses, parking reductions, fee deferrals and waivers, and CEQA exemptions) to infill and compact development projects.
- Expedite implementation of policies and programs presented in the California Statewide Housing Assessment 2025, such as streamlined permitting where applicable to encourage infill development consistent with local governments' General Plans and zoning policies.
- Encourage walkable and bikeable downtowns with improved active transportation infrastructure (e.g., ample sidewalks, seating, bike lanes, bike parking).

Recommendations for Urban Centers:

TC-2.2A Local governments should adopt advanced parking-management policies that reduce direct and indirect parking subsidies that cannibalize transit's modal share. These include requiring shared parking arrangements, eliminating parking minimums and replacing them with maximums for new development and redevelopments, or allowing fees in lieu of parking to fund transit and active-transportation improvements.

TC-2.3A Focus additional growth and development, including high-density development, around existing and planned frequent transit corridors. Prioritize state funding for development projects in high-frequency transit corridors. When designed to be transit-supportive, this development brings in new transit riders and leads to a virtuous cycle of enhanced frequency and ridership.

Recommendations for Suburban Communities:

TC-2.3C Emphasize key land uses (e.g., grocery markets, childcare centers, coffee shops, restaurants, and residential) concentrated around "town centers" that serve as hubs for public transit and other mobility services.

TC-2.2C Adopt shared-use parking policies that allow these town centers to serve as informal transit hubs for services such as commuter vanpools, paratransit, TNCs, express bus, BRT, and employer shuttles.

TC-2.1A Build ridership for community routes which feed "town center" mobility hubs.

# 4.2 Transforming Transit to Support Californians

## 4.2a From Transit Operator to Mobility Manager

Declining transit ridership, escalating costs, increasing demand for paratransit, and the competitive threat of new, cost-effective mobility services such as TNCs all require transit agencies to develop a new model to manage and provide mobility. Changing technology and business models require a balanced approach to embracing innovation while recognizing that a transit agency's public-service mission makes it necessarily less agile than a start-up company. Mobility management is this balanced approach.

Agencies want to avoid being sluggish and unresponsive to new market trends, business models, and technologies. They also wish to avoid operating unproductive legacy services such as expensive, infrequent, coverage-based, low-ridership fixed-route transit service. At the same time, transit agencies know that their public-service mandate is long-term: They must still facilitate mobility even as once-popular innovative mobility startups fail and cease to operate. It would be a waste of resources if agencies focused too much on operating "disruptive," flashy new mobility services that will be disrupted in five years' time by even newer mobility services.

### About mobility management

For over two decades, mobility management has been a best-practices approach to providing specialized transit services for seniors, people with disabilities, and other vulnerable populations. By coordinating multiple mobility services and funders using technology and common contact centers (e.g., 511 information services), mobility management provides an individualized, user-centric approach to meeting mobility needs.

More transit agencies are now applying a mobility management approach to mass transportation services for the general public. The American Public Transportation Association (APTA) defines mobility management for mass transportation as "a strategic approach to service coordination and customer service" that "[w]hen implemented [...] will move transit agencies away from their roles as fixed-route service operators, and toward collaboration with other transportation providers. The idea behind this approach is to create a full range of well synchronized mobility services within a community."[25] APTA sees this approach as critical to transit's proactive response to a rise in shared mobility services.[26]

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[25] American Public Transportation Association. (n.d.). *Mobility Management* . Retrieved from: http://www.apta.com/resources/mobility/Pages/default.aspx

[26] Murphy, C., and S. Feigon. (2016). *Shared Mobility and The Transformation of Public Transit*. TCRP J-11/TASK 21. [Report prepared for APTA].

Mobility management encompasses a pivot to the needs of users in addition to operations. Under a mobility management approach, agencies, in partnership with local governments and regional planning organizations, will:

- Transition from a singular focus on operating a few discrete mobility options toward arranging a continuum of mobility services (from bikeshare to TNCs) to move people, including services operated by the agency.
- Expand the scope of their planning activities to consider their role in facilitating mobility for those who do not use private vehicles.
- Place greater emphasis on improving out-of vehicle experiences, such as stop safety, amenities, and pedestrian connections.
- Seek to capitalize on two of public transit's strengths — unique authority and scale advantage — by advocating for and developing transit priority and bus-only lanes in areas of high demand and operating high-frequency bus rapid transit services.
- Make strategic, local-context-sensitive investments in mobility services to fill gaps and serve the public's interest.
- Establish contact centers that allow those without smartphones to access public and private mobility services, allowing users to book trips and receive updates via telephone or SMS text message.

Recommendations for Caltrans:

| | |
|---|---|
| IA-2.1, IA-4.1 | Develop advanced analytical tools and a Statewide Transit Data Warehouse, both of which are foundational for agencies to take a mobility management approach. |

Recommendations for others:

| | |
|---|---|
| SE-1.2 | Develop and implement a common, statewide, third-party-accessible Statewide Ticketing System to manage travel information, trip planning, and ticketing. Such a system is fundamental for a mobility management approach. |
| IA-2.3, IA-3.2 | Use real-time technology and robust algorithms for individualized, dynamic routing across multiple mobility services. |

## 4.2b Incorporate Mobility as a Service into Transit

The concept of "mobility as a service" encompasses a shift away from owning, operating, storing, and maintaining equipment (e.g. a vehicle or bicycle) and towards transportation solutions accessed only when mobility is desired. An expanding set of mobility services fills former gaps in mobility options for those without a personal vehicle for a trip. Transit agencies acting as

mobility managers will be able to arrange, manage, operate, or contract to provide trips made via new mobility services as they deem appropriate for their public-interest mission.

A common Integrated Statewide Ticketing System offers public benefits even when no public agency is involved in arranging or subsidizing a trip. By aggregating all trip options across a spectrum of competing for-profit providers, the platform can offer seamless, integrated mobility. By linking private mobility trips with public transit trips, the system can also move passengers towards lower-cost, lower-impact modes[27].
Increases in the volume of mobility-as-a-service trips will build the scale necessary to:

- Amortize substantial, fixed costs invested in the technology needed to enable seamless mobility management.
- Improve passenger-match probability and vehicle occupancy in order to reduce per-passenger costs and externalities.
- Invest in and develop strategic, successful new mobility models, such as a nonprofit and rural mobility services.

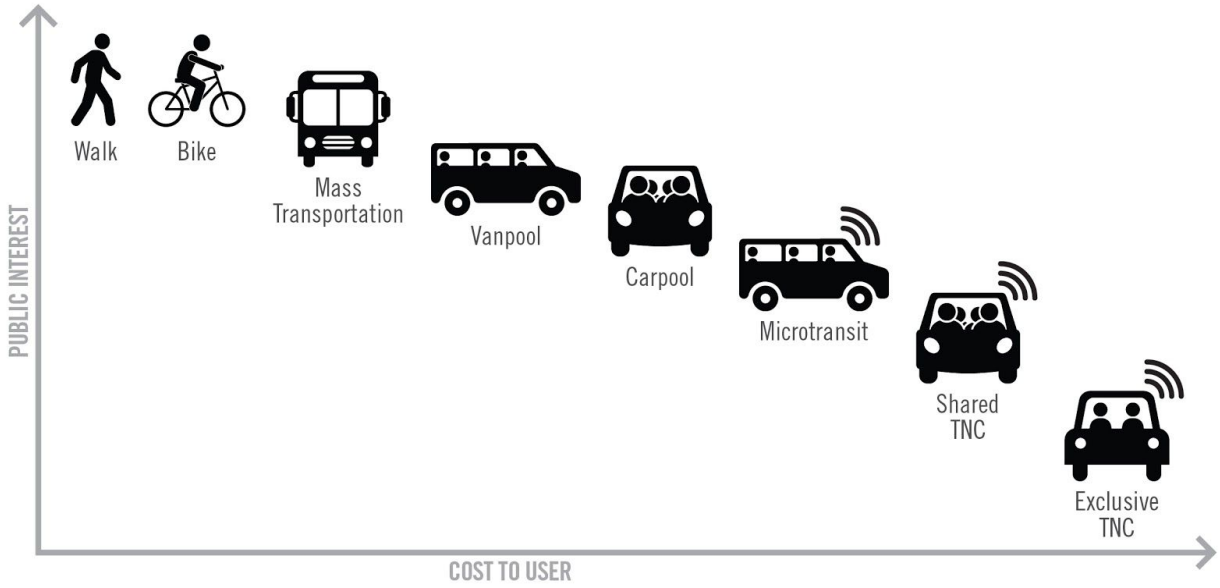
Using an integrated ticketing system, mobility service users will be able to make use of multiple services for different legs of a single trip (see Table 4-1), with dynamic, timed transfers that update in response to real-time information, like with a modern automobile navigation app.

## Prioritizing the Public Interest

The transit agency's role as a mobility manager is to manage shared transportation services in the public interest, as defined by the agency's governing board and state policy. Public interests typically include service affordability, subsidy effectiveness, social welfare, congestion reduction, and environmental sustainability. These broad public-sector objectives contrast with the narrower private-mobility service concerns with revenues, growth, profit, and market share. Mobility managers will need to prioritize which modes of travel are most in the public interest, and plan mobility services accordingly to instruct automated systems that arrange trips.

[27] Additionally, aggregating unsubsidized and subsidized trip demand will allow for higher match probabilities, greater vehicle occupancies and utilizations, lower per-passenger environmental impacts, and lower per-passenger costs to serve trips. This will further reduce the negative externalities of mobility and per-trip subsidies required from transit agencies.

Figure 4-1: Sample Public-Interest Prioritization of Mobility




## 4.2c Restructure Fares to Attract Ridership

Transit fares serve a number of purposes. First, fares significantly fund transit operations and maintenance. Without them, service would have to be cut substantially or subsidies would need to be increased significantly. Second, fares contribute to a sense of respect for and "buy-in" into the transit system.[28] Third, the costs of transit service provision vary substantially by time of day (peak-period trips are more expensive), direction (peak-direction trips are more expensive), distance (long-distance trips are more expensive), and mode (exclusive right-of-way busway and rail trips are more expensive), and fares can be used to steer passengers to consume more cheap-to-provide trips.[29] Well-designed fare policies match riders to the times of day, directions, and modes that can accommodate them most cost-effectively, attracting riders when seats would otherwise be empty and shifting travel demand to less crowded modes, routes, or times of day to avoid costly capacity enhancements.

[28] A National Center for Transit Research study found that "The absence of fares can make riders feel a lack of responsibility for the well being of the transit system" (p.6), Perone, J. S., & Volinski, J. M. (2003). Fare, Free, or Something in Between?.Available at nctr.usf.edu/wp-content/uploads/2015/10/473-13-2.pdf

[29] Yoh, A. C., Taylor, B. D., & Gahbauer, J. (2016). Does Transit Mean Business? Reconciling Economic, Organizational, and Political Perspectives on Variable Transit Fares. *Public Works Management & Policy*, *21*(2), 157-172.

But fares do not come without cost. First, fare collection entails a significant operational cost, which in some cases can approach or even exceed the amount collected in fare revenues.[30] Second, fare payment and collection (especially when conducted onboard) causes delays for transit riders and operators. Third, fare structures and procedures can be confusing, inconvenient, or even intimidating, degrading the experience of transit riders and discouraging use of the transit system. Finally, fares can be regressive, imposing a disproportionate and unfair burden or deterrent on those of modest means. For these reasons, California should encourage restructuring and improving the comprehensibility of fares, including eliminating fares in some cases. CTP 2040 assumed complete elimination of transit fares as a necessary intervention for achieving ridership necessary to reduce GHG emissions 80 percent by 2050.

**See Appendix C-4 for an analysis of fare models and research to support the recommendations.**

## Recommendations

California should pursue a twofold strategy to restructure fares statewide.

### Fare-free transit

California should encourage and support fare-free transit systems and pilot programs in targeted areas, including small, transit-intensive cities, and rural areas with low ridership. The State should also support efforts by cities, counties, and transit agencies in urban areas to pilot or implement fare-free systems. Large-scale fare-free schemes must plan for increased transit service that will be required to meet surging demand, as well as interventions to discourage criminal activity and maintain a comfortable onboard experience for all riders.

Recommendations for Caltrans:

SE-3.1A Fund studies and pilot programs for fare-free transit, including limited applications (e.g. off-peak times or directions, limited geographic areas).

SE-3.1B Work with the legislature to offer Transit Development Act farebox recovery ratio waivers for fare-free systems and pilot programs, especially in disadvantaged communities and areas which have implemented congestion-pricing programs.

[30] A survey conducted by the National Academies of agencies with fare-free policies found that 10 agencies (31% of agencies surveyed) reported that they abolished fares because the costs of collecting fares consumed the costs collected. For one agency, the cost of emptying fareboxes alone exceeded the revenue collected. (National Academies 2012, p. 22)
National Academies of Sciences, Engineering, and Medicine (2012). *Implementation and Outcomes of Fare-Free Transit Systems (TCRP Synthesis 101)*. Washington, DC: The National Academies Press. Retrieved from https://doi.org/10.17226/22753.

### Price transit according to marginal cost of provision and rider ability to pay

For areas where fare-free transit is impractical or undesired, the State should create guidance for a statewide, easy-to-understand, low-friction transit fare structure.

Recommendations for Caltrans:

SE-3.2A Work with CalSTA and other agencies to establish a taskforce to propose a statewide fare structure that:

- Sets fares low relative to the purchasing power of the individual transit rider.
- Manages limited transit capacity by encouraging riders with flexibility to travel during off-peak times, or to bike and walk when possible.
- Is highly legible or made seamless with technology (especially the Statewide Ticketing and Accounts Systems.

**See Appendix C-4 for an example fare structure.**

Recommendations for others:

SE-3.2B The legislature should consider requiring all transit agencies receiving State funds to either adhere to the statewide fare structure, or offer fare-free service.

## 4.2d Increase Transit Service Availability, Frequency, and Reliability

Transit service in many parts of California is difficult to access from desired origins and destinations; infrequent; slow; unavailable when needed; or requires unreliable transfers. CTP 2040 assumed that transit services would improve dramatically in order to meet ridership targets, including a doubling of service levels and a 50% increase in transit speeds.[31]

This service expansion should be part of a targeted effort to break the vicious cycle of low-quality, unreliable transit services encouraging personal vehicle travel and discouraging use of transit, walking, and bicycling. Breaking this cycle will increase the density of transit demand, even in places where land-use densities do not change. Increased frequencies will make transit more flexible, allowing passengers to reach their destinations sooner after they are ready to

[31] CTP 2040 Appendix 7 states: "For CTP 2040, an aggressive set of transit improvements was assumed. Transit service levels were assumed to double over 2040 baseline conditions, transit speeds for all services were assumed to increase by 50 percent, transit fares for all services were assumed to be free, and widespread timed transfers were also included." (p. 42)

depart. Where density of transit demand is sufficient, increased frequencies will make transit more flexible and additional routes will improve coverage and provide more direct service, requiring fewer transfers.

The performance measures that are adopted for tracking service availability, frequency, and reliability will guide the decisions that transit managers make in order to achieve them. Therefore, choosing appropriate performance measures is itself a process for improving service. Although some measures have historically involved burdensome data gathering and tracking, new methods and technology obviate this concern to a large extent. Determining how many transfer or connection points are in a system to gauge connectivity, for example, no longer requires manual map checking but can instead be accurately estimated using third-party mobile data analyses.

Recommendations for Caltrans:

| | |
|---|---|
| TC-1.2B *(PM)* | Caltrans and others should measure service levels using ridership-weighted headway averages, which factor in a passenger's average wait time (a demand-side measure of service quality) rather than time between vehicles (a supply-side measure). |
| TC-1.2C *(PM)* | Caltrans and others should measure service availability by tracking 1) total service hours provided against hours needed to meet transit demand, and 2) average hours per week transit service is available. |
| TC-1.2D *(PM)* | Caltrans and others should implement performance measures tracking connectivity and frequency, such as the number of locations where transfers can be made and average peak and off-peak headways. |

Recommendations for others:

| | |
|---|---|
| TC-1.2A | Increase capital and operating funding to provide more transit service. Consider prioritizing new and expanded sources of operations funding for agencies which have participated in Regional Comprehensive Operational Analyses (SE-1.3). |

## Bus-on-shoulder transit

Routine congestion impedes the performance of bus transit on freeway corridors within California's metropolitan areas, as well as along several intercity routes. Providing an exclusive right-of-way for buses on such corridors can help improve performance. However, constructing a dedicated bus lane by widening or reconfiguring a freeway is costly and politically difficult. Designating the left or right shoulder of a controlled-access highway for bus use during periods of peak congestion can achieve similar results for a significantly reduced cost.

Freeway "bus-on-shoulder programs" in the Twin Cities, Miami, and San Diego have significantly improved on-time performance and increased rider satisfaction (leading to ridership gains in the first region). Bus-on-shoulder programs have had a good safety record, with only a handful of minor accidents reported on North American programs more than two decades they were first implemented in the Twin Cities.[32] Bus-on-shoulder programs in San Diego, Miami,[33] and Atlanta have achieved perfect safety records.[34]


Recommendations for Caltrans:

TC-3.2D Establish a statewide bus-on-shoulder task force to select priority urban freeway corridors for safe transit use during congestion. Extend AB 1746 (2016) provisions to new agencies and corridors identified by the task force.

TC-3.2E Work with the Legislature to amend Section 148.1 of the state Streets and Highway code to allow buses to travel in freeway shoulders on segments designated by this task force.

**See the Bus on Shoulder Memo (Appendix C-8)**

[32] Florida Department of Transportation (2017). "Implementing Bus on Shoulder in Florida." http://www.fdot.gov/transit/Pages/Bus_on_shoulders_Guidance_013117.pdf
[33] The San Diego and Miami lanes were pilot programs.
[34] Ibid.

# Chapter 5: Making Transit Excellent

"Making Transit Excellent" presents a variety of strategies and measures that are designed to help agencies provide the best service they can, within the context in which they operate. With or without the changes described in the "Transforming California" chapter, transit agencies still have many opportunities to improve their organizational capabilities and offerings.

This chapter presents best practices for California and its transit agencies. Transit planning is by nature an interdependent activity, and many of the specific strategies and measures recommended in this chapter support more than one of the STSP Report's broad goals for California transit. Transit planning is also pan-governmental, and this chapter contains recommendations for entities at all levels of government.

## 5.1 SE — A California Transit Passenger's Multimodal Experience Should Be Seamless, Safe, and Affordable

If transit agencies want more passengers, they have to make it easier (and even more enjoyable) to ride. Easy, fast payment, personal safety, and fair pricing can help to attract more riders than ever.

### 5.1a Statewide Accounts and Ticketing System

The California high-speed rail system will create a well-utilized intercity transit option. In order to provide seamless transit connections throughout the state, the Draft 2018 State Rail Plan[1] anticipates integrating fare-payment systems in advance of high-speed rail's planned 2025 opening. This development has major implications for transit systems throughout the state. By eliminating the need for multiple fare media, an integrated payment system will ease transit use for Californians who use transit in different areas of the state, as well as for those who travel on multiple transit systems and shared-mobility services within a single metropolitan area.

The advent of high-speed rail, along with the desire to offer seamless mobility without the use of personal automobiles, motivate two closely integrated recommendations:

- **Statewide Account System** - To manage individual payment and discount eligibility; and distribute payment to providers

[1] Caltrans (2017). *Draft 2018 California State Rail Plan: Connecting California*. pgs 103-104.

- **Statewide Ticketing System** - To reserve and book passenger travel across multiple modes

### 5.1a.i Statewide Accounts System


Currently, fare-payment systems across the state range in complexity from cash fareboxes to electronic validators. Electronic fare-payment systems in the state tend to be "card-based" (with value stored on and transacted from the fare medium) and "closed" (accepting only the fare media specifically issued by a transit agency), and utilize "proprietary technology" (licensed to a specific company and operating according to non-conventional standards), all characteristics that prevent systems from becoming more fully integrated. In contrast, systems that are "account-based" (in which fares are stored in a cloud-based account and transactions are processed at a central server[2]) or "standards-based" (using non-licensed equipment that coheres to an international standard, e.g. ISO-14443 for contactless smart cards[3]) have more flexibility in terms of the fare media they can process.

[2] Discussed by Kankukken, Ilkka. Mobile tickets – A roadmap scenario of account based ticketing in Finland. http://nordicpublictransport.com/wp-content/uploads/4A-Mobile-tickets-Ilkka-Kankkunen.pdf And Masabi. "What is Account-based Ticketing?" http://blog.masabi.com/blog/what-is-account-based-ticketing

[3] Smart Card Alliance (March 2003). "Contactless Payment and the Retail Point of Sale: Applications, Technologies and Transaction Models." https://www.securetechalliance.org/resources/lib/Contactless_Pmt_Report.pdf

Table 5-1: Statewide Accounts System Overview

| | Store of Value | Interoperability | Technology Lock-in |
|---|---|---|---|
| **Most California transit-fare payment systems today** | Card-based: Fare purses and data are stored on a single card | Closed: Fare equipment accepts only smartcards issued by the agency | Proprietary: Licensed to a specific company and operating according to nonconventional standards |
| **In the future, with a Statewide Accounts System** | Account-based: Multiple access cards and other fare media link to a central transportation account, which processes transactions | Open: Equipment accepts multiple types of fare media issued by various providers | Standards-based: Using non-licensed equipment that coheres to an international standard, e.g. ISO-14443 |

Such a system could not only accept fare media from multiple transit agencies but any fare media that cohere to international standard specifications or contain payment data that can electronically transfer to the cloud-based system. An account-based, standards-based, open ticketing system could link to transit-specific mobile applications (to enable payment with visual- and barcode-based mobile fare media), and to apps for public or private carpool, rideshare, or bikeshare services, permitting joint ticketing with these shared-mobility platforms. More generally, the statewide account system would make payment more convenient for passengers by allowing them to pay with non-specialized fare media.

### 5.1a.ii Statewide Ticketing System

A Statewide Ticketing System would serve as a mobility service marketplace, allowing passengers to book trip itineraries with multiple providers. A system with a sufficient transaction volume could also support dynamic itinerary changes and rerouting in response to operational delays.

The state would manage the system in the public interest, by:

- Providing seamless mobility with an emphasis on low-carbon forms of transportation
- Integrating with appointment-booking systems commonly used by medical offices, social-service providers, and government to enhance mobility for seniors, the disabled, and persons of limited means
- Providing free or below-cost system access and support services to transit agencies
- Aggregating shared trips to increase vehicle occupancy, thereby reducing per-passenger costs and GHG emissions

Figure 5-1: Integrated Mobility Services Today (Without Statewide Ticketing and Accounts)

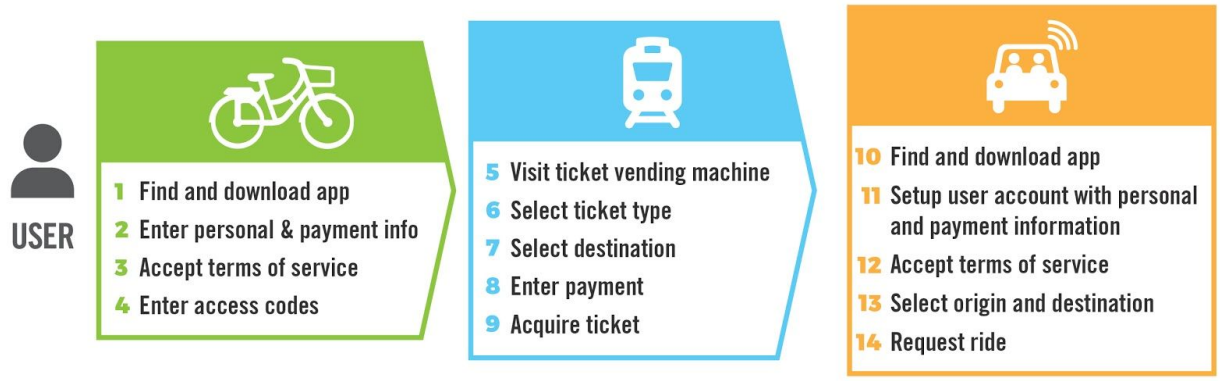
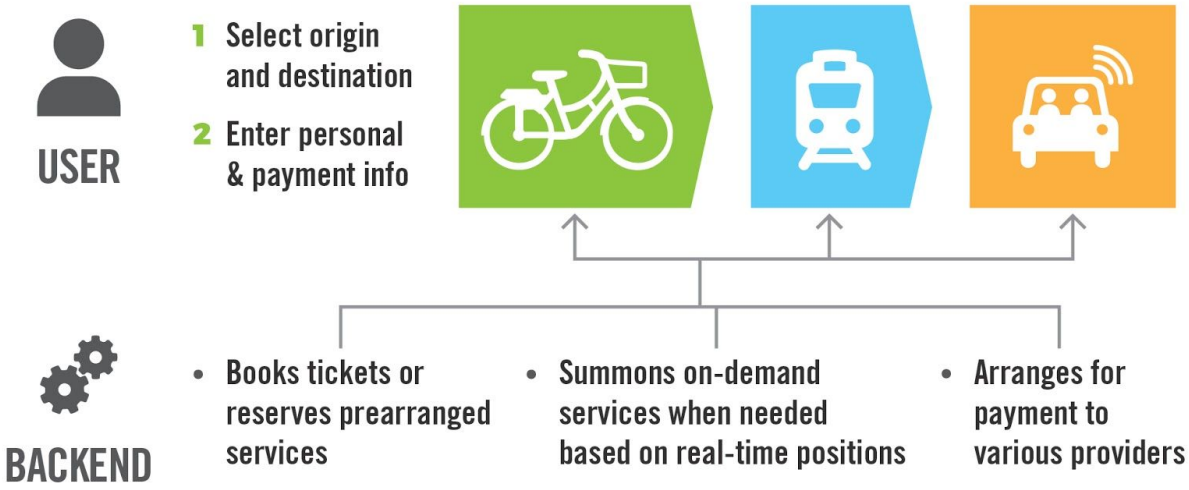



Figure 5-2: Integrated Mobility Services with Statewide Ticketing and Accounts




The State of California should fund and own[4] the ticketing system. Initial funding could be provided by the new SB1 State Rail Assistance Program Funds.[5] It could receive ongoing revenues in the form of referral fees from unsubsidized, for-profit services booked via the integrated system.

### 5.1a.iii Implementation

Successful implementation of a Statewide Ticketing and Accounts System will require sustained, formalized cooperation between both public- and private-sector stakeholders. Foreign case

[4] but perhaps not build, operate, and maintain
[5] Establishing the system may also be an eligible federal capital expense for Section 5302 mobility management programs.

studies of multi-jurisdictional fare integration (e.g. in Seoul, South Korea[6] and across Europe[7]) have involved cooperation between the major fare-payment system administrators, or transit agencies using the various systems, as well as national and local governments. A statewide ticketing program can accommodate agencies' concerns about loss of control over ticketing through a "standards-based" approach to integration that requires agencies to transition to systems with interoperable specifications, rather than to a particular technology.

A robust statewide ticketing system will provide the confidence in fare collection and remittance that agencies need to enter into interagency agreements that would allow for the most important benefits of a single fare system, namely riders being able to use multiple agencies' services on a single ticket or pass. It is important to note that some types of passes important for rider convenience (and increasing overall ridership) might require agreements untied to specific revenue: for example, agencies may need to agree to honor each other's day passes with the understanding that there is a reciprocal benefit of greater ridership even if revenues from individual tickets are not necessarily shared.

The standards-based approach could easily synchronize with California transit agencies' current initiatives to upgrade their electronic fare-collection systems.[8] By precluding the adoption of a specific technology, such an approach would also ease participation by non-urban agencies that lack the revenue or ridership volume to justify expensive hardware.[9] Mobile payment technology is presently a versatile and widely accessible fare medium (using NFC, QR codes, or unique imagery) and can offer low-cost validation.

By offering funds to assist with agency upgrades, the State can further assist cash-strapped agencies to adopt the new standards and provide a potential tool for discouraging noncompliance. Legislation mandating agencies' adoption of interoperable technology by a particular deadline can ensure that agencies join the statewide ticketing and accounts system in a timely manner.[10]

---

[6] Audouin, Maxime & Razaghi, Mohamad & Finger, Matthias. (2015). How Seoul used the 'T-Money' smart transportation card to re-plan the public transportation system of the city; implications for governance of innovation in urban public transportation systems. https://www.researchgate.net/publication/290574722_How_Seoul_used_the_'T-Money'_smart_transportation_card_to_re-plan_the_public_transportation_system_of_the_city_implications_for_governance_of_innovation_in_urban_public_transportation_systems

[7] Smart Ticketing Alliance (2014). "Founding Members." http://www.smart-ticketing.org/category/alliance/membership/founding_members/

[8] See Figure 2 in Appendix C-3

[9] A problem examined by: Iseki, H., Yoh, A., & Taylor, B. (2007). Are Smart Cards the Smart Way to Go?: Examining Their Adoption by US Transit Agencies. Transportation Research Record: Journal of the Transportation Research Board, (1992), 45-53. http://trrjournalonline.trb.org/doi/pdf/10.3141/1992-06

[10] Such a legislative mandate facilitated adoption of the Netherlands' OV-Chipkaart system. See "World Bank. 2016. Public Transport Automatic Fare Collection Interoperability Assessing Options for Poland.

Recommendations for Caltrans:

| | |
|---|---|
| SE-1.2C | CalSTA, Caltrans, and MPOs should make the Statewide Transportation Account system available for all forms of transportation payments, including transit fares, municipal parking, and toll collection. |

Recommendations for others:

| | |
|---|---|
| SE-1.2A | CalSTA should bring together Caltrans, the California High Speed Rail Authority, the California Transit Association, transit and transportation planning agencies that operate regional electronic fare payment systems, and shared-mobility providers into a permanent working group to decide on standard specifications and procedures for the implementation of an open, standards- and account-based statewide travel-booking and fare-payment system. |
| SE-1.2B | Funding agencies should require that transit agencies upgrade their fare-collection systems to the interoperable (account-based, standards-based) technological specifications decided on by the working group and establish a funding source to assist agencies' transition. |
| SE-1.2D / IA-4.1A | CalSTA should incorporate all transit services into the ticketing system and encourage private shared-mobility services' participation in order to promote seamless mobility. |
| SE-1.2E | CalSTA and other state agencies should examine the potential to use a commonly-issued but individually-unique card or identifier (such as a driver license) as a transit pass. Limited-identification cards, such as government employee and student ID cards, can also serve as fare media for deeply discounted group transit passes. |
| SE-3.3A | CalSTA should link reduced-fare eligibility information to the Statewide Transit Account to improve access to discounted fares among disadvantaged groups. |
| TC-4.3A | The Statewide Ticketing and Accounts System should integrate with appointment-booking systems commonly used by medical offices, social service providers, and government to enhance mobility for seniors, the disabled, and persons of limited means. |

**See additional research on Advanced Fare Payment and Accounts Technologies (Appendix C-3)**

**See an overview of Mobile Ticketing in California (Appendix C-8)**

World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/24931 License: CC BY 3.0 IGO."

**See an overview of Current Transit Fare Payment Systems Used in California (Appendix C-11)**

**Enhancing Californians' Mobility: The Statewide Ticketing and Accounts System**

California's future statewide, integrated ticketing system can serve as a platform for both mobility and accessibility.

When the Ochoa family in Covina wishes to travel to visit family in San Pablo, they take three minutes to find and book a multi-leg trip using a computer or smartphone. When it's time for the trip, they use their choice of smartphone app that integrates with the statewide ticketing system to validate their payment. Their boarding pass updates in real time with expected departure information for all legs of the trip. They take a local Foothill Transit bus to Metrolink regional rail, to high speed rail, to BART, to AC Transit bus, all on a single ticket. They reach their destination in 4 hours and 30 minutes, less time than possible by personal automobile.

The development of a statewide, integrated electronic ticketing system also means that medical and social-service providers can automatically book mobility services for transit-dependent individuals along with their appointments. An appointment system integrated with the statewide mobility ticketing system can even identify and book appointment times that allow for multiple passengers to share the ride.

## 5.1b Create a Safe and Secure Experience

In passenger surveys, transit riders place a heavy emphasis on their desire to feel safe and secure while travelling. Former riders cite security concerns as a primary factor for leaving transit. Studies[11] show that nighttime and daytime safety, adequate lighting at stops, emergency-notification systems, and the presence of a security guard are often more important determinants of transit ridership than factors that are fully within agencies' control. Studies[12] also indicate that crimes like assault, larceny, drunkenness, and groping are underreported and can sour passengers on the experience of riding transit. While crimes are rare onboard vehicles, they often happen at stops and stations; roadside bus stops can be especially problematic because transferring passengers are passing through neighborhoods with which they are not familiar, and waiting at these stops constitutes a large component of a transit rider's experience.

[11] Iseki, H., Smart, M., Taylor, B. D., & Yoh, A. (2012). Thinking outside the bus. Access Magazine, 1(40).
[12] Frazier, E. (2015). *Policing and Security Strategies for Small- and Medium-Size Public Transit Systems*. TCRP Report 180. National Academies Press, Washington, DC.

While overall safety is often the responsibility of the local police force, there are several things transit agencies can do to make journeys safer. Training vehicle operators in conflict de-escalation can help diffuse onboard tension. Implementing an emergency-notification system onboard vehicles ("panic buttons") is a relatively cost-effective way to increase security without the cost and equity concerns that come with a security officer stationed onboard. Agencies can also design stations so that they are well-lit, and ensure they are not placed near high-risk areas like liquor stores or vacant lots.

Recommendations for Caltrans:

SE-2.1A Caltrans and other state agencies should encourage and fund multiple methods of private, hassle-free emergency notification and reporting. Integrate an incident-reporting feature into any application[13] that uses the Statewide Ticketing System, enabling riders to send reports and evidence to appropriate authorities.

SE-2.2A Caltrans should work with the Commission on Peace Officer Standards and Training provide agencies with common training resources, including conflict de-escalation training for customer-facing transit operations personnel.

Recommendations for others:

SE-2.1B The Legislature should require transit agencies to create safety and security training and plans that that specifically address how to minimize gender harassment and non-severe ("petty") criminal activity such as littering.

SE-2.1A *(PM)* Transit agencies should assess perceived safety in transit user and nonuser surveys. Track not only trends over time but also response differentials between genders.

## 5.1c Improve Metropolitan Transit with Regional Comprehensive Operational Analyses

As transit agencies face changes in ridership and urban form, the practice of making marginal, ad-hoc changes to routes and schedules is yielding to a more coordinated, strategic process of comprehensively restructuring services. A Comprehensive Operational Analysis (COA) is a data-driven approach to reconfiguring a transit network to respond to changes in ridership and urban and regional form. While agency-level COAs are an emerging best practice, regular, regional COAs are a new approach that will better prepare transit agencies to jointly respond to changing land uses and demographics and evolving market conditions. COAs will become increasingly imperative as transit agencies shift from being transit operators to mobility managers.

[13] See Metro Los Angeles's Transit Watch App as an example.

In examining resources invested versus benefits conferred, COAs can spur greater emphasis on an agency's most productive services: frequent, higher-ridership service that mass transit excels at providing. Conversely, agencies may eliminate infrequent, low-ridership routes which appear to add more coverage to a transit network map but lack potential for fixed-route ridership growth, especially amid increasing competition with private shared-mobility services.

As mobility and California's built environment evolve in the coming decades, agencies must go beyond the two to five-year budget and service plan included in a typical Short Range Transit Plan (SRTP) and perform a more comprehensive, strategic analysis of an agency's services in relation to nearby transit agencies and emerging mobility services.[14] This is especially important in California's large metropolitan regions, which are served by multiple agencies. Even outside major regions, California counties are typically home to at least one regional (countywide) and one city-focused provider. A regional COA approach also enables the state or MPOs to set regional targets for transit ridership, which could encourage more interagency collaboration than agency-level targets would. Finally, planning processes based on a regional COA can provide an evidence-based approach to help to implement PUC § 99282,[15] which encourages multi-agency coordination.

<u>This recommendation is dependent on implementation of several others:</u>

- Agencies publish data to Statewide Transit Data Warehouse (IA-2.1A)
- Advanced analytical tools (IA-2.1C)
- Adoption of statewide transit data standard GTFS (IA-2.3A)

<u>Recommendations for Caltrans</u>:

SE-1.3A Caltrans, other state agencies, and MPOs should prioritize planning grants for regional COAs. Cities with HSR stations should be given priority consideration to build transit networks that develop ridership to station areas prior to HSR's arrival.

SE-1.3B Caltrans and other agencies which fund planning grants should collaborate to set minimum state standards for regional COAs, including expected processes, performance metrics, and update frequency, and consider allowing for multi-county COAs coordinated by MPOs.

[14] 2016-2017 Baselines Report, p. 73

[15] "All operators shall be encouraged to establish maximum coordination of public transportation services, fares, transfer privileges, and all other related matters for the overall improvement of public transportation service to the general public requiring such services within the affected areas."

Recommendations for others:

SE-1.3C CalSTA and others should consider the presence or absence of a state-recognized COA in evaluating applications for state discretionary funding programs. This funding criterion could first be phased in for transit agencies in counties with over 750,000 population.

SE-1.3D The Legislature should consider future amendments to the Transportation Development Act to require regular COAs for agencies to receive operating assistance.

### 5.1d Use Public-Private Partnerships to Improve Transit's Brand

As transit in the state becomes more seamless, the state and agencies should work on a coordinated marketing campaign that conveys this improved user experience. Key partners are employers and transportation-management organizations, which can provide employees with deeply discounted group transit passes and financial incentives to leave their cars at home.

Recommendations for Caltrans:

IA-1.4A Caltrans and others should create statewide marketing guidance, tools, and campaigns to enhance transit's perceived attractiveness. Collaborate with transit agencies on advertising campaigns. Consider a common, statewide visual element for transit stops to make them more universally identifiable.

IA-1.5A Caltrans and other state agencies should work with employers and Transportation Management Organizations to promote shared-mobility efforts. Provide guidance for agencies to offer annual transit pass programs for bulk business sales. Lead by example and increase state employees' monthly alternative-transportation subsidy to an amount sufficient to cover the cost of a monthly transit pass.

IA-1.5B Caltrans should work with the California Air Resources Board to enforce the parking cash-out law (Health and Safety Code § 43845), which provides money to employees not taking a free or reduced-cost parking space.

## 5.2 IA — Transit Agencies Must Become More Innovative and Agile to Vigorously Pursue Their Missions

For many decades, transit's mission has seemed relatively unchanging: provide fixed-route service within a set geographic area. As the state's demographics and transport options change,

so will Californians' travel needs. In order to provide reliable mobility, transit agencies must become more adept than ever at thinking creatively, analyzing data, and collaborating across sectors.

## 5.2a Pursue Open Data and Systems for Smarter, More Agile Transit

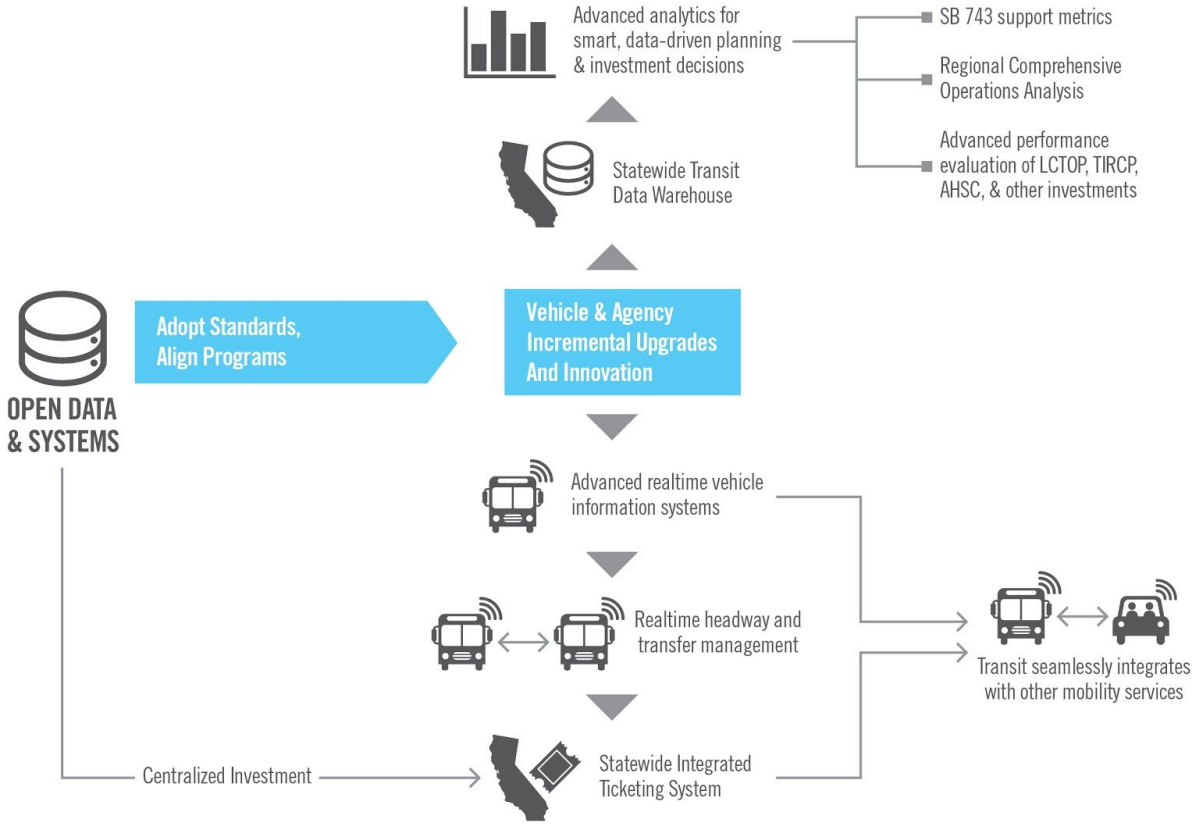
A 2016 ITS America Report for the U.S. Federal Highways Administration[16] explored barriers to adopting APTA's Transit Communications Interface Profiles (TCIP) communications standards that allow hardware from multiple vendors to become interoperable. According to that report, a chicken-and-egg problem exists where vendors are reluctant to develop standards-based products without a customer base on which they can rely for future sales, and transit agencies are reluctant to issue requests for proposals for standards-compliant systems if there are none on the market. The lack of standards leads to vendor and technology "lock-in" where transit agencies have high switching costs, leading to higher life-cycle costs with lesser system capabilities than with standards-based, upgradable systems.

Lock-in and the lack of interoperability standards makes incremental upgrades difficult: Agencies must replace the entirety of their technology systems to assure compatibility. Incremental upgrades are further complicated by an agency's rolling seven- to 12-year vehicle replacement cycle; an agency that replaces less than one-fifth of its vehicles in a given year is likely to outfit new vehicles with aging technology that matches existing systems.

California has the need, scale, and capabilities to overcome these barriers by assisting in the development of new standards, adopting open standards, and using funding programs to support accelerated and universal statewide implementation.

[16] Shaw, A. J. (2016). The Adoption of Transit Communications Interface Profiles in the Transit Industry Factors Inhibiting Adoption and Recommendations for Moving Forward (Rep. No. FHWA-JPO-17-432). Accessible at https://ntl.bts.gov/lib/59000/59300/59399/FHWA-JPO-17-432.pdf

Figure 5-2: Open Data & Systems: A Starting Point for Smarter, More Agile Transit




Open data and systems are a necessary first step for several recommendations that will enable transit to be more innovative and agile. Possible improvements include better-quality real-time passenger information systems, seamless integrated mobility, and regional comprehensive operations analysis.

The General Transit Feed Specification (GTFS) family of specifications for transit data has become a *de facto* standard in the United States and California, and should be officially adopted in California. The standard is evolving beyond operational data to include ridership and other planning data. Research for the 2016-17 Baselines Report[17] identified 66 California agencies with GTFS feeds. GTFS data feeds many existing passenger routing[18] and analytical[19] tools.

[17] p. 210
[18] E.g., Google Maps, Apple Maps, OpenTripPlanner, The Transit App
[19] E.g., Remix, WalkScore/TransitScore, Conveyal Analysis

Two interoperability standards initiatives, APTA's TCIP and the International Association for Public Transport's ITxPT, should be explored by a new task force.

Recommendations for Caltrans:

| | |
|---|---|
| IA-2.3A | Lead California in adopting the GTFS transit data standards for all passenger information systems and any future required and voluntary reporting. |
| IA-2.3B / IA-3.2B | Caltrans should adopt identified interoperability standards in the ITS Transit Statewide Plan and recommend that MPOs and counties do the same for regional/county ITS coordinating plans. |
| IA-2.3C / IA-3.2B | Caltrans or its designees should participate in the development of transit data standards and transit hardware and software and interoperability standards to ensure these standards serve the California public's interest. |
| IA-3.2A | Caltrans should establish a multi-stakeholder taskforce to assess hardware and software interoperability standards and determine the best path for California. |

Recommendations for others:

| | |
|---|---|
| IA-2.3B | The California Transportation Commission's Regional Transportation Plan Guidelines should be updated to incorporate advanced, standardized transit data into travel-demand modeling. |
| SE-1.1A / SE-2.3D / IA-3.2C/ SR-2.4A | CalSTA (via TIRCP) should provide funding for adoption of standards-based hardware and software systems that enable vast customer service and analytical capabilities, including reliable real-time arrival information for every vehicle in the state. |

**See Open Data & Systems Memo (Appendix C-1)**

**See the Real-Time Transit Information: Effects on Ridership and GHG Emissions Technical Memorandum (Appendix C-10) for a review of research to establish that reliable real-time information systems can increase ridership and reduce GHG emissions**

**See a list of over 80 GTFS-consuming applications on TransitWiki**

## 5.2b Establish a Statewide Transit Data Warehouse

A statewide repository for "big"[20] transit data is a prerequisite to enabling powerful statewide and regional analyses and multi-agency collaborations. This recommendation is included in CTP 2040 as a short-range action item to coordinate data and analysis.[21] A statewide data warehouse provides many benefits over agency and regional data repositories:

- Third-party consultants and tool developers can integrate with a single system.
- Consistency in data retention and resolution allows for the development of advanced statewide transit performance metrics.
- Cost-effective archival of historical "big" transit data that agencies may not retain.
- Leverage economies of scale to establish and maintain the system, train users, and provide support.
- Recurring state planning processes, such as TOD planning or the RTP/SCS process, would be expedited by a consistent format for transit data.
- Ensuring ease of uploading and accessing data.

Recommendations for Caltrans:

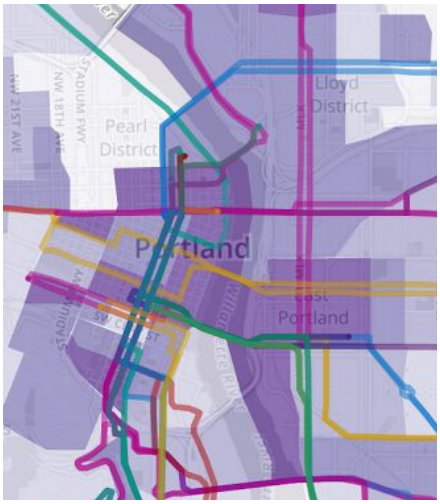
| | |
|---|---|
| IA-2.1A | Caltrans should create and maintain a Statewide Transit Data Warehouse. Connect the Data Warehouse with the statewide web-based reporting system (IA-2.2), survey tools (IA-1.2), third-party data (IA-1.1), and other analytical tools. |
| IA-2.1B | Caltrans and the State Controller's Office should establish minimum data reporting requirements and require agencies that receive state funds for hardware and software systems to automatically report data to the warehouse. |
| IA-2.1D | Caltrans should use the newly-available data as a basis for updating the Statewide Transit Strategic Plan in 2023. |

## 5.2c Facilitate Introduction of Advanced Analytical Tools

Since the last Statewide Transit Strategic Plan in 2012, incumbent technology companies and startups have launched dozens of applications for transit data visualization and analysis, network planning, and operations analysis. Many of these tools take standardized GTFS data as inputs, easing use for agencies that produce this data.

[20] The data warehouse would contain much richer information than the National Transit Database and other reporting databases. For example boardings per route/stop and historic vehicle position and delay. All data reporting would be automated.
[21] CTP 2040 Appendix p. 67

For example, a network planning tool such as **Remix** could allow multiple agencies to iterate new regional transit network plans and estimate the performance of each scenario.[22] The tool could also highlight service gaps between agency territories. This would serve as a platform for multi-agency collaboration as part of a Regional Comprehensive Operations Analysis.




Not all advanced transit analytical tools are privately developed. The Florida Department of Transportation sponsored development of TBEST, which is used to estimate ridership, analyze market viability, and assess impacts to protected classes for Title VI compliance.[23] TBEST can import data from the Florida Transit Information System, and is free to agencies.

**See TransitWiki for more information on TBEST, Remix, and over a dozen other advanced analytical tools for transit.**

Dependencies:

- Statewide Transit Data Warehouse (IA-2.1)
- Ubiquitous standardized transit data (IA-2.3)

Recommendations for Caltrans:

| | |
|---|---|
| IA-2.1C / IA-4.1B | Allow agencies and MPOs to easily link third-party analytical tools to the State Transit Data Warehouse. Evaluate and enter into master contracts for the most useful analytical tools, and provide targeted or universal access to analytical tools. |
| IA-2.3E / IA-4.1C | Caltrans and CalSTA should support multi-agency consortia to develop or fund open transit applications of strategic importance to the State of California. |

## 5.2d Create a Statewide, Web-Based Reporting and Funding Platform

New state programs (LCTOP, TIRCP) have introduced new ways transit agencies can apply for funding. At the same time, FTA's Transit Asset Management rule has introduced new

[22] http://www.remix.com
[23] Transit Boardings Estimation and Simulation Tool

data-tracking and reporting requirements. Agency stakeholders lament the repetitiveness and inconsistencies of reporting and funding applications.

A consolidated, statewide, web-based system would greatly assist agencies in managing data and meeting reporting requirements and pre-populating funding applications. Such a system would bring many benefits:

- Agencies save time by reporting information once, rather than multiple times. A cloud-based system can connect to existing third-party systems (e.g. State Controller's Office's FTP server).
- Extensibility means the system can be frequently updated with new forms and modules without need for agency-side upgrades or the need to distribute new electronic or paper forms.
- Costs to develop requested features, such as the development of a mass data upload tool to convert excel-based records, can be amortized over many users.
- A common system means employees can be trained in common classes or webinars, and this knowledge is transferable for employees who go to work at other agencies.
- A cloud-based system that pre-populates responses and enables automated verification of grant conditions. For instance, the system could automate eligibility verification for a grant program that only funded new transit facilities if existing facilities met a minimum standard for state of good repair.
- Enables advanced, cloud-based analytics, especially when linked to Statewide Transit Data Warehouse.

Recommendations for Caltrans:

IA-2.2A CalSTA, Caltrans, and the State Controller's Office should establish a statewide, consolidated web-based reporting and funding platform for transit. Look to Pennsylvania as an example in working with an outside vendor to establish a statewide, open-source, web-based data-management and reporting system that assists agencies with tracking asset data. Consider future expansions to collect additional data, such as climate resilience information.

## 5.2e Augment Transit Planning with Third-Party Data

The ubiquity of smartphones means that planners now have at their disposal fine-grained data on people's movement that can supplement large, longitudinal studies or even on-board transit user surveys, enabling a better understanding of travel patterns and trip characteristics. Multiple data-provider firms, including AirSage and Streetlight Data, sell aggregated origin-destination travel activity data based on cell-phone movements that can "describe" trips at many scales, from regional to street-level (e.g., how many people pass a certain point, such as

a bus stop, in a given amount of time). Other firms, including Moovit, Swiftly, and Conveyal, specialize in analyzing either cell-phone location data or General Transit Feed Specification-Real Time (GTFS-RT) to identify transit riders' trip characteristics, such as how often they need to transfer, how long they need to wait, how long they ride, and how many legs their journeys require.

Increasingly, private transportation providers are using data like these to identify and serve specific niche markets, such as commuters, and to direct resources efficiently to that purpose. In conjunction with their existing data on sociodemographics, transit agencies could use these data to assess how well-aligned their current services are with travel patterns, and to identify areas of latent demand for new or expanded transit service. The state could use these data to assess how well transit service is meeting overall regional travel demand.

Recommendations for Caltrans:

IA-2.1E Caltrans should execute master contracts with data-provider firms that grant universal access to transit agencies and transportation planners. Establish standard data parameters for use across agencies and feed third-party data into the Statewide Transit Data Warehouse (IA-2.1).

## 5.2f Assist with Transit User and Non-User Surveys

Transit agencies, planners, and researchers lack consistent information that can be used to understand trends in market and demographic conditions. Without multi-agency information, some individual agencies have come to different conclusions on causes of present ridership declines. Other agencies lack the resources to regularly collect information.

Regular surveys of both transit users and non-users provide transit agencies and planners with important data on a transit system's performance and effectiveness at serving the public. Simple Likert ratings of perceived overall performance, reliability, convenience, safety, and satisfaction can identify areas where improvement is needed. These ratings can also be analyzed to pinpoint problems in particular service areas. Non-user survey data, while more difficult to collect, are valuable for determining what aspects of service should be improved to attract greater ridership in specific areas.

The state can provide assistance with onboard surveys, follow-up surveys, and polling of the general population. This assistance can take advantage of scale efficiencies to collect and analyze data while providing consistency.

Recommendations for Caltrans:

IA-1.2A Caltrans should provide assistance with:

- A question bank of valid, professionally-reviewed questions for local agencies to choose from.
- A statewide master contract for cost-effective survey administration tools (e.g., Tablet App, agency- and individual-level accounts, and rights management to administer app).
- Archiving responses in the Statewide Transit Data Warehouse (IA-2.1) and connecting with analytical tools.
- Privacy management to ensure that responses are only disclosed for the purposes of research and transportation planning.

## 5.2g Make TNC Data Available to Transportation Planning and Transit Agencies

Transportation planners and transit agencies currently have little to no data on TNC use, including on trips that integrate with or substitute for transit. Any data provided directly to local governments may be subject to public records requests, and TNCs are wary of releasing data that could be used for business intelligence purposes, and individual requests are time-consuming.

Universities are working on secure and anonymized data warehouses that can provide answers to transportation planning queries (e.g. popularity of an origin-destination pair) without jeopardizing confidential business information or privacy. University research data can also be subject to higher standards of confidentiality.

Recommendations for others::

IA-1.1A The CPUC should work with universities to develop TNC and private mobility service data warehouses.

IA-1.1B The CPUC or other applicable state agency should consider a requirement for TNC contracts with transit agencies and other public entities to require a minimum release of data.

IA-1.1C The Legislature should consider future changes to require TNCs to provide data to data warehouses.

## 5.2h Enable a Proactive Response to New Private Mobility Services

TNC companies such as Uber or Lyft rarely share information about their ridership or routing, posing a frequent challenge for transit agencies that want to discover where people are traveling and why. Cities have not been successful in requiring TNCs to divulge their data. TNCs may also be contributing to the recent decline in transit ridership, but a lack of data limits evidence to support or dismiss this claim. Insurance requirements and other legal difficulties frequently prevent transit companies from partnering with TNCs for mutual gain.

Without data or guidelines for what to expect from new mobility services, transportation planning and transit agencies have largely taken a reactionary approach. A more proactive approach is needed for the future.

Recommendations for others:

IA-3.3A The CPUC and others should establish state guidelines requiring TNCs to meet benchmarks in equity, accessibility, and safety.

IA-3.3B The Legislature should remove regulatory and other obstacles that prevent public transit agencies from collaborating with TNCs and other private shared mobility services. For instance, either require TNCs have a higher level insurance for applications stemming from agreements with transit agencies, or change state insurance law to indemnify transit agencies from TNC actions.

**See The Rise of Transportation Network Companies and Shared Mobility Memo (Appendix C-5)**

## 5.2i Prioritize Agency Coordination Over Consolidation

Transit service provision in California is spread among hundreds of individual agencies. In some geographies, numerous agencies may operate. For example, Contra Costa County is served by four local bus operators and at least four other agencies offering regional service. This sort of fragmentation leads to inefficiencies and waste, including higher total administrative costs. Poor inter-agency coordination leads to redundant or mismatched investments, impracticable inter-agency transfers, confusing fare policies, a lack of adequate information for transit users, balkanized data collection and analysis, and higher costs due to low-volume purchases; it also discourages coherent, ambitious future plans.

It may be tempting to imagine that consolidating small transit agencies into new, larger agencies will solve these issues. However, consolidation can introduce new problems. In the short term, organizational mergers disrupt operations, sow confusion, harm morale, and impose significant financial costs. Even once the merger process is complete, larger agencies may be less responsive to local community needs, imposing policies by administrative fiat on areas formerly served by small operators who were able to more finely tailor their policies and services. Moreover, the inefficiencies of large bureaucracies risk undermining any efficiencies gained through consolidation.

An appropriate middle ground is to support the simplification of multi-agency travel and for regions or the state to provide a stronger foundation for interagency coordination. Multiple recommendations for statewide ticketing and fare media, planning and coordination, and open data and systems will strengthen this foundation. Additionally, regional authorities may be identified or established to facilitate interagency coordination.

**When Agency Consolidation is Appropriate**

Consolidation may be appropriate when an agency consistently underserves its users. Regions should have the ability to establish user-oriented performance metrics and consider a limited number of small, underperforming agencies for consolidation through a planning process and regional board approval. In general, agencies considered for consolidation should have fewer than 100 vehicles, operate within or adjacent to the service area of a larger, better-performing agency, and not serve a significantly demographically distinct community from the larger agency.

With greater interagency coordination managed by regional authorities, individual operators would continue to independently operate service, albeit on schedules and routes established in consultation with the regional authority. Operators would use rolling stock procured through a streamlined regional or statewide process, and would be presented to the public under a branding and communications umbrella that emphasizes an integrated, regional transit system. To ensure agency compliance in providing holistic transit service, a portion of agency funding could be channeled through regional authorities. Fares would be set by individual agencies in consultation with the local regional authority, with particular attention paid to transfer fares.

<u>Recommendations for Caltrans:</u>

IA-1.3D Caltrans should provide statewide web-based platforms for data sharing and interagency service planning and coordination. (IA-2.1, IA-4.1)

Recommendations for others:

IA-1.3A The Legislature should identify or establish regional authorities to facilitate coordination among transit agencies within MPO, RTPA, megaregion areas, and any other defined areas relevant to transit trip-making, which may overlap.

IA-1.3B The State and regional authorities should increase regional coordination and oversight in areas with multiple transit operators, particularly with regards to regional transit planning and policy, monitoring and coordinating infrastructure investments, scheduling, and providing information for riders.

IA-1.3C Transit agencies throughout the state should leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle, device and information systems procurement; and data collection and analytics at the county, regional, or state level.

## 5.2j Allow New and Emerging Technology to Support Transit and HOV Priority

The U.S. Department of Transportation is working on national guidance, standards, and requirements for Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communication systems for transportation. A proposed rule would require new vehicles to have such communication capabilities beginning with the 2021 model year. The introduction of such vehicles will spur investments in connected infrastructure, and California can channel these early investments to areas where they can best support transit and other mobility objectives.


Transit-priority violations and HOV-lane degradation slow transit vehicles, compounding transit's competitive disadvantage in areas where policymakers want to advantage transit. Advancements in visual and LIDAR sensors and systems create opportunities for enhanced automated enforcement, which will enable a more consistent and reliable transit experience.

Adopting technology capable of supporting these recommendations statewide is dependent on implementing an interoperability standard for transit technology systems. (IA-3.2A).

Recommendations for Caltrans:

IA-3.2E Caltrans, state funding agencies, transit agencies, and cities should prioritize connected infrastructure in high-volume transit corridors in any future state programs to fund connected infrastructure.

Recommendations for others:

IA-3.2D The Legislature should allow additional jurisdictions besides San Francisco & Alameda County to opt in to Vehicle Code 40240 Et. Seq, allowing video imaging of parking violations in transit-only lanes.

IA-3.2F The Legislature and other funding agencies should require transit priority treatments as a condition of connected infrastructure funding. Interventions including queue jumps, signal priority, dynamically-managed transit lanes, and connected infrastructure can be used to speed up buses and at-grade rail.

## 5.2k Pursue Real-Time Transfer Coordination and Headway Management

Bus bunching causes passenger wait times to greatly exceed those in an agency's service plan, causing vehicle crowding and delays. Missed transfers can cause riders extensive delays and frustration, discouraging future transit usage. Real-time headway management and transfer coordination can address these two problems.

Transfers and headways can be coordinated by a centralized computer system. However, an automated, decentralized system in which each bus (or other transit vehicle) functions as a decision-maker can achieve significant benefits without the logistical and computational complexity of a centralized system.

Prior research demonstrates how buses could decide in real time whether to wait for the arrival of connecting lines or to depart immediately.[24] This would be accomplished by real-time information about backward headways (the projected time until the next bus), the number of passengers on board, projected arrival time of connecting lines, and the number of expected transfers from connecting lines. This distributed-control strategy significantly reduced delays associated with missed transfers, and reduced out-of-bus waiting time.

Similarly, buses can use real-time information to manage headways and avoid bunching. Buses that risk catching up to a leading bus, or creating too large a gap between themselves and the

[24] Daganzo, C. and P. Anderson (2016). *Coordinating Transit Transfers in Real Time.* California Department of Transportation (Technical Report No. CA16-2873). Retrieved from http://www.dot.ca.gov/research/researchreports/reports/2016/CA16-2873_FinalReport.pdf

following bus, may purposely slow themselves or dynamically hold at predetermined stops to avoid bunching.[25] Buses could also dispatch earlier or later than scheduled in order to fill gaps, preventing long headways.

Dependencies
IA 3.2B: Adoption of data standards for ITS tracking and timing in each region or statewide.
IA 3.2C: Widespread adoption of modern transit vehicle technology systems.

Recommendations for Caltrans:

IA-3.2G Caltrans should establish a taskforce to set statewide standards for dynamic holds at transfer and control points, which will allow automated, distributed transfer coordination and headway management.

IA-3.2H Caltrans should establish statewide ITS standards for headway-based dispatching for routes with frequent service, allowing buses to dispatch themselves early to prevent bunching.

Recommendations for others:

IA-3.2I Funding agencies should incentivize or mandate real-time transfer coordination and headway management, with an emphasis on automated, distributed coordination and management by individual transit vehicles.

## 5.2l Enhance Statewide Professional-Development Opportunities

As a result of job growth, retirements, and employee turnover, as well as significant changes in the business of transit, the transportation industry faces an uncertain employment landscape over the next 10 years.[26] At the same time, agencies need professional and managerial talent to be agile, innovative, and resourceful in identifying new solutions to old and emerging problems. The State can respond by increasing capacity for education and training through professional development programs.

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[25] See, for example, Daganzo and Pilachowski (2011) and Xuan et al. (2011).
Carlos F. Daganzo, Josh Pilachowski, Reducing bunching with bus-to-bus cooperation, In Transportation Research Part B: Methodological, Vol 45, Issue 1, 2011, Pages 267-277, ISSN 0191-2615, https://doi.org/10.1016/j.trb.2010.06.005.
Yiguang Xuan, Juan Argote, Carlos F. Daganzo, Dynamic bus holding strategies for schedule reliability: Optimal linear control and performance analysis, In Transportation Research Part B: Methodological, Vol 45, Issue 10, 2011, Pages 1831-1845, ISSN 0191-2615, https://doi.org/10.1016/j.trb.2011.07.009.

[26] Federal Transit Administration. (2016). *Workforce Development Summit –Implementing, Disseminating, and Modeling Ladders of Opportunity –Proceedings (FTA Report No. 0096).* Retrieved from: https://www.transit.dot.gov/research-innovation/workforce-development-summit-proceedings-fta-report-no-0096

Recommendations for Caltrans:

IA-4.2A Support statewide educational and certificate programs focused on training existing and future transit managers and operators. Refresh Caltrans' Transit Professional Development Grant Program to increase capacity at programs such as Mineta Transportation Institute's Graduate Certificate Program, Southern California Regional Transit Training Consortium, and UOP's Transit and Paratransit Management Certificate Program. Prioritize award grants to programs that share industry knowledge and best practices with agency staff to better understand competitive and cooperative forces with transit and how to manage them (TNCs, automation, etc.).

IA-4.2B Increase TransitWiki's utilization for professional development and disseminating innovative practices and approaches.

**See More on TransitWiki.org**

TransitWiki.org was developed as part of the 2012 Statewide Transit Strategic Plan. The goal of this Caltrans-funded site is to facilitate information transfer among transit agencies and accelerate the successful implementation of cost-effective strategies to improve transit service.

## 5.2m Plan Collaboratively for Disruptions to the Transportation Workforce

Transportation-related jobs across industry sectors are likely to be affected by automation, reducing demand for vehicle operators while increasing demand for technicians who service advanced vehicles and connected infrastructure. The trend will likely affect trucking before transit, as truck operators perform fewer in-vehicle functions than transit vehicle operators.

Individual transit agencies aren't prepared to launch worker training and economic development activities. Furthermore, public transit plays a deliberate role in supporting middle-class careers, requiring a deeper discussion about the economic and career tradeoffs that will need to be made during a switch to automated mobility.

Recommendations for others:

IA-3.1A State workforce development, education, and employment functions should plan ahead for potential changes to transportation-related employment, including in the public transit sector.

## 5.3 SR — Use Strategic Investments to Make Transit More Sustainable and Resilient

Transit agencies rely on multiple sources of funding, many of which have strings attached, and transportation by its nature is a capital-intensive business. To allocate resources in a way that is fair to riders and staff, and fiscally sustainable in the long term, transit agencies and planners must be good stewards of funds, vehicles, and facilities.

### 5.3a Prioritize a State of Good Repair

Transit agencies with limited capital dollars frequently face tradeoffs between maintaining their existing assets and expanding their network and facilities. Amidst concern that transit agencies pursuing the latter ignored the former, MAP-21 required the Federal Transit Administration to establish minimum requirements for transit asset management.[27] Under the 2016 Transit Asset Management rule, agencies must now develop and implement Transit Asset Management Plans and track and report performance measures for the condition of rolling stock, equipment, facilities, and infrastructure. This agency-level asset management data will be included in the National Transit Database beginning in 2018. The Act also established FTA's Section 5337 State of Good Repair grants program.

California can use this newly reported data to assess state of good repair investment needs and channel California Transportation Commission, TIRCP, and other discretionary grants for capital expansion only to agencies which meet objective standards for state of good repair. California should follow the example of Pennsylvania and Virginia, which have used the federal transit asset-management reporting requirements as an opportunity to implement statewide web-based data tracking and reporting systems (IA-2.2A).

Recommendations for Caltrans:

SR-1.1 Conduct research and disseminate best design practices for adaptive transit infrastructure.

[27] The 2012 Federal transportation spending reauthorization.

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| SR-1.2 | Encourage transit agencies' participation in local climate adaptation and resilience planning, as this is integral to maintaining a state of good repair in the future. |
| SR-2.1B *(PM)* | Use new transit asset-management data to assess state of good repair and reliability. Track miles (and/or service hours) between vehicle breakdowns, the frequency of delays due to breakdowns, and the percentage of preventative maintenance tasks performed on schedule. |

Recommendations for others:

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| SR-2.1A | Prioritize discretionary state funding to agencies and transportation commissions which prioritize investments in state of good repair. |

## 5.3b Take a Strategic Approach to Innovative Clean Transit

Transitioning California's transit fleets to zero-emission technology is a necessary policy that can establish precedent and markets for other heavy-duty vehicles to follow. However, the State must provide transit agencies with sufficient funding, training, and regulatory flexibility to allow transit agencies to embrace zero-emission technology without compromising their pursuit of other crucial goals and objectives for California.

### 5.3b.i Strategic Investments


Zero-emissions buses are more expensive to procure, require new and different skills and equipment to maintain, an because they are new, have more uncertain reliability and maintenance requirements than do internal-combustion buses. Offering reliable, frequent transit service in areas where demand warrants is a top priority for California. In order to ensure that the added capital costs do not force agencies to acquire fewer vehicles than needed, and that service is reliable, resources for ZEV transit vehicles must be additive and sufficient to cover added costs. Funding for ZEV technology should not replace the operating and capital funding needed to pursue State objectives for service expansion and a state of good repair.

### 5.3b.ii A Flexible Regulatory Approach

The state should set performance-based requirements for zero-emissions buses, as opposed to technology-specific requirements. Various factors, including differences in geography, weather,

vehicle speeds, route lengths, and headways, influence the type of zero-emission technology local transit agencies prefer to pursue. For example, the hilly topography of San Francisco lends itself to electric trolley coaches, which are better at hill-climbing compared to motor coaches. Allowing flexibility in the types of technology agencies can choose to implement will encourage technological innovation, and will also prevent those agencies which are the first to adopt ZEVs from being unfairly disadvantaged.

### 5.3b.iii Agency Cooperation

The costs and other burdens of establishing zero-emission fleets can be reduced through interagency coordination. Encouraging economies of scale and regional coordination for ZEV infrastructure and training will ensure a robust, standardized charging network that can be shared between agencies.

Recommendations for Caltrans:

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| SR-2.2C *(PM)* | Encourage agencies to track and report ZEV-specific performance metrics, including service reliability metrics, the percentage of fleet vehicles that are ZEV, and estimated tons of emissions per 100,000 vehicle miles. |

Recommendations for others:

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| SR-2.2A | Ensure that TIRCP and other sources of transit capital funding for ZEV are additive and do not replace other resources needed for maintenance of effort by transit agencies. |
| SR-2.2B | To enhance ZEV performance and reliability, MPOs, RTPAs, CTCs, or other regional authorities should help coordinate the soft and hard infrastructure needed for zero-emission vehicles. For example: establishing standardized charging technology across a region, and creating transit terminals with charging docks that can be interchangeable depending on the vehicle type, will increase vehicle range and reduce infrastructure costs. |

## 5.3c Identify and Promote New Revenues for Transit

Jurisdictions at all levels in California should continue to pursue new and expanded sources of transit funding. The State can provide guidance and resources for local agencies seeking to raise new revenues or receive a fair share of revenue programs.

### 5.3c.i Transit Benefit Assessment Districts

SB 142 (2013) allows Transit Benefit Assessment Districts within one-half mile of a transit station or proposed transit station. The property-tax assessment must be proportional to the benefit received by property within this zone. Approval requires a two-thirds affirmative vote of the agency's board and absence of protest by a majority of property owners within the zone. SB 142 extended provisions used by the Santa Clara Valley Transportation Authority to a BART extension to San Jose.

Recommendations for Caltrans:

SR-3.1A Develop common statewide guidance for agencies considering use of SB 142's Transit Benefit Assessment Districts.

### 5.3c.ii Ensure that Local Transportation Impact Mitigation Fees Support Transit

SB 743 (2013) directed the Governor's Office of Planning and Research to update the way that public agencies use the California Environmental Quality Act (CEQA) to evaluate transportation impacts. Draft guidelines and a Technical Advisory[28] recommended the use of vehicle miles traveled (VMT) as the primary metric to assess transportation impacts.

Several jurisdictions[29] have adopted or are considering VMT-based analysis and VMT-based impact mitigation fees ahead of the guidelines update. Transit plays a critical role not only in reducing VMT with its current ridership, but also in its potential to attract even greater ridership with improved service that provides a meaningful alternative for those who wish to avoid the (increasing) costs of driving. The Governor's Office of Planning and Research identifies[30] improved transit service and investments in transit projects as examples of VMT mitigation measures.

VMT impact fees will be assessed on development projects and collected by cities and counties. When designing the fees and identifying the mitigation investments they will fund, cities and counties should involve transit agencies to ensure that these fees are effective at improving Californians' mobility alternatives. Cities and counties which use the fees to fund transit should expect transit agencies to improve service and increase ridership. Transit agencies can use newly-produced "big data" (IA-2.3B) to demonstrate the benefits resulting from such

[28] Governor's Office of Planning and Research (2016). Revised Proposal on Updates to the CEQA Guidelines on Evaluating Transportation Impacts in CEQA. Available at http://www.opr.ca.gov/docs/Revised_VMT_CEQA_Guidelines_Proposal_January_20_2016.pdf
[29] Los Angeles, Oakland, Pasadena, Sacramento, San Francisco, San Jose, Santa Clara County
[30] p. III:45

investments, including increases in transit ridership, improved transit service quality, and reductions in VMT.

Recommendations for others:

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| SR-3.1B | Cities and counties should consult transit agencies and consider drafting MOUs or other agreements concerning the use of fee revenues for improved mobility when identifying post-SB 743 mitigation options. |
| SR-3.1C (PM) | Agencies and cities should use corridor transit passenger delay[31] as a key performance metric to prioritize projects that will speed up at-grade and mixed-traffic transit vehicles and/or will optimize street design and operations to move more transit passengers within a corridor. Reducing corridor transit passenger delay to attract and increase ridership should be a key objective for expenditures of post-SB 743 impact mitigation fees. |

## 5.4 TC — Effective, High-Quality Transit is Integral to Transforming California

California's ambitions for the coming decade — creating a healthier, lower-carbon, more socially equitable society with less reliance on private cars — depend largely on being able to construct a convenient, comprehensive transit system to serve a growing state. The recommendations in this section complement many of the transformative changes outlined in Chapter 4, but can and should be implemented independently of those more substantial changes.

### 5.4a Transit Agencies Must Improve Coordination With Land Use Authorities

A lack of coordination between transit and land-use authorities often results in local land-use policies and decisions that thwart transit agencies' efforts to improve mobility and increase ridership. Transit agencies do not have authority over land use, but they should have a seat at the table to influence the local bodies that do make these decisions.

Recommendations for others:

[31]Passenger weighted-delay takes into account the total amount of delay passengers face both waiting for and riding on a transit vehicle (compared to the optimized, modeled schedule), and weighs it against the total number of transit passengers in the corridor.

TC-2.4B CalSTA, the Department of Housing and Community Development, and the Strategic Growth Council should develop guidance for voluntary agreements (e.g. MOUs[32]) between transit agencies and local government agencies with land-use authority.

TC-2.4C State funding agencies should prioritize discretionary state funding, including the Affordable Housing and Sustainable Communities Program, for projects in jurisdictions which have an MOU with the local transit agency or have meaningfully involved transit agencies in their planning processes.

## 5.4b Introduce New Metrics for More Equitable Transit

Past transformative changes to the transportation system, such as the development of urban freeways, have often had disproportionate adverse impacts on historically disadvantaged groups. As mobility changes throughout the the state, it is essential to ensure that these changes enhance accessibility and well-being for disadvantaged groups.

Pursuit of equity for transit extends beyond establishing compliance with the Civil Rights Act of 1964.[33] Existing equity metrics used in transit planning often fail to account for the actual experiences of marginalized groups, and do not include demographic factors such as income, age, and vehicle ownership.[34] An alternative more likely to capture and lead to improvement of the lived experiences of disadvantaged people is to focus on minority and protected groups' actual travel behavior, as well as the transit service offered to, from, and within geographic areas inhabited by these groups.

**Demographic and Geographic Factors of Disadvantaged Groups**

- Race
- Ethnicity
- Gender
- Income
- Disability status
- Age (children and elderly)
- Level of education
- Access to private vehicle
- Proximity to or particular exposure to sources of pollution (e.g., located near freeways)

[32] See example MOUs between the Puget Sound Regional Council and six local public transit agencies and the Transportation Agency for Monterey County, the City of Salinas, and the Monterey-Salinas Transit District.
[33] U.S. Department of Justice. *Title VI of the Civil Rights Act Of 1964 42 U.S.C. § 2000D Et Seq.* Retrieved from: https://www.justice.gov/crt/fcs/TitleVI-Overview
[34] Marcantonio, R. A. & Karner, A. (2016). Social Equity in Transportation Planning: A Community-Based Framework. *Progressive Planning Magazine*, 206, 38-41.

Recommendations for Caltrans:

TC-4.4A Provide tools and guidance to identify community needs via a combination of onboard and other surveys; consultation with community-based organizations; and interviews with community leaders.

ⓘ See Appendix C-7 for example survey questions.

TC-4.4B Work with transit agencies and regional planners to adopt new equity metrics in transit service planning to assess equity challenges and create opportunities that are tailored to meet community-identified needs.

ⓘ See Appendix C-7 for example metrics.

TC-4.4C Provide data and tools to track equity metrics via a combination of census data; onboard and offboard surveys; and on-board and at-stop observation.

TC-4.4D Caltrans and the California Transportation Commission should consider adopting a comprehensive transit equity index[35] for Regional Transportation Plans and to assess transit capital investments and service changes.

## 5.4c Use LCTOP and Other Funding to Transform Transit in Disadvantaged Communities

The State's Low Carbon Transit Operations Program (LCTOP) must comply with SB 535 (2012), which requires a portion of cap-and-trade funds to be used to benefit disadvantaged communities. Existing LCTOP guidelines use a route's geographic proximity to disadvantaged communities as an indicator of benefit to disadvantaged communities. Additionally, although some transit agency service areas do not include disadvantaged communities, residents of disadvantaged areas use their service.

LCTOP set-asides for disadvantaged communities can be used for fare subsidies. Fare subsidies in disadvantaged communities can spur demand and cause a virtuous cycle that improves transit service. A combination of other STSP recommendations can be leveraged to ensure that LCTOP set-asides bring the maximum benefit to disadvantaged communities.

Recommendations for Caltrans:

TC-4.1B Caltrans should provide sample questions and permit the use of onboard surveys to demonstrate that LCTOP-funded transit service benefits residents of disadvantaged communities.

[35] As an example The Tri-County Metropolitan (TriMet) Transportation District of Oregon's Transit Equity Index includes components such as income, race, ethnicity, English language proficiency, age, gender, disability, vehicle ownership, job access, level of education, and social service access.

Recommendations for others:

TC-4.1A Use the program eligibility verification functionality of the Statewide Accounts System to allow agencies to use LCTOP funds on deeply discounted passes for residents of disadvantaged communities.

## 5.4d Apply New Approaches to Rural and Intercity Mobility

**California's Definition of Unmet Transit Needs[36]**

Unmet mobility needs for persons who rely on public transit to:

- Reach employment or medical assistance
- Shop for food or clothing
- Obtain social services such as health care, county welfare programs, and educational programs

Trips requested by transit-dependent or transit-disadvantaged persons, for which there is no other available means of transportation. Transit-dependent or transit-disadvantaged include, but are not be limited to,

- The elderly
- The disabled
- Persons of limited financial means

Rural areas present a challenge for traditional forms of transit, as their trip densities are too low to meet normal standards of ridership and cost-efficiency. Costs to provide demand-responsive paratransit trips can be much higher in rural areas because they are more likely to be longer and less likely to be shared.

At the same time, residents of rural areas need mobility options, and otherwise isolated rural communities need to stay connected with each other and to larger metropolitan areas in the state. While most rural residents own a car, 22% of adults 65 and older have a medical condition that restricts them from driving.[37]

New approaches to rural mobility are needed to maximize the utility of service provided and meet community transportation needs. Nonprofit mobility services may be able to effectively serve as a viable option to address rising paratransit costs and cost-effectively meet transit needs in rural and disadvantaged communities.

[36] (Caltrans guidance derived from PUC sections (99238.5, 99401.5 and 99401.6)

[37] National Academies of Sciences, Engineering, and Medicine. (2016). *Between Public and Private Mobility: Examining the Rise of Technology-enabled Transportation Services*. (p. 91). Washington, DC: The National Academies Press. https://doi.org/10.17226/21875.

Recommendations for Caltrans:

TC-5.1A Support the establishment and operation of nonprofit TNCs that can provide basic mobility services (e.g., to grocery stores, doctor visits, social-services visits) to rural residents in need.[38]

TC-5.2A Expand and improve intercity bus service to rural communities by allowing direct-ticket, bus-only travel on Amtrak California's Thruway service and expanding public and privately operated intercity bus services.[39]

**Appendix C-6: Nonprofit and Rural Mobility Service Memorandum presents an example of a federated, non-profit mobility service focused on rural areas and other areas where for-profit TNC services do not serve.**

## 5.4e Enhance Multimodal Connections to Urban Rail

In 1951, when PUC § 1202 established the Public Utilities Commission's authority to prescribe locations and treatments for railroad crossings, including at-grade light rail crossings, most passenger rail transit was privately-operated. As California has developed more at-grade light rail transit in urban areas, the number of crossings where rail vehicles interact with pedestrians, cyclists, and/or automobiles has increased. A new oversight approach could bring greater balance to transit, pedestrian, bicyclist, and automobile considerations near light rail stations and at-grade crossings.

Caltrans should ensure that agencies adhere to the multimodal access strategies laid out in *Toward an Active California*, the statewide pedestrian and bicycle plan. In particular, officials should consult Strategies M2.1 ("Incorporate first mile/last mile planning for pedestrian access needs for all intercity/high-speed rail and transit systems") and M2.2 ("Identify bicycle parking needs and transit, rail, and park and ride services and define appropriate bicycle accommodation policies") for guidance.[40]

Recommendations for others:

TC-3.1G Update urban passenger-rail crossing guidelines to promote transit priority and pedestrian and cyclist connections to transit stations.

[38] Additional details in Chapter 4 and Appendix C-6.
[39] As an example, WSDOT's Travel Washington Intercity Bus Program brands, coordinates, and contracts private bus operators to provide intercity bus service from underserved areas to cities with connecting bus and other transit service
[40] Caltrans (2017). *Toward an Active California: Bicycle and Pedestrian Plan* pg. 45

# Conclusion

In areas ranging from housing and land use to education and transportation, California has for decades maintained a strong culture of "home rule," local control, and decentralized government. While this type of governance has clear advantages, it has also made it difficult for the state to solve problems that are regional in nature — such as the planning and provision of public transit. The state has a clear interest in facilitating the mobility of people who live, work, and visit here, and public transit enables this in a manner less carbon-intensive and more equitable than the automobile-dependent model of the 20th century. Caltrans is in a unique position to coordinate efforts among the state's hundreds of local jurisdictions and transit agencies, providing the scale needed to pursue innovations in transit that better serve Californians' mobility needs.

The previous Statewide Transit Strategic Plan, published in 2012, focused exclusively on actions that were directly within Caltrans' authority. UCLA ITS recommends that the upcoming STSP, like this report, be multisector and pan-governmental in scope. A higher level of statewide involvement and coordination will lead to better outcomes for public transit, but equally important, it will align public-transit policies with the statewide greenhouse-gas emissions reduction requirements. In order to achieve the goals set out in this report, CalSTA, Caltrans, various MPOs, and transit agencies must all convene, find new ways to collaborate, and take on increased responsibilities for improving transit in California. The state legislature may also need to set clear expectations, policies, and benchmarks that transit operators can look to for guidance in the years ahead.

For this reason, the recommendations in the "Transformative Changes" chapter of this report can be the foundation to make transit more indispensable to congested areas of the state. In particular, transit-only lanes on major streets are an essential complement to the state's transit-oriented infill development strategy. Such policies will also be an essential complement to any future road-pricing system. How and to what extent California chooses to price and manage motor-vehicle use will be one of the primary factors which determines transit's future role in the state. Automobile pricing carries great potential benefits for both the road system and transit, but transit agencies themselves must also rise to the occasion by providing more and enhanced transit service to compensate for the higher price of driving in congested areas. Enhanced transit and roadway pricing can together create a "virtuous cycle" whereby pricing

reduces the demand for solo driving, which allows transit to operate better and faster, thus attracting riders who can be served more efficiently and effectively.

At the same time, the rapid rise of innovative and new-mobility services over the last five years has demonstrated that the future of mobility entails much that is uncertain. However, the state's vision and values are not uncertain: future mobility must be more equitable, lower-carbon, and complement an infill development strategy. This means that in the state's largest urban areas, traditional fixed-route, fixed-schedule public transit will remain a crucial public resource. Any expectation that tech-enabled new mobility services, such as TNCs, can replace frequent urban mass transit is naive and misguided. But all transit services will see significant changes in some way, and by anticipating and planning for these changes, Caltrans can better serve the millions of users who depend on transit today, and millions more who will depend on transit in California's future.

# STSP Project Executive Committee

| Name | Organization |
|---|---|
| Kome Ajise | Caltrans |
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# STSP Project Advisory Committee

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| John Andoh | City of Escalon |
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| Jennifer Bergener | Los Angeles – San Diego – San Luis Obispo Rail Corridor |
| Brent Bernegger | Sacramento Regional Transit |
| Alix Bockelman | Metropolitan Transportation Commission |
| Kurt Brotcke | Orange County Transportation Authority |
| Tilly Chang | San Francisco County Transportation Authority |
| Coleen Clementson | San Diego Association of Governments |
| James Corless | Sacramento Area Council of Governments |
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| Roderick Diaz | Metrolink |
| Barrow Emerson | Santa Cruz Metropolitan Transit District |
| Len Engel | Antelope Valley Transit Authority |
| Tiffani Fink | Paratransit Inc. |
| Hasan Ikhrata | Southern California Association of Governments |
| Darton Ito | San Francisco Municipal Transportation Agency |
| Paul Jablonski | San Diego Metropolitan Transit System |
| Edward King | Santa Monica Big Blue Bus |
| Philip Law | Southern California Association of Governments |
| Henry Li | Sacramento Regional Transit |
| Therese McMillan | Los Angeles Metropolitan Transportation Authority |
| Jacklyn Montgomery | California Association for Coordinated Transportation |
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| Rick Ramacier | Central Contra Costa Transit Authority |
| Elizabeth Scanlon | Peninsula Corridor Joint Powers Board |
| Josh Shaw | California Transit Authority |
| Moses Stites | Fresno County Rural Transit Agency |
| Matthew Tucker | North County Transit District |
| Mark Wall | Lake Transit Authority |
| Mark Zabaneh | Transbay Joint Powers Authority |

| Code | Description |
|---|---|
| **TC** | **Effective, high-quality transit is integral to transforming California** |
| TC-1 | Transit is necessary to enable dense, highly productive, low-carbon economic agglomerations to exist and thrive |
| TC-1.1 | Increase transit service availability, frequency, and reliability to complement dynamic pricing with meaningful travel choices |
| TC-1.1A | The Legislature should grant local governments authority to establish transit-supportive cordon pricing systems, i.e., they improve the speed and reliability of existing transit services and provide transit with revenues needed to expand capacity to meet increased demand. |
| TC-1.1B | Caltrans should support local governments that wish to initiate cordon pricing systems: Provide planning and technical support for local and regional authorities considering cordon-area pricing to address traffic congestion. Prioritize planning grants for proposals that include studies of cordon areas and other congestion pricing. Require locally-initiated automobile pricing programs to use electronic toll collection platforms that are compatible with the State's FasTrak system. |
| TC-1.1B (PM) | Measure service levels using ridership-weighted headway averages, which factor in a passenger's average wait time (a demand-side measure of service quality) rather than time between vehicles (a supply-side measure). |
| TC-1.1C | The Legislature should require that a share of revenues generated by all locally- and regionally-established tolling programs is dedicated to complementary transit, walking, and bicycling programs; and that a share of revenues is dedicated to transportation allowances for disadvantaged groups. |
| TC-1.1C (PM) | Measure service availability by tracking 1) total service hours provided against hours needed to meet transit demand, and 2) average hours per week transit service is available. |
| TC-1.1D | Support the state's first cordon-tolled areas with additional funding and technical assistance. Once one or more tolled cordon areas have been established in California, Caltrans should facilitate inter-regional knowledge transfer on experiences and best practices. Caltrans should also prioritize discretionary funding (e.g. Active Transportation Program) for sustainable mobility projects and programs in the state's first cordon-tolled areas. |
| TC-1.1D (PM) | Implement performance measures tracking connectivity and frequency, such as the number of locations where transfers can be made and average peak and off-peak headways. |
| TC-1.2 | Promote transit investments and operations that significantly reduce the GHG impact of mobility |

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| TC-1.2A | Increase capital and operating funding to provide more transit service. Consider prioritizing new and expanded sources of operations funding for agencies which have participated in Regional Comprehensive Operational Analyses (SE-1.3). |
| TC-2 | Implement transit-supportive land use strategies that also benefit biking and walking |
| TC-2.1 | Ensure that transit provides efficient mobility for urban and compact communities |
| TC-2.1A | Build ridership for community routes which feed “town center” mobility hubs. |
| TC-2.2 | Implement transit-supportive parking policies in areas with high-quality transit services |
| TC-2.2A | Local governments should adopt advanced parking-management policies that reduce direct and indirect parking subsidies that cannibalize transit’s modal share. These include requiring shared parking arrangements, eliminating parking minimums and replacing them with maximums for new development and redevelopments, or allowing fees in lieu of parking to fund transit and active-transportation improvements. |
| TC-2.2B | Adopt parking-management policies that allow for a reduction in emphasis on automobile accessibility over time. |
| TC-2.2C | Adopt shared-use parking policies that allow these town centers to serve as informal transit hubs for services such as commuter vanpools, paratransit, TNCs, express bus, BRT, and employer shuttles. |
| TC-2.3 | Pursue complete, mixed-use, and higher density neighborhoods near frequently-served transit stops and stations to enhance the accessibility of the transit network |
| TC-2.3A | Focus additional growth and development, including high-density development, around existing and planned frequent transit corridors. Prioritize state funding for development projects in high-frequency transit corridors. When designed to be transit-supportive, this development brings new transit riders and leads to a virtuous cycle of enhanced frequency and ridership. |
| TC-2.3B | Transitional places should adopt a targeted land-use strategy that will help these places urbanize and come into their own as complete, livable neighborhoods with a variety of housing and transit amenities. |
| TC-2.3C | Emphasize key land uses (e.g., grocery markets, childcare centers, coffee shops, and restaurants, and residential) concentrated around “town centers” that serve as hubs for public transit and other mobility services. These locations may be malls or large retail districts with abundant surface parking, complementary parking demand with commuters, and a desire to add more daily activities to remain competitive in a changing retail environment. |
| TC-2.3D | Emphasize the use of retail centers as mobility hubs, with transit services such as commuter vanpools, paratransit, TNCs, express bus, and employer shuttles. |
| TC-2.4 | Improve planning coordination between transit agencies and land use authorities |
| TC-2.4A | Encourage coordination between transit agencies and local municipalities on the location |

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| | and design of transit stations to ensure accessibility on the street network and facilitate the use of transit. |
| TC-2.4B | Develop guidance for voluntary agreements (e.g. MOUs) between transit agencies and local government agencies with land-use authority. |
| TC-2.4C | Prioritize discretionary state funding, including the Affordable Housing and Sustainable Communities Program, for projects in jurisdictions which have an MOU with the local transit agency or meaningfully involved transit agencies in their planning processes. |
| TC-2A | The state should continue to establish policies that facilitate infill development, use of transit and active transportation, and an increase in housing near employment.<br>Provide incentives (such as ministerial permitting, density bonuses, parking reductions, fee deferrals and waivers, and CEQA exemptions) to infill and compact development projects.<br>Expedite implementation of policies and programs presented in the California Statewide Housing Assessment 2025, such as streamlined permitting where applicable to encourage infill development consistent with local governments' General Plans and zoning policies.<br>Encourage walkable and bikeable downtowns with improved active transportation infrastructure (e.g., ample sidewalks, seating, bike lanes, bike parking). |
| TC-3 | A Transit First policy advantages walking, bicycling and the use of public transit in places where these modes can best thrive |
| TC-3A | Work with CalSTA and the Legislature to adopt a Statewide Transit First policy that advantages walking, bicycling, and the use of public transit in places where they can be most successful. |
| TC-3.1 | Support communities' transition to complete streets and pursuit of multimodal safety goals |
| TC-3.1A | Prioritize discretionary funding for projects that comply with the NACTO Transit Street Design Guide, including bus and bike lanes; pedestrian path, crossing and wayfinding improvements; and vehicle lane reductions. |
| TC-3.1B | Prioritize funding for transit, pedestrian, and bicycle improvements near major transit facilities such as transfer centers or rail stations, especially pedestrian and bicycle improvements which close network gaps and significantly reduce distances required for safe station ingress and egress |
| TC-3.1C / SR-2.3A | To implement SB 1's reasonable and feasible objectives for complete streets, local governments should produce findings to explain why roadway projects in HQTAs and Transit Priority Areas do not adhere to NACTO design guidelines. |
| TC-3.1D | Work with the Legislature to re-introduce vehicle code regulations that prioritize transit, pedestrians, and bicyclists. For example, Vehicle Code § 21810 required that drivers of vehicles overtaking transit buses yield to buses re-entering traffic, but sunsetted in 2004. |
| TC-3.1E | Partner with the Office of Traffic Safety to promote the enforcement of new and existing rules which support pedestrian connections to transit, such as those requiring vehicles to stop completely at stop signs or red lights (Vehicle Code § 22450). |

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| TC-3.1G | Update urban passenger-rail crossing guidelines to promote transit priority and pedestrian and cyclist connections to transit stations. |
| TC-3.2 | Pursue transit-only lanes and transit priority to enhance comparative advantage in high-ridership, high-frequency, high-congestion transit corridors |
| TC-3.2A | Lead by example and implement transit priority treatments, including HOV-only, transit-only, bulbouts, and boarding platforms, on state-managed facilities with recurrent congestion and high bus ridership. Fund planning studies and implementation on facilities managed by others. |
| TC-3.2B / SR-2.5A | Develop guidance for post-SB 743 expedited environmental review for bus-only lane projects. |
| TC-3.2C / SR-2.5B | Share best-practice bus-only lane case studies as models for local replication, and fund related education for agency staff as needed |
| TC-3.2D | Establish a statewide bus-on-shoulder task force to select priority urban freeway corridors for safe transit use during congestion. Extend AB 1746 (2016) provisions to new agencies and corridors identified by the task force. |
| TC-3.2E | Work with the Legislature to amend Section 148.1 of the state Streets and Highway code to allow buses to travel in freeway shoulders on segments designated by this task force. |
| TC-4 | Transit planning and operations promote healthy communities and social equity |
| TC-4.1 | Offer enhanced transit services in disadvantaged communities |
| TC-4.1A | Use the program eligibility verification functionality of the Statewide Accounts System to allow agencies to use LCTOP funds on deeply discounted passes for residents of disadvantaged communities. |
| TC-4.1B | Provide sample questions and permit the use of onboard surveys to demonstrate that LCTOP-funded transit service benefits residents of disadvantaged communities. |
| TC-4.2 | Support local efforts to repurpose street space to enhance community well-being |
| TC-4.2A | Fund planning efforts to identify major corridors that could be converted to transit-only streets or linear parks. |
| TC-4.2B | Provide post-SB 743 guidance for reducing the proportion of the public right-of-way dedicated to automobile uses. |
| TC-4.3 | Develop new approaches to enhance accessibility for seniors, the disabled, and persons of limited means |
| TC-4.3A | Integrate with appointment booking systems commonly used by medical offices, social service providers, and government to enhance mobility for seniors, the disabled, and persons of limited means |
| TC-4.4 | Encourage the use of comprehensive equity metrics and analyses |
| TC-4.4A | Provide tools and guidance to identify community needs via a combination of onboard and other surveys ; consultation with community-based organizations; and interviews with community leaders |

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| TC-4.4B | Work with transit agencies are regional planners to adopt new equity metrics in transit service planning to assess equity challenges and create opportunities that are tailored to meet community-identified needs. |
| TC-4.4C | Provide data and tools to track equity metrics via a combination of census data; onboard and offboard surveys; and on-board and at-stop observation. |
| TC-4.4D | Caltrans and the California Transportation Commission should consider adopting a comprehensive transit equity index for Regional Transportation Plans and to assess transit capital investments and service changes. |
| TC-5 | Pursue strategic opportunities for delivering transit outside of metropolitan California |
| TC-5.1 | Develop and support non-profit mobility services in rural areas and disadvantaged communities |
| TC-5.1A | Support the establishment and operation of nonprofit TNCs that provide basic mobility services (e.g., to grocery stores, doctor visits, social services visits) to rural residents in need. |
| TC-5.2 | Pursue new models for intercity mobility and connections with regional and statewide rail |
| TC-5.2A | Expand and improve intercity bus service to rural communities by allowing direct-ticket, bus-only travel on Amtrak California's Thruway service and expanding public and privately-operated intercity bus services. |
| **SE** | **A California transit passenger's multimodal experience should be seamless, safe, and affordable** |
| SE-1 | Take a user-centric approach to improving the passenger experience |
| SE-1.1 | Use technology to improve a user's experience, especially by offering reliable real-time arrival information for every vehicle in the state |
| SE-1.1A / SE-2.3D / IA-3.2C / SR-2.4A | CalSTA (via TIRCP) should provide funding for adoption of standards-based hardware and software systems that enable vast customer service and analytical capabilities, including reliable real-time arrival information for every vehicle in the state. |
| SE-1.2 | Create Statewide Ticketing and Accounts Systems for seamless integrated mobility on transit and other transportation services |
| SE-1.2A | CalSTA should bring together Caltrans, the California High Speed Rail Authority, the California Transit Association, and transit and transportation planning agencies that operate regional electronic fare payment systems, and shared-mobility providers into a permanent working group to decide on standard specifications and procedures for the implementation of an open-, standards- and account-based statewide travel booking and fare payment system. |

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| SE-1.2B | Funding agencies should require that transit agencies upgrade their fare-collection systems to the interoperable (account-based, standards-based) technological specifications decided on by the working group and establish a funding source to assist agencies' transition. |
| SE-1.2C | Make the Statewide Transportation Account system available for all forms of transportation payments, including transit fares, municipal parking, and toll collection. |
| SE-1.2D / IA-4.1A | CalSTA should incorporate all transit services and encourage the participation of private shared-mobility services into the ticketing system in order to promote seamless mobility. |
| SE-1.2E | CalSTA and other state agencies should examine the potential to use a commonly-issued but individually-unique card or identifier (such as a driver license) as a transit pass. Limited-identification cards, such as government employee and student ID cards, can also serve as fare media for deeply discounted group transit passes. |
| SE-1.3 | Support Regional Comprehensive Operational Analyses (RCOAs) to enable coordinated, seamless regional mobility |
| SE-1.3A | Caltrans, other state agencies, and MPOs should prioritize planning grants for regional COAs. Cities with HSR stations should be given priority consideration to build transit networks that develop ridership to station areas prior to HSR's arrival. |
| SE-1.3B | Caltrans and other agencies which fund planning grants should collaborate to set minimum state standards for regional COAs, including expected processes, performance metrics, and update frequency, and consider allowing for multi-county COAs coordinated by MPOs. |
| SE-1.3C | CalSTA and others should consider the presence or absence of a state-recognized COA in evaluating applications for state discretionary funding programs. This funding criterion could first be phased in for transit agencies in counties with over 750,000 population |
| SE-1.3D | The Legislature should consider future amendments to the Transportation Development Act to require regular COAs for agencies to receive operating assistance. |
| SE-2 | Reduce actual and perceived threats to safety to lower a key barrier to using transit |
| SE-2.1 | Provide users and agencies with resources to ensure consistently safe and secure on-board and out-of-vehicle experience |
| SE-2.1A | Caltrans and other state agencies should encourage and fund multiple methods of private, hassle-free emergency notification and reporting. Integrate an incident-reporting feature with applications using the Statewide Ticketing System to send reports and evidence to appropriate authorities. |
| SE-2.1B | The Legislature should require transit agencies to create safety and security training and plans that that specifically address how to minimize gender harassment and non-severe ("petty") criminal activity such as littering. |
| SE-2.2 | Work with law enforcement community to address transit's specific needs |
| SE-2.21 (PM) | Transit agencies should assess perceived safety in transit user and nonuser surveys. Track not only trends over time but also response differentials between genders. |

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| SE-2.2A | Caltrans should work with the Commission on Peace Officer Standards and Training provide agencies with common training resources, including conflict de-escalation training for customer-facing transit operations personnel. |
| SE-3 | Restructure and simplify fares to bolster transit ridership |
| SE-3.1 | Reduce non-financial barriers for agencies which wish to offer fare-free transit |
| SE-3.1A | Fund studies and pilot programs for fare-free transit, including limited applications (e.g. off-peak times or directions, limited geographic areas). |
| SE-3.1B | Work with the legislature to offer Transit Development Act farebox recovery ratio waivers for fare-free systems and pilot programs. |
| SE-3.2 | Provide statewide guidance for a easy-to-understand, low-friction transit fare structure |
| SE-3.2A | Work with CalSTA and other agencies to establish a taskforce to propose a statewide fare structure that:<br>Sets fares low relative to the purchasing power of the individual transit rider.<br>Manages limited transit capacity by encouraging riders with flexibility to travel during off-peak times, or to bike and walk when possible.<br>Is highly legible or made seamless with technology (especially the Statewide Ticketing and Accounts Systems. |
| SE-3.2B | The legislature should consider requiring all transit agencies receiving State funds to either adhere to the statewide fare structure, or offer fare-free service. |
| SE-3.3 | Provide a platform for common verification of eligibility for discounted fares and passes |
| SE-3.3A | CalSTA should link reduced-fare eligibility information to the Statewide Transit Account to improve access to discounted fares among disadvantaged groups. |
| **IA** | **Transit agencies must become more innovative and agile to vigorously pursue their missions** |
| IA-1 | Transit agencies must be able to understand and respond to changing market and demographic conditions |
| IA-1.1 | Illuminate the effects and potential of private mobility services by publishing operational data |
| IA-1.1A | The CPUC should work with universities to develop TNC and private mobility service data warehouses. |
| IA-1.1B | The CPUC or other applicable state agency should consider a requirement for TNC contracts with transit agencies and other public entities to require a minimum release of data. |
| IA-1.1C | The Legislature should consider future changes to require TNCs to provide data to data warehouses. |
| IA-1.2 | Provide resources for more frequent, robust surveys of transit users and nonusers |
| IA-1.2A | Caltrans should provide assistance with: |

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| | A question bank of valid, professionally-reviewed questions for local agencies to choose from.<br>A statewide master contract for cost-effective survey administration tools (e.g., Tablet App, agency- and individual-level accounts, and rights management to administer app).<br>Archiving responses in the Statewide Transit Data Warehouse (IA-2.1) and connecting with analytical tools.<br>Privacy management to ensure that responses are only disclosed for the purposes of research and transportation planning. |
| IA-1.3 | Improve transit's efficiency through better regional planning and coordination |
| IA-1.3A | The Legislature should identify or establish regional authorities to facilitate coordination among transit agencies within MPO, RTPA, megaregion areas, and any other defined areas relevant to transit trip-making, which may overlap. |
| IA-1.3B | The State and regional authorities should increase regional coordination and oversight in areas with multiple transit operators, particularly with regards to regional transit planning and policy, monitoring and coordinating infrastructure investments, scheduling, and providing information for riders. |
| IA-1.3C | Leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle, device and information systems procurement; and data collection and analytics at the county, regional, or state level. |
| IA-1.3D | Transit agencies throughout the state should leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle, device and information systems procurement; and data collection and analytics at the county, regional, or state level. |
| IA-1.4 | Use statewide marketing guidance, tools, and campaigns to enhance transit's perceived attractiveness |
| IA-1.4A | Caltrans and others should create statewide marketing guidance, tools, and campaigns to enhance transit's perceived attractiveness. Collaborate with transit agencies on advertising campaigns. Consider a common, statewide visual element for transit stops to make them more universally identifiable. |
| IA-1.5 | Collaborate strategically with employers and Transportation Management Organizations (TMOs) on shared mobility efforts |
| IA-1.5A | Caltrans and other state agencies should work with employers and Transportation Management Organizations to promote shared-mobility efforts. Provide guidance for agencies to offer annual transit pass programs for bulk business sales. Lead by example and increase state employees' monthly alternative-transportation subsidy to an amount sufficient to cover the cost of a monthly transit pass. |
| IA-1.5B | Caltrans should work with the California Air Resources Board to enforce the parking cash-out law (Health and Safety Code § 43845), which provides money to employees not taking a free or reduced-cost parking space. |

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| IA-2 | Provide common data and tools for agencies to track, understand, and optimize their operations |
| IA-2.1 | Establish a Statewide Transit Data Warehouse to support advanced performance analysis and multi-agency collaborations |
| IA-2.1A | Caltrans should create and maintain a Statewide Transit Data Warehouse. Connect the Data Warehouse with the statewide web-based reporting system (IA-2.2), survey tools (IA-1.2), third-party data (IA-1.1), and other analytical tools. |
| IA-2.1B | Caltrans and the State Controller's Office should establish minimum data reporting requirements and require agencies that receive state funds for hardware and software systems to automatically report data to the warehouse. |
| IA-2.1C | Allow agencies and MPOs to easily link third-party analytical tools to the State Transit Data Warehouse. Evaluate and enter into master contracts for the most useful analytical tools, and provide targeted or universal access to analytical tools. |
| IA-2.1C | Allow agencies and MPOs to easily link third-party analytical tools to the State Transit Data Warehouse. Evaluate and enter into master contracts for the most useful analytical tools, and provide targeted or universal access to analytical tools. |
| IA-2.1E | Caltrans should execute master contracts with data-provider firms that grant universal access to transit agencies and transportation planners. Establish standard data parameters for use across agencies and feed third-party data into the Statewide Transit Data Warehouse (IA-2.1). |
| IA-2.2 | Implement a statewide, web-based platform for required reporting and funding applications |
| IA-2.2A | CalSTA, Caltrans, and the State Controller's Office should establish a statewide, consolidated web-based reporting and funding platform for transit. Look to Pennsylvania as an example in working with an outside vendor to establish a statewide, open-source, web-based data-management and reporting system that assists agencies with tracking asset data. Consider future expansions to collect additional data, such as climate resilience information. |
| IA-2.3 | Adopt open data standards to improve service quality, planning and operating analytics, and multi-agency collaboration |
| IA-2.3A | Lead California in adopting the GTFS transit data standards for all passenger information systems and any future required and voluntary reporting. |
| IA-2.3B | Caltrans should adopt identified interoperability standards in the ITS Transit Statewide Plan and recommend that MPOs and counties do the same for regional/county ITS coordinating plans. |
| IA-2.3B / IA-3.2B | Caltrans should adopt GTFS data and identified interoperability standards in the ITS Transit Statewide Plan and recommend that MPOs and counties do the same for regional/county ITS coordinating plans. |
| IA-2.3C / IA-3.2B | Caltrans or its designees should participate in the development of transit data standards and transit hardware and software and interoperability standards to insure these |

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| | standards serve the California public's interest.. |
| IA-2.3E | Caltrans and CalSTA should support multi-agency consortia to develop or fund open transit applications of strategic importance to the State of California. |
| IA-3 | Understand and respond proactively to technological innovations which affect transportation |
| IA-3.1 | Coordinate preparations for connected and automated vehicles |
| IA-3.1A | State workforce development, education, and employment functions should plan ahead for potential changes to transportation-related employment, including in the public transit sector. |
| IA-3.2 | Adopt technology systems standards to improve transit's technological agility |
| IA-3.2A | Caltrans should establish a multi-stakeholder taskforce to assess hardware and software interoperability standards and determine the best path for California. |
| IA-3.2D | The Legislature should allow additional jurisdictions besides San Francisco & Alameda County to opt in to Vehicle Code 40240 Et. Seq, allowing video imaging of parking violations in transit-only lanes. |
| IA-3.2E | Caltrans, state funding agencies, transit agencies, and cities should prioritize connected infrastructure in high-volume transit corridors in any future state programs to fund connected infrastructure. |
| IA-3.2F | The Legislature and other funding agencies should require transit priority treatments as a condition of connected infrastructure funding. Interventions including queue jumps, signal priority, dynamically-managed transit lanes, and connected infrastructure can be used to speed up buses and at-grade rail. |
| IA-3.2G | Caltrans should establish a taskforce to set statewide standards for dynamic holds at transfer and control points, which will allow automated, distributed transfer coordination and headway management. |
| IA-3.2H | Caltrans should establish statewide ITS standards for headway-based dispatching for routes with frequent service, allowing buses to dispatch themselves early to prevent bunching. |
| IA-3.2I | Funding agencies should incentivize or mandate real-time transfer coordination and headway management, with an emphasis on automated, distributed coordination and management by individual transit vehicles. |
| IA-3.3 | Partner with private mobility services that can increase use of transit, bicycling, and walking |
| IA-3.3A | The CPUC and others should establish state guidelines requiring TNCs to meet benchmarks in equity, accessibility, and safety. |
| IA-4 | Foster innovation by transit agencies and individuals |
| IA-4.1 | Provide transit agencies with tools and support for a transition from transit operator to mobility manager |

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| IA-4.2 | Expand and enhance transit's professional development opportunities to empower innovators |
| IA-4.2A | Support statewide educational and certificate programs focused on training existing and future transit managers and operators. Refresh Caltrans' Transit Professional Development Grant Program to increase capacity at programs such as Mineta Transportation Institute's Graduate Certificate Program, Southern California Regional Transit Training Consortium, and UOP's Transit and Paratransit Management Certificate Program. Prioritize award grants to programs that share industry knowledge and best practices with agency staff to better understand competitive and cooperative forces with transit and how to manage them (TNCs, automation, etc.). |
| IA-4.2B | Increase TransitWiki's utilization for professional development and disseminating innovative practices and approaches. |
| **SR** | **Strategic investments make transit more sustainable and resilient** |
| SR-1 | Create more resilient, adaptive transit infrastructure |
| SR-1.1 | Conduct research and disseminate best design practices for adaptive transit infrastructure |
| SR-1.1 | Conduct research and disseminate best design practices for adaptive transit infrastructure. |
| SR-1.2 | Encourage transit agencies' participation in local climate adaptation and resilience planning |
| SR-1.2 | Encourage transit agencies' participation in local climate adaptation and resilience planning, as this is integral to maintaining a state of good repair in the future. |
| SR-2 | Use state transit funding programs for strategic capital investments |
| SR-2.1 | Allocate capital funding to agencies which prioritize investments in state of good repair |
| SR-2.1A | Prioritize discretionary state funding to agencies and transportation commissions that prioritize investments in state of good repair. |
| SR-2.1B (PM) | Use new transit asset management data to assess state of good repair and reliability. Track miles (and/or service hours) between vehicle breakdowns, the frequency of delays due to breakdowns, and the percentage of preventative maintenance tasks performed on schedule. |
| SR-2.2 | Help to lead California's transition to clean and energy-efficient heavy duty vehicles |
| SR-2.2A | Ensure that TIRCP and other sources of transit capital funding for ZEV are additive and not replace other resources needed for maintenance of effort by transit agencies. |
| SR-2.2B | To enhance ZEV performance and reliability, MPOs, RTPAs, CTCs, or other regional authorities should help coordinate the soft and hard infrastructure needed for zero-emission vehicles. For example: establishing standardized charging technology |

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| | across a region, and creating transit terminals with charging docks that can be interchangeable depending on the vehicle type, will increase vehicle range and reduce infrastructure costs. |
| SR-2.2C (PM) | Encourage agencies to track and report ZEV-specific performance metrics, including service reliability metrics, the percentage of fleet vehicles that are ZEV, estimate tons of emissions per 100,000 vehicle miles. |
| SR-2.3 | Pursue transit-supportive street design through roadway construction, maintenance, and operations |
| SR-2.4 | Prioritize funds for updated technology systems that enable more innovative infrastructure and vehicles |
| SR-2.5 | Encourage and prioritize investments in bus rapid transit |
| SR-3 | Pursue new state and local sources of transit funding |
| SR-3.1 | Create statewide guidance for use of new and emerging local revenue mechanisms |
| SR-3.1A | Develop common statewide guidance for agencies considering use of SB 142's Transit Benefit Assessment Districts. |
| SR-3.1B | Cities and counties should consult transit agencies and consider drafting MOUs or other agreements concerning the use of fee revenue for improved mobility when designing post-SB 743 VMT impact mitigation fees and identifying mitigation options. |
| SR-3.1C (PM) | Agencies and cities should use corridor transit passenger delay as a key performance metric to prioritize projects that will speed up at-grade and mixed-traffic transit vehicles and/or will optimize street design and operations to move more transit passengers within a corridor. Reducing corridor transit passenger delay to attract and increase ridership should be a key objective for expenditures of post-SB 743 impact mitigation fees. |
| SR-3.2 | Enhance mass transit services with revenues from congestion pricing systems |
| SR-3.2A | Direct toll revenues to transit services and programs that provide alternatives for auto trips that would require tolls. |
| SR-3.3B | The Legislature should remove regulatory and other obstacles that prevent public transit agencies from collaborating with TNCs and other private shared mobility services. For instance, either require TNCs have a higher level insurance for applications stemming from agreements with transit agencies or change state insurance law to indemnify transit agencies from TNC actions. |

**Caltrans**

TC-1.1B: Caltrans should support local governments that wish to initiate cordon pricing systems: Provide planning and technical support for local and regional authorities considering cordon-area pricing to address traffic congestion. Prioritize planning grants for proposals that include studies of cordon areas and other congestion pricing. Require locally-initiated automobile pricing programs to use electronic toll collection platforms that are compatible with the State's FasTrak system.

TC-1.1D: Support the state's first cordon-tolled areas with additional funding and technical assistance. Once one or more tolled cordon areas have been established in California, Caltrans should facilitate inter-regional knowledge transfer on experiences and best practices. Caltrans should also prioritize discretionary funding (e.g. Active Transportation Program) for sustainable mobility projects and programs in the state's first cordon-tolled areas.

TC-3: Work with CalSTA and the Legislature to adopt a Statewide Transit First policy that advantages walking, bicycling, and the use of public transit in places where they can be most successful.

TC-3.1A: Prioritize discretionary funding for projects that comply with the NACTO Transit Street Design Guide, including bus and bike lanes; pedestrian path, crossing and wayfinding improvements; and vehicle lane reductions.

TC-3.1B: Prioritize funding for transit, pedestrian, and bicycle improvements near major transit facilities such as transfer centers or rail stations, especially pedestrian and bicycle improvements which close network gaps and significantly reduce distances required for safe station ingress and egress

TC-3.1C / SR-2.3A: To implement SB 1's reasonable and feasible objectives for complete streets, local governments should produce findings to explain why roadway projects in HQTAs and Transit Priority Areas do not adhere to NACTO design guidelines.

TC-3.1D: Work with the Legislature to re-introduce vehicle code regulations that prioritize transit, pedestrians, and bicyclists. For example, Vehicle Code § 21810 required that drivers of vehicles overtaking transit buses yield to buses re-entering traffic, but sunsetted in 2004.

TC-3.1E: Partner with the Office of Traffic Safety to promote the enforcement of new and existing rules which support pedestrian connections to transit, such as those requiring vehicles to stop completely at stop signs or red lights (Vehicle Code § 22450).

TC-4.2A: Fund planning efforts to identify major corridors that could be converted to transit-only streets or linear parks.

TC-4.2B: Provide post-SB 743 guidance for reducing the proportion of the public right-of-way dedicated to automobile uses.

TC-3.2A: Lead by example and implement transit priority treatments, including HOV-only, transit-only, bulbouts, and boarding platforms, on state-managed facilities with recurrent congestion and high bus ridership. Fund planning studies and implementation on facilities managed by others.

TC-3.2B / SR-2.5A: Develop guidance for post-SB 743 expedited environmental review for bus-only lane projects.

TC-3.2C / SR-2.5B: Share best-practice bus-only lane case studies as models for local replication, and fund related education for agency staff as needed

SE-3.1A: Fund studies and pilot programs for fare-free transit, including limited applications (e.g. off-peak times or directions, limited geographic areas).

SE-3.1B: Work with the legislature to offer Transit Development Act farebox recovery ratio waivers for fare-free systems and pilot programs.

SE-3.2A: Work with CalSTA and other agencies to establish a taskforce to propose a statewide fare structure that:
Sets fares low relative to the purchasing power of the individual transit rider.
Manages limited transit capacity by encouraging riders with flexibility to travel during off-peak times, or to bike and walk when possible.
Is highly legible or made seamless with technology (especially the Statewide Ticketing and Accounts Systems.

SE-3.2B: The legislature should consider requiring all transit agencies receiving State funds to either adhere to the statewide fare structure, or offer fare-free service.

TC-1.2A: Increase capital and operating funding to provide more transit service. Consider prioritizing new and expanded sources of operations funding for agencies which have participated in Regional Comprehensive Operational Analyses (SE-1.3).

TC-3.2D: Establish a statewide bus-on-shoulder task force to select priority urban freeway corridors for safe transit use during congestion. Extend AB 1746 (2016) provisions to new agencies and corridors identified by the task force.

TC-3.2E: Work with the Legislature to amend Section 148.1 of the state Streets and Highway code to allow buses to travel in freeway shoulders on segments designated by this task force.

SE-1.2A: CalSTA should bring together Caltrans, the California High Speed Rail Authority, the California Transit Association, and transit and transportation planning agencies that operate regional electronic fare payment systems, and shared-mobility providers into a permanent working group to decide on standard specifications and procedures for the implementation of an open-, standards- and account-based statewide travel booking and fare payment system.

SE-1.2B: Funding agencies should require that transit agencies upgrade their fare-collection systems to the interoperable (account-based, standards-based) technological specifications

decided on by the working group and establish a funding source to assist agencies' transition.

SE-1.2C: Make the Statewide Transportation Account system available for all forms of transportation payments, including transit fares, municipal parking, and toll collection.

SE-1.2D / IA-4.1A: CalSTA should incorporate all transit services and encourage the participation of private shared-mobility services into the ticketing system in order to promote seamless mobility.

SE-1.2E: CalSTA and other state agencies should examine the potential to use a commonly-issued but individually-unique card or identifier (such as a driver license) as a transit pass. Limited-identification cards, such as government employee and student ID cards, can also serve as fare media for deeply discounted group transit passes.

SE-3.3A: CalSTA should link reduced-fare eligibility information to the Statewide Transit Account to improve access to discounted fares among disadvantaged groups.

SE-1.3A: Caltrans, other state agencies, and MPOs should prioritize planning grants for regional COAs. Cities with HSR stations should be given priority consideration to build transit networks that develop ridership to station areas prior to HSR's arrival.

SE-1.3B: Caltrans and other agencies which fund planning grants should collaborate to set minimum state standards for regional COAs, including expected processes, performance metrics, and update frequency, and consider allowing for multi-county COAs coordinated by MPOs.

SE-1.3C: CalSTA and others should consider the presence or absence of a state-recognized COA in evaluating applications for state discretionary funding programs. This funding criterion could first be phased in for transit agencies in counties with over 750,000 population

SE-2.1A: Caltrans and other state agencies should encourage and fund multiple methods of private, hassle-free emergency notification and reporting. Integrate an incident-reporting feature with applications using the Statewide Ticketing System to send reports and evidence to appropriate authorities.

SE-2.1B: The Legislature should require transit agencies to create safety and security training and plans that that specifically address how to minimize gender harassment and non-severe ("petty") criminal activity such as littering.

SE-2.2A: Caltrans should work with the Commission on Peace Officer Standards and Training provide agencies with common training resources, including conflict de-escalation training for customer-facing transit operations personnel.

SE-2.21 (PM): Transit agencies should assess perceived safety in transit user and nonuser surveys. Track not only trends over time but also response differentials between genders.

TC-4.4A: Provide tools and guidance to identify community needs via a combination of onboard

and other surveys ; consultation with community-based organizations; and interviews with community leaders

TC-4.4B: Work with transit agencies are regional planners to adopt new equity metrics in transit service planning to assess equity challenges and create opportunities that are tailored to meet community-identified needs.

TC-4.4C: Provide data and tools to track equity metrics via a combination of census data; onboard and offboard surveys; and on-board and at-stop observation.

TC-4.4D: Caltrans and the California Transportation Commission should consider adopting a comprehensive transit equity index for Regional Transportation Plans and to assess transit capital investments and service changes.

TC-4.1A: Use the program eligibility verification functionality of the Statewide Accounts System to allow agencies to use LCTOP funds on deeply discounted passes for residents of disadvantaged communities.

TC-4.1B: Provide sample questions and permit the use of onboard surveys to demonstrate that LCTOP-funded transit service benefits residents of disadvantaged communities.

TC-5.1A: Support the establishment and operation of nonprofit TNCs that provide basic mobility services (e.g., to grocery stores, doctor visits, social services visits) to rural residents in need.

TC-5.2A: Expand and improve intercity bus service to rural communities by allowing direct-ticket, bus-only travel on Amtrak California's Thruway service and expanding public and privately-operated intercity bus services.

SR-2.1A: Prioritize discretionary state funding to agencies and transportation commissions which prioritize investments in state of good repair.

SR-2.1B
(PM): Use new transit asset management data to assess state of good repair and reliability. Track miles (and/or service hours) between vehicle breakdowns, the frequency of delays due to breakdowns, and the percentage of preventative maintenance tasks performed on schedule.

SR-1.2: Encourage transit agencies' participation in local climate adaptation and resilience planning, as this is integral to maintaining a state of good repair in the future.

SR-3.1A: Develop common statewide guidance for agencies considering use of SB 142's Transit Benefit Assessment Districts.

IA-2.3A: Lead California in adopting the GTFS transit data standards for all passenger information systems and any future required and voluntary reporting.

IA-2.3B: Caltrans should adopt identified interoperability standards in the ITS Transit Statewide Plan and recommend that MPOs and counties do the same for regional/county ITS coordinating plans.

IA-2.3B /
IA-3.2B: Caltrans should adopt GTFS data and identified interoperability standards in the ITS Transit Statewide Plan and recommend that MPOs and counties do the same for regional/county ITS coordinating plans.

IA-3.2A: Caltrans should establish a multi-stakeholder taskforce to assess hardware and software interoperability standards and determine the best path for California.

IA-2.3C /
IA-3.2B: Caltrans or its designees should participate in the development of transit data standards and transit hardware and software and interoperability standards to insure these standards serve the California public's interest..

SE-1.1A /
SE-2.3D /
IA-3.2C / SR-2.4A: CalSTA (via TIRCP) should provide funding for adoption of standards-based hardware and software systems that enable vast customer service and analytical capabilities, including reliable real-time arrival information for every vehicle in the state.

IA-2.1A: Caltrans should create and maintain a Statewide Transit Data Warehouse. Connect the Data Warehouse with the statewide web-based reporting system (IA-2.2), survey tools (IA-1.2), third-party data (IA-1.1), and other analytical tools.

IA-2.1B: Caltrans and the State Controller's Office should establish minimum data reporting requirements and require agencies that receive state funds for hardware and software systems to automatically report data to the warehouse.

IA-2.1C: Allow agencies and MPOs to easily link third-party analytical tools to the State Transit Data Warehouse. Evaluate and enter into master contracts for the most useful analytical tools, and provide targeted or universal access to analytical tools.

IA-2.3E: Caltrans and CalSTA should support multi-agency consortia to develop or fund open transit applications of strategic importance to the State of California.

IA-2.1E: Caltrans should execute master contracts with data-provider firms that grant universal access to transit agencies and transportation planners. Establish standard data parameters for use across agencies and feed third-party data into the Statewide Transit Data Warehouse (IA-2.1).

IA-1.2A: Caltrans should provide assistance with:
A question bank of valid, professionally-reviewed questions for local agencies to choose from.
A statewide master contract for cost-effective survey administration tools (e.g., Tablet App, agency- and individual-level accounts, and rights management to administer app).
Archiving responses in the Statewide Transit Data Warehouse (IA-2.1) and connecting with analytical tools.
Privacy management to ensure that responses are only disclosed for the purposes of research

and transportation planning.

IA-1.3A: The Legislature should identify or establish regional authorities to facilitate coordination among transit agencies within MPO, RTPA, megaregion areas, and any other defined areas relevant to transit trip-making, which may overlap.

IA-1.3B: The State and regional authorities should increase regional coordination and oversight in areas with multiple transit operators, particularly with regards to regional transit planning and policy, monitoring and coordinating infrastructure investments, scheduling, and providing information for riders.

IA-1.3C: Leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle, device and information systems procurement; and data collection and analytics at the county, regional, or state level.

IA-1.3D: Transit agencies throughout the state should leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle, device and information systems procurement; and data collection and analytics at the county, regional, or state level.

IA-3.2E: Caltrans, state funding agencies, transit agencies, and cities should prioritize connected infrastructure in high-volume transit corridors in any future state programs to fund connected infrastructure.

IA-3.2F: The Legislature and other funding agencies should require transit priority treatments as a condition of connected infrastructure funding. Interventions including queue jumps, signal priority, dynamically-managed transit lanes, and connected infrastructure can be used to speed up buses and at-grade rail.

IA-3.2G: Caltrans should establish a taskforce to set statewide standards for dynamic holds at transfer and control points, which will allow automated, distributed transfer coordination and headway management.

IA-3.2H: Caltrans should establish statewide ITS standards for headway-based dispatching for routes with frequent service, allowing buses to dispatch themselves early to prevent bunching.

IA-3.2I: Funding agencies should incentivize or mandate real-time transfer coordination and headway management, with an emphasis on automated, distributed coordination and management by individual transit vehicles.

IA-4.2A: Support statewide educational and certificate programs focused on training existing and future transit managers and operators. Refresh Caltrans' Transit Professional Development Grant Program to increase capacity at programs such as Mineta Transportation Institute's Graduate Certificate Program, Southern California Regional Transit Training Consortium, and UOP's Transit and Paratransit Management Certificate Program. Prioritize award grants to

programs that share industry knowledge and best practices with agency staff to better understand competitive and cooperative forces with transit and how to manage them (TNCs, automation, etc.).

IA-4.2B: Increase TransitWiki's utilization for professional development and disseminating innovative practices and approaches.

IA-3.1A: State workforce development, education, and employment functions should plan ahead for potential changes to transportation-related employment, including in the public transit sector.

TC-4.3A: Integrate with appointment booking systems commonly used by medical offices, social service providers, and government to enhance mobility for seniors, the disabled, and persons of limited means

SR-1.1: Conduct research and disseminate best design practices for adaptive transit infrastructure.

IA-2.2A: CalSTA, Caltrans, and the State Controller's Office should establish a statewide, consolidated web-based reporting and funding platform for transit. Look to Pennsylvania as an example in working with an outside vendor to establish a statewide, open-source, web-based data-management and reporting system that assists agencies with tracking asset data. Consider future expansions to collect additional data, such as climate resilience information.

TC-2.4B: Develop guidance for voluntary agreements (e.g. MOUs) between transit agencies and local government agencies with land-use authority.

IA-2.1C: Allow agencies and MPOs to easily link third-party analytical tools to the State Transit Data Warehouse. Evaluate and enter into master contracts for the most useful analytical tools, and provide targeted or universal access to analytical tools.

IA-1.4A: Caltrans and others should create statewide marketing guidance, tools, and campaigns to enhance transit's perceived attractiveness. Collaborate with transit agencies on advertising campaigns. Consider a common, statewide visual element for transit stops to make them more universally identifiable.

**Calsta**

TC-1.1A: The Legislature should grant local governments authority to establish transit-supportive cordon pricing systems, i.e., they improve the speed and reliability of existing transit services and provide transit with revenues needed to expand capacity to meet increased demand.

TC-3: Work with CalSTA and the Legislature to adopt a Statewide Transit First policy that advantages walking, bicycling, and the use of public transit in places where they can be most successful.

TC-3.1A: Prioritize discretionary funding for projects that comply with the NACTO Transit Street Design Guide, including bus and bike lanes; pedestrian path, crossing and wayfinding improvements; and vehicle lane reductions.

TC-3.1B: Prioritize funding for transit, pedestrian, and bicycle improvements near major transit facilities such as transfer centers or rail stations, especially pedestrian and bicycle improvements which close network gaps and significantly reduce distances required for safe station ingress and egress

TC-3.1C / SR-2.3A: To implement SB 1's reasonable and feasible objectives for complete streets, local governments should produce findings to explain why roadway projects in HQTAs and Transit Priority Areas do not adhere to NACTO design guidelines.

TC-3.1D: Work with the Legislature to re-introduce vehicle code regulations that prioritize transit, pedestrians, and bicyclists. For example, Vehicle Code § 21810 required that drivers of vehicles overtaking transit buses yield to buses re-entering traffic, but sunsetted in 2004.

TC-3.2A: Lead by example and implement transit priority treatments, including HOV-only, transit-only, bulbouts, and boarding platforms, on state-managed facilities with recurrent congestion and high bus ridership. Fund planning studies and implementation on facilities managed by others.

SE-3.2A: Work with CalSTA and other agencies to establish a taskforce to propose a statewide fare structure that:
Sets fares low relative to the purchasing power of the individual transit rider.
Manages limited transit capacity by encouraging riders with flexibility to travel during off-peak times, or to bike and walk when possible.
Is highly legible or made seamless with technology (especially the Statewide Ticketing and Accounts Systems.

TC-2A: The state should continue to establish policies that facilitate infill development, use of transit and active transportation, and an increase in housing near employment.
Provide incentives (such as ministerial permitting, density bonuses, parking reductions, fee deferrals and waivers, and CEQA exemptions) to infill and compact development projects.
Expedite implementation of policies and programs presented in the California Statewide Housing Assessment 2025, such as streamlined permitting where applicable to encourage infill development consistent with local governments' General Plans and zoning policies.
Encourage walkable and bikeable downtowns with improved active transportation infrastructure (e.g., ample sidewalks, seating, bike lanes, bike parking).

TC-1.2A: Increase capital and operating funding to provide more transit service. Consider prioritizing new and expanded sources of operations funding for agencies which have participated in Regional Comprehensive Operational Analyses (SE-1.3).

TC-3.2D: Establish a statewide bus-on-shoulder task force to select priority urban freeway corridors for safe transit use during congestion. Extend AB 1746 (2016) provisions to new

agencies and corridors identified by the task force.

TC-3.2E: Work with the Legislature to amend Section 148.1 of the state Streets and Highway code to allow buses to travel in freeway shoulders on segments designated by this task force.

SE-1.2A: CalSTA should bring together Caltrans, the California High Speed Rail Authority, the California Transit Association, and transit and transportation planning agencies that operate regional electronic fare payment systems, and shared-mobility providers into a permanent working group to decide on standard specifications and procedures for the implementation of an open-, standards- and account-based statewide travel booking and fare payment system.

SE-1.2B: Funding agencies should require that transit agencies upgrade their fare-collection systems to the interoperable (account-based, standards-based) technological specifications decided on by the working group and establish a funding source to assist agencies' transition.

SE-1.2C: Make the Statewide Transportation Account system available for all forms of transportation payments, including transit fares, municipal parking, and toll collection.

SE-1.2D / IA-4.1A: CalSTA should incorporate all transit services and encourage the participation of private shared-mobility services into the ticketing system in order to promote seamless mobility.

SE-1.2E: CalSTA and other state agencies should examine the potential to use a commonly-issued but individually-unique card or identifier (such as a driver license) as a transit pass. Limited-identification cards, such as government employee and student ID cards, can also serve as fare media for deeply discounted group transit passes.

SE-3.3A: CalSTA should link reduced-fare eligibility information to the Statewide Transit Account to improve access to discounted fares among disadvantaged groups.

SE-1.3C: CalSTA and others should consider the presence or absence of a state-recognized COA in evaluating applications for state discretionary funding programs. This funding criterion could first be phased in for transit agencies in counties with over 750,000 population

SE-1.3D: The Legislature should consider future amendments to the Transportation Development Act to require regular COAs for agencies to receive operating assistance.

TC-4.4D: Caltrans and the California Transportation Commission should consider adopting a comprehensive transit equity index for Regional Transportation Plans and to assess transit capital investments and service changes.

TC-4.1A: Use the program eligibility verification functionality of the Statewide Accounts System to allow agencies to use LCTOP funds on deeply discounted passes for residents of disadvantaged communities.

TC-5.1A: Support the establishment and operation of nonprofit TNCs that provide basic mobility services (e.g., to grocery stores, doctor visits, social services visits) to rural residents in need.

SR-2.1A: Prioritize discretionary state funding to agencies and transportation commissions which

prioritize investments in state of good repair.

SR-2.1B
(PM): Use new transit asset management data to assess state of good repair and reliability. Track miles (and/or service hours) between vehicle breakdowns, the frequency of delays due to breakdowns, and the percentage of preventative maintenance tasks performed on schedule.

SR-1.2: Encourage transit agencies' participation in local climate adaptation and resilience planning, as this is integral to maintaining a state of good repair in the future.

SR-2.2A: Ensure that TIRCP and other sources of transit capital funding for ZEV are additive and not replace other resources needed for maintenance of effort by transit agencies.

IA-3.2A: Caltrans should establish a multi-stakeholder taskforce to assess hardware and software interoperability standards and determine the best path for California.

SE-1.1A /
SE-2.3D /
IA-3.2C / SR-2.4A: CalSTA (via TIRCP) should provide funding for adoption of standards-based hardware and software systems that enable vast customer service and analytical capabilities, including reliable real-time arrival information for every vehicle in the state.

IA-2.1A: Caltrans should create and maintain a Statewide Transit Data Warehouse. Connect the Data Warehouse with the statewide web-based reporting system (IA-2.2), survey tools (IA-1.2), third-party data (IA-1.1), and other analytical tools.

IA-2.3E: Caltrans and CalSTA should support multi-agency consortia to develop or fund open transit applications of strategic importance to the State of California.

IA-1.1A: The CPUC should work with universities to develop TNC and private mobility service data warehouses.

IA-1.1B: The CPUC or other applicable state agency should consider a requirement for TNC contracts with transit agencies and other public entities to require a minimum release of data.

IA-1.1C: The Legislature should consider future changes to require TNCs to provide data to data warehouses.

IA-1.3A: The Legislature should identify or establish regional authorities to facilitate coordination among transit agencies within MPO, RTPA, megaregion areas, and any other defined areas relevant to transit trip-making, which may overlap.

IA-1.3B: The State and regional authorities should increase regional coordination and oversight in areas with multiple transit operators, particularly with regards to regional transit planning and policy, monitoring and coordinating infrastructure investments, scheduling, and providing information for riders.

IA-1.3C: Leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle,

device and information systems procurement; and data collection and analytics at the county, regional, or state level.

IA-3.3A: The CPUC and others should establish state guidelines requiring TNCs to meet benchmarks in equity, accessibility, and safety.

SR-3.3B: The Legislature should remove regulatory and other obstacles that prevent public transit agencies from collaborating with TNCs and other private shared mobility services. For instance, either require TNCs have a higher level insurance for applications stemming from agreements with transit agencies or change state insurance law to indemnify transit agencies from TNC actions.

IA-3.2D: The Legislature should allow additional jurisdictions besides San Francisco & Alameda County to opt in to Vehicle Code 40240 Et. Seq, allowing video imaging of parking violations in transit-only lanes.

IA-3.2E: Caltrans, state funding agencies, transit agencies, and cities should prioritize connected infrastructure in high-volume transit corridors in any future state programs to fund connected infrastructure.

IA-3.2F: The Legislature and other funding agencies should require transit priority treatments as a condition of connected infrastructure funding. Interventions including queue jumps, signal priority, dynamically-managed transit lanes, and connected infrastructure can be used to speed up buses and at-grade rail.

IA-3.1A: State workforce development, education, and employment functions should plan ahead for potential changes to transportation-related employment, including in the public transit sector.

TC-2.4C: Prioritize discretionary state funding, including the Affordable Housing and Sustainable Communities Program, for projects in jurisdictions which have an MOU with the local transit agency or meaningfully involved transit agencies in their planning processes.

IA-1.5B: Caltrans should work with the California Air Resources Board to enforce the parking cash-out law (Health and Safety Code § 43845), which provides money to employees not taking a free or reduced-cost parking space.

**Metropolitan Planning Organizations and Regional Transportation Planning Agencies**

TC-1.1B: Caltrans should support local governments that wish to initiate cordon pricing systems: Provide planning and technical support for local and regional authorities considering cordon-area pricing to address traffic congestion. Prioritize planning grants for proposals that include studies of cordon areas and other congestion pricing. Require locally-initiated automobile pricing programs to use electronic toll collection platforms that are compatible with the State's FasTrak system.

TC-1.1D: Support the state's first cordon-tolled areas with additional funding and technical assistance. Once one or more tolled cordon areas have been established in California, Caltrans

should facilitate inter-regional knowledge transfer on experiences and best practices. Caltrans should also prioritize discretionary funding (e.g. Active Transportation Program) for sustainable mobility projects and programs in the state's first cordon-tolled areas.

TC-3: Work with CalSTA and the Legislature to adopt a Statewide Transit First policy that advantages walking, bicycling, and the use of public transit in places where they can be most successful.

SE-3.2A: Work with CalSTA and other agencies to establish a taskforce to propose a statewide fare structure that:
Sets fares low relative to the purchasing power of the individual transit rider.
Manages limited transit capacity by encouraging riders with flexibility to travel during off-peak times, or to bike and walk when possible.
Is highly legible or made seamless with technology (especially the Statewide Ticketing and Accounts Systems.

TC-2A: The state should continue to establish policies that facilitate infill development, use of transit and active transportation, and an increase in housing near employment.
Provide incentives (such as ministerial permitting, density bonuses, parking reductions, fee deferrals and waivers, and CEQA exemptions) to infill and compact development projects.
Expedite implementation of policies and programs presented in the California Statewide Housing Assessment 2025, such as streamlined permitting where applicable to encourage infill development consistent with local governments' General Plans and zoning policies.
Encourage walkable and bikeable downtowns with improved active transportation infrastructure (e.g., ample sidewalks, seating, bike lanes, bike parking).

TC-2.4A: Encourage coordination between transit agencies and local municipalities on the location and design of transit stations to ensure accessibility on the street network and facilitate the use of transit.

TC-2.3A: Focus additional growth and development, including high-density development, around existing and planned frequent transit corridors. Prioritize state funding for development projects in high-frequency transit corridors. When designed to be transit-supportive, this development brings new transit riders and leads to a virtuous cycle of enhanced frequency and ridership.

TC-2.2A: Local governments should adopt advanced parking-management policies that reduce direct and indirect parking subsidies that cannibalize transit's modal share. These include requiring shared parking arrangements, eliminating parking minimums and replacing them with maximums for new development and redevelopments, or allowing fees in lieu of parking to fund

transit and active-transportation improvements.

TC-1.1B (PM): Measure service levels using ridership-weighted headway averages, which factor in a passenger's average wait time (a demand-side measure of service quality) rather than time between vehicles (a supply-side measure).

TC-1.1C (PM): Measure service availability by tracking 1) total service hours provided against hours needed to meet transit demand, and 2) average hours per week transit service is available.

TC-1.1D (PM): Implement performance measures tracking connectivity and frequency, such as the number of locations where transfers can be made and average peak and off-peak headways.

TC-3.2D: Establish a statewide bus-on-shoulder task force to select priority urban freeway corridors for safe transit use during congestion. Extend AB 1746 (2016) provisions to new agencies and corridors identified by the task force.

SE-1.2A: CalSTA should bring together Caltrans, the California High Speed Rail Authority, the California Transit Association, and transit and transportation planning agencies that operate regional electronic fare payment systems, and shared-mobility providers into a permanent working group to decide on standard specifications and procedures for the implementation of an open-, standards- and account-based statewide travel booking and fare payment system.

SE-1.2C: Make the Statewide Transportation Account system available for all forms of transportation payments, including transit fares, municipal parking, and toll collection.

SE-3.3A: CalSTA should link reduced-fare eligibility information to the Statewide Transit Account to improve access to discounted fares among disadvantaged groups.

SE-1.3A: Caltrans, other state agencies, and MPOs should prioritize planning grants for regional COAs. Cities with HSR stations should be given priority consideration to build transit networks that develop ridership to station areas prior to HSR's arrival.

SE-1.3B: Caltrans and other agencies which fund planning grants should collaborate to set minimum state standards for regional COAs, including expected processes, performance metrics, and update frequency, and consider allowing for multi-county COAs coordinated by MPOs.

TC-4.4B: Work with transit agencies are regional planners to adopt new equity metrics in transit service planning to assess equity challenges and create opportunities that are tailored to meet community-identified needs.

TC-5.1A: Support the establishment and operation of nonprofit TNCs that provide basic mobility services (e.g., to grocery stores, doctor visits, social services visits) to rural residents in need.

SR-1.2: Encourage transit agencies' participation in local climate adaptation and resilience planning, as this is integral to maintaining a state of good repair in the future.

SR-2.2B: To enhance ZEV performance and reliability, MPOs, RTPAs, CTCs, or other regional authorities should help coordinate the soft and hard infrastructure needed for zero-emission vehicles. For example: establishing standardized charging technology across a region, and creating transit terminals with charging docks that can be interchangeable depending on the vehicle type, will increase vehicle range and reduce infrastructure costs.

IA-2.1C: Allow agencies and MPOs to easily link third-party analytical tools to the State Transit Data Warehouse. Evaluate and enter into master contracts for the most useful analytical tools, and provide targeted or universal access to analytical tools.

IA-1.3A: The Legislature should identify or establish regional authorities to facilitate coordination among transit agencies within MPO, RTPA, megaregion areas, and any other defined areas relevant to transit trip-making, which may overlap.

IA-1.3B: The State and regional authorities should increase regional coordination and oversight in areas with multiple transit operators, particularly with regards to regional transit planning and policy, monitoring and coordinating infrastructure investments, scheduling, and providing information for riders.

IA-1.3C: Leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle, device and information systems procurement; and data collection and analytics at the county, regional, or state level.

IA-1.3D: Transit agencies throughout the state should leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle, device and information systems procurement; and data collection and analytics at the county, regional, or state level.

**Transit Agencies**

TC-3.2C / SR-2.5B: Share best-practice bus-only lane case studies as models for local replication, and fund related education for agency staff as needed

SE-3.2A: Work with CalSTA and other agencies to establish a taskforce to propose a statewide fare structure that:
Sets fares low relative to the purchasing power of the individual transit rider.
Manages limited transit capacity by encouraging riders with flexibility to travel during off-peak times, or to bike and walk when possible.
Is highly legible or made seamless with technology (especially the Statewide Ticketing and Accounts Systems.

TC-2.4A: Encourage coordination between transit agencies and local municipalities on the location and design of transit stations to ensure accessibility on the street network and facilitate the use of transit.

TC-2.2A: Local governments should adopt advanced parking-management policies that reduce direct and indirect parking subsidies that cannibalize transit's modal share. These include requiring shared parking arrangements, eliminating parking minimums and replacing them with maximums for new development and redevelopments, or allowing fees in lieu of parking to fund transit and active-transportation improvements.

TC-2.3B: Transitional places should adopt a targeted land-use strategy that will help these places urbanize and come into their own as complete, livable neighborhoods with a variety of housing and transit amenities.

TC-2.2C: Adopt shared-use parking policies that allow these town centers to serve as informal transit hubs for services such as commuter vanpools, paratransit, TNCs, express bus, BRT, and employer shuttles.

TC-2.1A: Build ridership for community routes which feed "town center" mobility hubs.

TC-2.3D: Emphasize the use of retail centers as mobility hubs, with transit services such as commuter vanpools, paratransit, TNCs, express bus, and employer shuttles.

TC-1.2A: Increase capital and operating funding to provide more transit service. Consider prioritizing new and expanded sources of operations funding for agencies which have participated in Regional Comprehensive Operational Analyses (SE-1.3).

TC-1.1B (PM): Measure service levels using ridership-weighted headway averages, which factor in a passenger's average wait time (a demand-side measure of service quality) rather than time between vehicles (a supply-side measure).

TC-1.1C (PM): Measure service availability by tracking 1) total service hours provided against hours needed to meet transit demand, and 2) average hours per week transit service is available.

TC-1.1D (PM): Implement performance measures tracking connectivity and frequency, such as the number of locations where transfers can be made and average peak and off-peak headways.

TC-3.2D: Establish a statewide bus-on-shoulder task force to select priority urban freeway corridors for safe transit use during congestion. Extend AB 1746 (2016) provisions to new agencies and corridors identified by the task force.

SE-1.2A: CalSTA should bring together Caltrans, the California High Speed Rail Authority, the California Transit Association, and transit and transportation planning agencies that operate regional electronic fare payment systems, and shared-mobility providers into a permanent working group to decide on standard specifications and procedures for the implementation of an open-, standards- and account-based statewide travel booking and fare payment system.

SE-1.2B: Funding agencies should require that transit agencies upgrade their fare-collection systems to the interoperable (account-based, standards-based) technological specifications decided on by the working group and establish a funding source to assist agencies' transition.

SE-1.2C: Make the Statewide Transportation Account system available for all forms of transportation payments, including transit fares, municipal parking, and toll collection.

SE-2.1A: Caltrans and other state agencies should encourage and fund multiple methods of private, hassle-free emergency notification and reporting. Integrate an incident-reporting feature with applications using the Statewide Ticketing System to send reports and evidence to appropriate authorities.

SE-2.1B: The Legislature should require transit agencies to create safety and security training and plans that that specifically address how to minimize gender harassment and non-severe ("petty") criminal activity such as littering.

SE-2.2A: Caltrans should work with the Commission on Peace Officer Standards and Training provide agencies with common training resources, including conflict de-escalation training for customer-facing transit operations personnel.

SE-2.21 (PM): Transit agencies should assess perceived safety in transit user and nonuser surveys. Track not only trends over time but also response differentials between genders.

TC-4.4A: Provide tools and guidance to identify community needs via a combination of onboard and other surveys ; consultation with community-based organizations; and interviews with community leaders

TC-4.4B: Work with transit agencies are regional planners to adopt new equity metrics in transit service planning to assess equity challenges and create opportunities that are tailored to meet community-identified needs.

TC-5.2A: Expand and improve intercity bus service to rural communities by allowing direct-ticket, bus-only travel on Amtrak California's Thruway service and expanding public and privately-operated intercity bus services.

SR-1.2: Encourage transit agencies' participation in local climate adaptation and resilience planning, as this is integral to maintaining a state of good repair in the future.

SR-2.2B: To enhance ZEV performance and reliability, MPOs, RTPAs, CTCs, or other regional authorities should help coordinate the soft and hard infrastructure needed for zero-emission vehicles. For example: establishing standardized charging technology across a region, and creating transit terminals with charging docks that can be interchangeable depending on the vehicle type, will increase vehicle range and reduce infrastructure costs.

SR-2.2C (PM): Encourage agencies to track and report ZEV-specific performance metrics, including service reliability metrics, the percentage of fleet vehicles that are ZEV, estimate tons of emissions per 100,000 vehicle miles.

IA-2.3B /
IA-3.2B: Caltrans should adopt GTFS data and identified interoperability standards in the ITS Transit Statewide Plan and recommend that MPOs and counties do the same for regional/county ITS coordinating plans.

IA-3.2A: Caltrans should establish a multi-stakeholder taskforce to assess hardware and software interoperability standards and determine the best path for California.

IA-2.3C /
IA-3.2B: Caltrans or its designees should participate in the development of transit data standards and transit hardware and software and interoperability standards to insure these standards serve the California public's interest..

IA-2.1C: Allow agencies and MPOs to easily link third-party analytical tools to the State Transit Data Warehouse. Evaluate and enter into master contracts for the most useful analytical tools, and provide targeted or universal access to analytical tools.

IA-2.3E: Caltrans and CalSTA should support multi-agency consortia to develop or fund open transit applications of strategic importance to the State of California.

IA-2.1E: Caltrans should execute master contracts with data-provider firms that grant universal access to transit agencies and transportation planners. Establish standard data parameters for use across agencies and feed third-party data into the Statewide Transit Data Warehouse (IA-2.1).

IA-1.3B: The State and regional authorities should increase regional coordination and oversight in areas with multiple transit operators, particularly with regards to regional transit planning and policy, monitoring and coordinating infrastructure investments, scheduling, and providing information for riders.

IA-1.3C: Leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle, device and information systems procurement; and data collection and analytics at the county, regional, or state level.

IA-1.3D: Transit agencies throughout the state should leverage scale efficiencies and improve legibility for riders by standardizing fare and transfer policies; branding and communications standards; emergency preparedness; vehicle, device and information systems procurement; and data collection and analytics at the county, regional, or state level.

IA-3.2G: Caltrans should establish a taskforce to set statewide standards for dynamic holds at transfer and control points, which will allow automated, distributed transfer coordination and headway management.

IA-3.2H: Caltrans should establish statewide ITS standards for headway-based dispatching for routes with frequent service, allowing buses to dispatch themselves early to prevent bunching.

IA-3.2I: Funding agencies should incentivize or mandate real-time transfer coordination and headway management, with an emphasis on automated, distributed coordination and management by individual transit vehicles.

IA-4.2A: Support statewide educational and certificate programs focused on training existing and future transit managers and operators. Refresh Caltrans' Transit Professional Development Grant Program to increase capacity at programs such as Mineta Transportation Institute's Graduate Certificate Program, Southern California Regional Transit Training Consortium, and UOP's Transit and Paratransit Management Certificate Program. Prioritize award grants to programs that share industry knowledge and best practices with agency staff to better understand competitive and cooperative forces with transit and how to manage them (TNCs, automation, etc.).

IA-2.2A: CalSTA, Caltrans, and the State Controller's Office should establish a statewide, consolidated web-based reporting and funding platform for transit. Look to Pennsylvania as an example in working with an outside vendor to establish a statewide, open-source, web-based data-management and reporting system that assists agencies with tracking asset data. Consider future expansions to collect additional data, such as climate resilience information.

IA-1.4A: Caltrans and others should create statewide marketing guidance, tools, and campaigns to enhance transit's perceived attractiveness. Collaborate with transit agencies on advertising campaigns. Consider a common, statewide visual element for transit stops to make them more universally identifiable.

IA-1.5A: Caltrans and other state agencies should work with employers and Transportation Management Organizations to promote shared-mobility efforts. Provide guidance for agencies to offer annual transit pass programs for bulk business sales. Lead by example and increase state employees' monthly alternative-transportation subsidy to an amount sufficient to cover the cost of a monthly transit pass.

**Strategic Growth Council**

TC-1.1B: Caltrans should support local governments that wish to initiate cordon pricing systems: Provide planning and technical support for local and regional authorities considering cordon-area pricing to address traffic congestion. Prioritize planning grants for proposals that include studies of cordon areas and other congestion pricing. Require locally-initiated automobile pricing programs to use electronic toll collection platforms that are compatible with the State's FasTrak system.

TC-4.2A: Fund planning efforts to identify major corridors that could be converted to transit-only streets or linear parks.

SE-3.1A: Fund studies and pilot programs for fare-free transit, including limited applications (e.g. off-peak times or directions, limited geographic areas).

TC-2A: The state should continue to establish policies that facilitate infill development, use of transit and active transportation, and an increase in housing near employment.
Provide incentives (such as ministerial permitting, density bonuses, parking reductions, fee deferrals and waivers, and CEQA exemptions) to infill and compact development projects.
Expedite implementation of policies and programs presented in the California Statewide Housing Assessment 2025, such as streamlined permitting where applicable to encourage infill development consistent with local governments' General Plans and zoning policies.
Encourage walkable and bikeable downtowns with improved active transportation infrastructure (e.g., ample sidewalks, seating, bike lanes, bike parking).

TC-2.4A: Encourage coordination between transit agencies and local municipalities on the location and design of transit stations to ensure accessibility on the street network and facilitate the use of transit.

SE-3.3A: CalSTA should link reduced-fare eligibility information to the Statewide Transit Account to improve access to discounted fares among disadvantaged groups.

TC-2.4B: Develop guidance for voluntary agreements (e.g. MOUs) between transit agencies and local government agencies with land-use authority.

TC-2.4C: Prioritize discretionary state funding, including the Affordable Housing and Sustainable Communities Program, for projects in jurisdictions which have an MOU with the local transit agency or meaningfully involved transit agencies in their planning processes.

**California Transportation Commission**

TC-1.1B: Caltrans should support local governments that wish to initiate cordon pricing systems: Provide planning and technical support for local and regional authorities considering cordon-area pricing to address traffic congestion. Prioritize planning grants for proposals that include studies of cordon areas and other congestion pricing. Require locally-initiated automobile pricing programs to use electronic toll collection platforms that are compatible with the State's FasTrak system.

TC-3.1A: Prioritize discretionary funding for projects that comply with the NACTO Transit Street Design Guide, including bus and bike lanes; pedestrian path, crossing and wayfinding improvements; and vehicle lane reductions.

TC-3.1B: Prioritize funding for transit, pedestrian, and bicycle improvements near major transit facilities such as transfer centers or rail stations, especially pedestrian and bicycle improvements which close network gaps and significantly reduce distances required for safe station ingress and egress

TC-3.1C / SR-2.3A: To implement SB 1's reasonable and feasible objectives for complete streets, local governments should produce findings to explain why roadway projects in HQTAs and

Transit Priority Areas do not adhere to NACTO design guidelines.

TC-3.2A: Lead by example and implement transit priority treatments, including HOV-only, transit-only, bulbouts, and boarding platforms, on state-managed facilities with recurrent congestion and high bus ridership. Fund planning studies and implementation on facilities managed by others.

TC-3.2D: Establish a statewide bus-on-shoulder task force to select priority urban freeway corridors for safe transit use during congestion. Extend AB 1746 (2016) provisions to new agencies and corridors identified by the task force.

SR-2.1A: Prioritize discretionary state funding to agencies and transportation commissions which prioritize investments in state of good repair.

SR-2.1B
(PM): Use new transit asset management data to assess state of good repair and reliability. Track miles (and/or service hours) between vehicle breakdowns, the frequency of delays due to breakdowns, and the percentage of preventative maintenance tasks performed on schedule.

SR-2.2A: Ensure that TIRCP and other sources of transit capital funding for ZEV are additive and not replace other resources needed for maintenance of effort by transit agencies.

SR-3.2A: Direct toll revenues to transit services and programs that provide alternatives for auto trips that would require tolls.

IA-2.3B: Caltrans should adopt identified interoperability standards in the ITS Transit Statewide Plan and recommend that MPOs and counties do the same for regional/county ITS coordinating plans.

SE-1.1A /
SE-2.3D /
IA-3.2C / SR-2.4A: CalSTA (via TIRCP) should provide funding for adoption of standards-based hardware and software systems that enable vast customer service and analytical capabilities, including reliable real-time arrival information for every vehicle in the state.

IA-3.2E: Caltrans, state funding agencies, transit agencies, and cities should prioritize connected infrastructure in high-volume transit corridors in any future state programs to fund connected infrastructure.

IA-3.2F: The Legislature and other funding agencies should require transit priority treatments as a condition of connected infrastructure funding. Interventions including queue jumps, signal priority, dynamically-managed transit lanes, and connected infrastructure can be used to speed up buses and at-grade rail.

**Office of Traffic Safety**

TC-3.1E: Partner with the Office of Traffic Safety to promote the enforcement of new and existing rules which support pedestrian connections to transit, such as those requiring vehicles to stop

completely at stop signs or red lights (Vehicle Code § 22450).

TC-3.2D: Establish a statewide bus-on-shoulder task force to select priority urban freeway corridors for safe transit use during congestion. Extend AB 1746 (2016) provisions to new agencies and corridors identified by the task force.

**Legislature**

TC-1.1A: The Legislature should grant local governments authority to establish transit-supportive cordon pricing systems, i.e., they improve the speed and reliability of existing transit services and provide transit with revenues needed to expand capacity to meet increased demand.

TC-3: Work with CalSTA and the Legislature to adopt a Statewide Transit First policy that advantages walking, bicycling, and the use of public transit in places where they can be most successful.

TC-3.1D: Work with the Legislature to re-introduce vehicle code regulations that prioritize transit, pedestrians, and bicyclists. For example, Vehicle Code § 21810 required that drivers of vehicles overtaking transit buses yield to buses re-entering traffic, but sunsetted in 2004.

SE-3.1B: Work with the legislature to offer Transit Development Act farebox recovery ratio waivers for fare-free systems and pilot programs.

SE-3.2B: The legislature should consider requiring all transit agencies receiving State funds to either adhere to the statewide fare structure, or offer fare-free service.

TC-1.2A: Increase capital and operating funding to provide more transit service. Consider prioritizing new and expanded sources of operations funding for agencies which have participated in Regional Comprehensive Operational Analyses (SE-1.3).

TC-3.2E: Work with the Legislature to amend Section 148.1 of the state Streets and Highway code to allow buses to travel in freeway shoulders on segments designated by this task force.

SE-1.2C: Make the Statewide Transportation Account system available for all forms of transportation payments, including transit fares, municipal parking, and toll collection.

SE-1.2E: CalSTA and other state agencies should examine the potential to use a commonly-issued but individually-unique card or identifier (such as a driver license) as a transit pass. Limited-identification cards, such as government employee and student ID cards, can also serve as fare media for deeply discounted group transit passes.

SE-1.3D: The Legislature should consider future amendments to the Transportation Development Act to require regular COAs for agencies to receive operating assistance.

TC-5.2A: Expand and improve intercity bus service to rural communities by allowing direct-ticket, bus-only travel on Amtrak California's Thruway service and expanding public and privately-operated intercity bus services.

SR-2.2A: Ensure that TIRCP and other sources of transit capital funding for ZEV are additive and not replace other resources needed for maintenance of effort by transit agencies.

SR-3.2A: Direct toll revenues to transit services and programs that provide alternatives for auto trips that would require tolls.

IA-1.1B: The CPUC or other applicable state agency should consider a requirement for TNC contracts with transit agencies and other public entities to require a minimum release of data.

IA-1.1C: The Legislature should consider future changes to require TNCs to provide data to data warehouses.

IA-1.3A: The Legislature should identify or establish regional authorities to facilitate coordination among transit agencies within MPO, RTPA, megaregion areas, and any other defined areas relevant to transit trip-making, which may overlap.

IA-1.3B: The State and regional authorities should increase regional coordination and oversight in areas with multiple transit operators, particularly with regards to regional transit planning and policy, monitoring and coordinating infrastructure investments, scheduling, and providing information for riders.

IA-3.3A: The CPUC and others should establish state guidelines requiring TNCs to meet benchmarks in equity, accessibility, and safety.

SR-3.3B: The Legislature should remove regulatory and other obstacles that prevent public transit agencies from collaborating with TNCs and other private shared mobility services. For instance, either require TNCs have a higher level insurance for applications stemming from agreements with transit agencies or change state insurance law to indemnify transit agencies from TNC actions.

IA-3.2D: The Legislature should allow additional jurisdictions besides San Francisco & Alameda County to opt in to Vehicle Code 40240 Et. Seq, allowing video imaging of parking violations in transit-only lanes.

**Governor's Office of Planning and Research**

TC-4.2B: Provide post-SB 743 guidance for reducing the proportion of the public right-of-way dedicated to automobile uses.

TC-3.2B / SR-2.5A: Develop guidance for post-SB 743 expedited environmental review for bus-only lane projects.

**Department of Housing and Community Development**

TC-2A: The state should continue to establish policies that facilitate infill development, use of transit and active transportation, and an increase in housing near employment.
Provide incentives (such as ministerial permitting, density bonuses, parking reductions, fee deferrals and waivers, and CEQA exemptions) to infill and compact development projects.
Expedite implementation of policies and programs presented in the California Statewide Housing Assessment 2025, such as streamlined permitting where applicable to encourage infill development consistent with local governments' General Plans and zoning policies.
Encourage walkable and bikeable downtowns with improved active transportation infrastructure (e.g., ample sidewalks, seating, bike lanes, bike parking).

TC-2.4A: Encourage coordination between transit agencies and local municipalities on the location and design of transit stations to ensure accessibility on the street network and facilitate the use of transit.

IA-2.3B /
IA-3.2B: Caltrans should adopt GTFS data and identified interoperability standards in the ITS Transit Statewide Plan and recommend that MPOs and counties do the same for regional/county ITS coordinating plans.

TC-2.4B: Develop guidance for voluntary agreements (e.g. MOUs) between transit agencies and local government agencies with land-use authority.

TC-2.4C: Prioritize discretionary state funding, including the Affordable Housing and Sustainable Communities Program, for projects in jurisdictions which have an MOU with the local transit agency or meaningfully involved transit agencies in their planning processes.

**California Highway Patrol / State Law Enforcement**

TC-3.2D: Establish a statewide bus-on-shoulder task force to select priority urban freeway corridors for safe transit use during congestion. Extend AB 1746 (2016) provisions to new agencies and corridors identified by the task force.

SE-2.2A: Caltrans should work with the Commission on Peace Officer Standards and Training provide agencies with common training resources, including conflict de-escalation training for customer-facing transit operations personnel.

**California Public Utilities Commission**

TC-3.1G: Update urban passenger-rail crossing guidelines to promote transit priority and pedestrian and cyclist connections to transit stations.

IA-1.1A: The CPUC should work with universities to develop TNC and private mobility service data warehouses.

IA-1.1B: The CPUC or other applicable state agency should consider a requirement for TNC contracts with transit agencies and other public entities to require a minimum release of data.

IA-1.1C: The Legislature should consider future changes to require TNCs to provide data to data warehouses.

IA-3.3A: The CPUC and others should establish state guidelines requiring TNCs to meet benchmarks in equity, accessibility, and safety.

SR-3.3B: The Legislature should remove regulatory and other obstacles that prevent public transit agencies from collaborating with TNCs and other private shared mobility services. For instance, either require TNCs have a higher level insurance for applications stemming from agreements with transit agencies or change state insurance law to indemnify transit agencies from TNC actions.

**Air Resources Board**

SR-2.2B: To enhance ZEV performance and reliability, MPOs, RTPAs, CTCs, or other regional authorities should help coordinate the soft and hard infrastructure needed for zero-emission vehicles. For example: establishing standardized charging technology across a region, and creating transit terminals with charging docks that can be interchangeable depending on the vehicle type, will increase vehicle range and reduce infrastructure costs.

SR-2.2C (PM): Encourage agencies to track and report ZEV-specific performance metrics, including service reliability metrics, the percentage of fleet vehicles that are ZEV, estimate tons of emissions per 100,000 vehicle miles.

IA-1.5B: Caltrans should work with the California Air Resources Board to enforce the parking cash-out law (Health and Safety Code § 43845), which provides money to employees not taking a free or reduced-cost parking space.

**Other State**

SE-1.2E: CalSTA and other state agencies should examine the potential to use a commonly-issued but individually-unique card or identifier (such as a driver license) as a transit pass. Limited-identification cards, such as government employee and student ID cards, can also serve as fare media for deeply discounted group transit passes.

TC-4.3A: Integrate with appointment booking systems commonly used by medical offices, social service providers, and government to enhance mobility for seniors, the disabled, and persons of limited means

IA-1.5A: Caltrans and other state agencies should work with employers and Transportation Management Organizations to promote shared-mobility efforts. Provide guidance for agencies to offer annual transit pass programs for bulk business sales. Lead by example and increase state employees' monthly alternative-transportation subsidy to an amount sufficient to cover the cost of a monthly transit pass.

**Counties**

SE-1.2C: Make the Statewide Transportation Account system available for all forms of transportation payments, including transit fares, municipal parking, and toll collection.

IA-3.2E: Caltrans, state funding agencies, transit agencies, and cities should prioritize connected infrastructure in high-volume transit corridors in any future state programs to fund connected infrastructure.

IA-3.2F: The Legislature and other funding agencies should require transit priority treatments as a condition of connected infrastructure funding. Interventions including queue jumps, signal priority, dynamically-managed transit lanes, and connected infrastructure can be used to speed up buses and at-grade rail.

TC-2.4B: Develop guidance for voluntary agreements (e.g. MOUs) between transit agencies and local government agencies with land-use authority.

**Cities**

TC-2A: The state should continue to establish policies that facilitate infill development, use of transit and active transportation, and an increase in housing near employment.
Provide incentives (such as ministerial permitting, density bonuses, parking reductions, fee deferrals and waivers, and CEQA exemptions) to infill and compact development projects.
Expedite implementation of policies and programs presented in the California Statewide Housing Assessment 2025, such as streamlined permitting where applicable to encourage infill development consistent with local governments' General Plans and zoning policies.
Encourage walkable and bikeable downtowns with improved active transportation infrastructure (e.g., ample sidewalks, seating, bike lanes, bike parking).

TC-2.4A: Encourage coordination between transit agencies and local municipalities on the location and design of transit stations to ensure accessibility on the street network and facilitate the use of transit.

TC-2.3A: Focus additional growth and development, including high-density development, around existing and planned frequent transit corridors. Prioritize state funding for development projects in high-frequency transit corridors. When designed to be transit-supportive, this development brings new transit riders and leads to a virtuous cycle of enhanced frequency and ridership.

TC-2.2A: Local governments should adopt advanced parking-management policies that reduce direct and indirect parking subsidies that cannibalize transit’s modal share. These include requiring shared parking arrangements, eliminating parking minimums and replacing them with maximums for new development and redevelopments, or allowing fees in lieu of parking to fund transit and active-transportation improvements.

TC-2.3B: Transitional places should adopt a targeted land-use strategy that will help these

places urbanize and come into their own as complete, livable neighborhoods with a variety of housing and transit amenities.

TC-2.2B: Adopt parking-management policies that allow for a reduction in emphasis on automobile accessibility over time.

TC-2.3C: Emphasize key land uses (e.g., grocery markets, childcare centers, coffee shops, and restaurants, and residential) concentrated around “town centers” that serve as hubs for public transit and other mobility services. These locations may be malls or large retail districts with abundant surface parking, complementary parking demand with commuters, and a desire to add more daily activities to remain competitive in a changing retail environment.

TC-2.2C: Adopt shared-use parking policies that allow these town centers to serve as informal transit hubs for services such as commuter vanpools, paratransit, TNCs, express bus, BRT, and employer shuttles.

TC-2.1A: Build ridership for community routes which feed “town center” mobility hubs.

TC-2.3D: Emphasize the use of retail centers as mobility hubs, with transit services such as commuter vanpools, paratransit, TNCs, express bus, and employer shuttles.

SE-1.2C: Make the Statewide Transportation Account system available for all forms of transportation payments, including transit fares, municipal parking, and toll collection.

SE-2.1A: Caltrans and other state agencies should encourage and fund multiple methods of private, hassle-free emergency notification and reporting. Integrate an incident-reporting feature with applications using the Statewide Ticketing System to send reports and evidence to appropriate authorities.

IA-3.2E: Caltrans, state funding agencies, transit agencies, and cities should prioritize connected infrastructure in high-volume transit corridors in any future state programs to fund connected infrastructure.

IA-3.2F: The Legislature and other funding agencies should require transit priority treatments as a condition of connected infrastructure funding. Interventions including queue jumps, signal priority, dynamically-managed transit lanes, and connected infrastructure can be used to speed up buses and at-grade rail.

TC-2.4B: Develop guidance for voluntary agreements (e.g. MOUs) between transit agencies and local government agencies with land-use authority.

**Shared Mobility Providers**

SE-1.2A: CalSTA should bring together Caltrans, the California High Speed Rail Authority, the California Transit Association, and transit and transportation planning agencies that operate regional electronic fare payment systems, and shared-mobility providers into a permanent working group to decide on standard specifications and procedures for the implementation of an open-, standards- and account-based statewide travel booking and fare payment system.

SE-1.2D / IA-4.1A: CalSTA should incorporate all transit services and encourage the participation of private shared-mobility services into the ticketing system in order to promote seamless mobility.

IA-1.5A: Caltrans and other state agencies should work with employers and Transportation Management Organizations to promote shared-mobility efforts. Provide guidance for agencies to offer annual transit pass programs for bulk business sales. Lead by example and increase state employees' monthly alternative-transportation subsidy to an amount sufficient to cover the cost of a monthly transit pass.

**Employers/Transportation Management Organizations**

IA-1.5A: Caltrans and other state agencies should work with employers and Transportation Management Organizations to promote shared-mobility efforts. Provide guidance for agencies to offer annual transit pass programs for bulk business sales. Lead by example and increase state employees' monthly alternative-transportation subsidy to an amount sufficient to cover the cost of a monthly transit pass.

IA-1.5B: Caltrans should work with the California Air Resources Board to enforce the parking cash-out law (Health and Safety Code § 43845), which provides money to employees not taking a free or reduced-cost parking space.

# Goals, Policies, and Strategies

| California Transportation Plan 2040 | | STSP Crosswalk |
|---|---|---|
| **GOAL:IMPROVE MULTIMODAL MOBILITY AND ACCESSIBILITY FOR ALL PEOPLE** | | Goal: A California transit passenger's multimodal experience should be seamless, safe, and affordable |
| Policy 1 | Manage and operate an efficient integrated system. | Incorporated value; TC-2.1, IA-1.3 |
| P1-S3 | Implement programs to reduce vehicle trips while preserving personal mobility, such as employee transit incentives, telecommute programs and alternative work schedules, carsharing, parking policies, public education programs, and other strategies that enhance and complement land use and transit strategies. | Thoroughly incorporated idea |
| P1-S4 | Continue incremental improvements to the state's intercity and commuter rail system, while providing for connectivity to a future high-speed rail (HSR) network, and local transit and tribal transit networks. | TC-5.2 |
| Policy 3 | Provide viable and equitable multimodal choices including active transportation. | Incorporated value throughout plan |
| P3-S10 | Incorporate safe facilities for pedestrians, bicyclists and transit into roadway capacity and expansion projects. | SR-2.3 |
| P3-S12 | Simplify the environmental and permitting process to more easily integrate bike, pedestrian, and transit improvements into maintenance projects. | TC-3.2B / SR-2.5A |
| **GOAL:PRESERVE THE MULTIMODAL TRANSPORTATION SYSTEM** | | Goal: Strategic investments make transit more sustainable and resilient |
| Policy 2 | Apply sustainable preventive maintenance and rehabilitation strategies. | SR-2.1 |
| P2-S4 | Implement a strategic approach for assessing and prioritizing transit assets to bring the public transit system into good repair (Federal Transit Administration [FTA] FAST Act State of Good Repair and Asset Management). | SR-2.1B, IA-2.2A |

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| Policy 3 | Adapt the transportation system to reduce impacts from climate change. | SR-1.1, SR-1.2 |
| P3-S9 | Expand, repair, and upgrade existing roadways to increase access for walking, bicycling, public transit use, and freight use. | TC-2, SR-2.3 |
| P3-S10 | Incorporate safe facilities for pedestrians, bicyclists and transit into roadway capacity and expansion projects. | SR-2.3 |
| P3-S12 | Simplify the environmental and permitting process to more easily integrate bike, pedestrian, and transit improvements into maintenance projects. | TC-3.2B / SR-2.5A |
| **GOAL:SUPPORT A VIBRANT ECONOMY** | | Incorporated into Vision statement; TC-1 |
| Policy 1 | Support transportation choices to enhance economic activity. | TC-1.1 |
| P4-S1 | Develop and promote incentive programs designed to encourage efficient travel and utilization of active modes (e.g., Complete Streets). | TC-3.1, IA-1.5B |
| P4-S2 | Utilize technology to inform travelers of the best available travel options in terms of both time and cost. | SE-1.1, SE-2.2 |
| **GOAL:IMPROVE PUBLIC SAFETY AND SECURITY** | | SE-2 |
| Policy 1 | Reduce fatalities, serious injuries, and collisions. | SR-2.1 |
| P4-S4 | Invest in at-grade railroad crossing safety on over 10,000 at-grade (level) railroad crossings. | TC-3.1G |
| **GOAL:FOSTER LIVABLE AND HEALTHY COMMUNITIES AND PROMOTE SOCIAL EQUITY** | | Incorporated into Vision Statement and California's values for transit; TC-4 |
| Policy 1 | Expand engagement in multimodal transportation planning and decision-making. | TC-4 |
| P4-S3 | Develop partnerships with schools to support increased use of public and transit options, walking, and bicycling among students and teachers (Safe Routes to School). | IA-1.5A |
| Policy 2 | Integrate multimodal transportation and land use development. | TC-2, TC-3 |
| P2-S5 | Encourage increased densities and mix of land uses, and other “smart growth” principles to support transit service, walking, and bicycling while accommodating goods | TC-2 |

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| | movement. | |
| P2-S8 | Promote incentives that reward employers who locate near transit or housing; and developers who build housing near employment centers. | IA-1.5A |
| P2-S9 | Target funding toward existing communities—through strategies like HSR/transit-oriented, mixed-use development and land recycling—to increase community revitalization and the efficiency of public works investments and safeguard rural landscapes. | TC-2.1 |
| Policy 3 | Integrate health and social equity in transportation planning and decision-making. | TC-4 |
| P3-S10 | Develop models that integrate land use, transportation, health, and environmental issues. | TC-4.4, TC-4.4B |
| P3-S11 | Identify sustainability and equity indicators to enhance current transportation system PMs, such as access to public transit, safe transportation, recreation, healthy food, economic opportunities, and medical services. | TC-4.4C, TC-4.4D |
| **GOAL:PRACTICE ENVIRONMENTAL STEWARDSHIP** | | Incorporated into Vision Statement and California's values for transit; TC-1 |
| Policy 3 | Reduce GHG emissions and other air pollutants. | TC-1, TC-1.2 |
| P4-S10 | Improve links between land use planning and climate adaptation planning by using the tools such as the previous California Regional Blueprint Program and Sustainable Communities Strategies (SCSs) to better integrate adaptation strategies into regional plans, general plans, and Local Coastal Programs (LCPs). | SR-1.2 |
| Policy 4 | Transform to a clean and energy-efficient transportation system. | SR-2.2 |
| P4-S11 | Ensure transportation systems, including multimodal options, are more efficient through smart land use, operational improvements, and ITS. | TC-3, IA-3.2 |

# Actions and Measures

| California Transportation Plan 2040 | | STSP Crosswalk |
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| **Expand Transit and Rail Services and Operations** | | TC-1.1 |
| | Modernize rail and transit networks for intercity transit connections. | TC-5.2 |
| | Support technologies and capital improvements that increase convenience and competitiveness… includ[ing] real-time transit information and trip planning tools, universal payment systems, as well as cost-effective infrastructure improvements optimizing reliability and connectivity between systems. | IA-2.3, SE-1.2, SE-1.3 |
| | Analyze the implications of changing market demands for transit and rail service and demographics and optimize existing resources to improve service to those markets. | IA-1, IA-1.2, IA1.3 |
| | Improve transit payment methods to speed up vehicle boarding, which in turn can increase the efficiency of buses arriving on-time more often. | SE-1.2, SE-1.2B |
| | Expand funding for transit and rail service operations and capital improvements | TC-1.1, SR-3 |
| *Short-Range* | Coordinate with tribes to expand transit services. | SE-1.3, TC-5.1A |
| | Work with other State and regional agencies and operators to improve the perception of transit and rail in California through marketing and outreach. | IA-1.4A |
| | Continue to coordinate between Caltrans modal divisions. | |
| | Share statewide successes and lessons learned in order to accelerate the implementation of cost-effective strategies to improve transit and rail. | IA-4.2B |
| | Streamline reporting processes for State and federal grants, and funding allocations. | IA-2.2, IA-2.2A |
| | Provide statewide resources for customer service improvements like real-time passenger information systems. | SE-1.1, SE-1.1A |
| | Report publicly-sponsored vanpool service data in order to attract federal operating funds. | IA-2.2, SE-1.2, SE-2.1 |
| | Support employer-assisted housing and use of Transportation Demand Management (TDM) policies with employers in transit | IA-1.5A |

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| | corridors. | |
| *Mid-to-Long-Range* | Implement rail capital improvements that will support a greatly expanded rail and transit system in California. Support seamless transfers between local-regional transit and passenger rail systems. | IA-3.2I |
| | Help transit operators understand real-time passenger information systems and offer grants that can help offset initial costs of publishing data. | SE-1.1A / SE-2.3D / IA-3.2C / SR-2.4A |
| | Caltrans Division of Rail and Mass Transportation can work with local transit stakeholders throughout the State to evaluate and learn from the bus rapid transit (BRT) projects. | SR-2.5, SR-2.5A |
| | Improve perception of transit services by working with other state and local agencies. | IA-1.4A |
| | Improve upon scheduled transfers between regional transit services. | SE-1.3 |
| ***Improve Multimodal Mobility and Accessibility for All*** | | |
| *Short-Range* | Implement land use strategies that make travel easier through the reduction of distances in consumer activities (e.g., shopping, recreation, etc.). | TC-2.1 |
| | Create public spaces with bicycle/pedestrian and transit access in order to reduce automobile dependency. | TC-4.2 |
| | Provide funding and emphasize Transportation Demand Strategies such as ridesharing, vanpooling, park-and-ride lots, transportation information dissemination, and employer outreach programs. Focus on HSR/transit-oriented development (TOD) projects that capitalize on incorporating high-density, mixed use areas thereby reducing individual dependency on cars and encouraging the use of transit. | TC-2.1A, TC-2.2C, TC-2.3C |
| | Create supportive policies and secure funding for the promotion of shared mobility (car sharing, bike sharing, real-time ridesharing, Transportation Network Companies, scooter share, shared neighborhood electric vehicles, and on-demand shuttle and jitney services). | SE-1.2A, SE-1.4D, IA-4.1A |
| | Support a unified or universal transportation account that combines all forms of public transportation payments including transit fares, municipal parking and toll collection into a single user-friendly system. | SE-1.2, SE-1.2C |
| *Mid-Range* | Support infill development to slow urban sprawl and increase density. This will reduce distances between consumer activities, thus encouraging more people to take advantage of transit services, | TC-2 |

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| | bicycling and walking. | |
| | Increase the efficiency and reliability of transit service trips by timing signals to favor public transit. | IA-3.2B, IA-3.2E, TC-3 |
| | Develop rideshare programs and efficient parking management strategies to allow more people to travel using existing infrastructure, and support HSR/TOD and alternative transportation choices. | TC-2.2, TC-2.2A, TC-2.2C |
| ***Coordinate Data and Analysis*** | | IA-2 |
| *Short-Range* | Coordinate data and analysis efforts across regions to ensure consistency and comparability of results. | IA-2.1C |
| | Support funding for the purchase and maintenance of a statewide transit data collection repository that can capture and organize the transit data funneled to Caltrans by local transit providers. | IA-2.1A |
| ***Invest Strategically*** | | SR-2 |
| *Short-Range* | Support a competitive capital program for transit capital replacement, acquisition, and the development and construction of transit centers and bus maintenance facilities. | SR-2.1, SR-2.2, SR-33 |
| ***Advance Modeling and Data*** | | IA-2 |
| *Short-Range* | Secure funding for regular modal surveys (including transit on-board surveys, and pedestrian/bicycle activity surveys), and big data analysis using anonymous cell phone/GPS data to improve understanding of travel patterns. | IA-1.2, IA-2.1C, IA-2.1D |

Transit agencies have been able to use technology to attract passengers and make smarter service and system planning decisions. Improvements in passenger information systems allow for more consistent, efficient, and convenient transit trips. Studies[1] have shown that the provision of real-time arrival information can increase transit ridership without any service adjustments. Real-time information can be a highly cost-effective means of attracting additional transit ridership.

Publicly-available passenger information presented in standard, machine-readable format can serve as the foundation for universal planning and analytical tools. For example the Federal Transit Administration has created a National Transit Map for visualization of stops and services from multiple agencies. The 2017 Statewide Transit Strategic Plan Baselines Report included a multi-agency analysis of interagency stops and multi-agency corridor frequencies which was created using GTFS data. The Remix platform allows agencies and the public to plan transit networks using the publicly-accessible GTFS data feed that powers Google Maps transit directions.

These developments are the first of many technology-enabled advancements that will improve transit in California over the coming decades. However, many agencies lag behind in taking advantage of technological innovation to improve service and decision-making. Others don't see a path forward for regional compatibility. Adopting standards for systems interoperability and data will accelerate their adoption and substantially reduce barriers for future upgrades.

# Challenges

A 2016 ITS America Report for the US Federal Highways Administration[2] explored barriers to adopting APTA's TCIP communications standards that allows hardware from multiple vendors to become interoperable. According to that report, a circular problem exists where vendors are reluctant to develop standards-based products without a customer base on which they can rely on future sales and transit agencies are reluctant to issue RFPs for standards-compliant systems if there are none on the market. The lack of standards leads to vendor and technology "lock-in" where transit agencies have high switching costs and those who sell proprietary systems can count on contract renewal and continued revenues - even from transit agency customers who are

[1] Brakewood, C., Macfarlane, G. S., & Watkins, K. (2015). The impact of real-time information on bus ridership in New York City. *Transportation Research Part C: Emerging Technologies*, *53*, 59-75. Watkins, Kari Edison, et al. "Where Is My Bus? Impact of mobile real-time information on the perceived and actual wait time of transit riders." *Transportation Research Part A: Policy and Practice* 45.8 (2011): 839-848.
[2] Accessible at https://ntl.bts.gov/lib/59000/59300/59399/FHWA-JPO-17-432.pdf

unhappy with their products. This leads to higher life-cycle costs with lesser system capabilities than standards-based, upgradable systems.

Lock-in makes incremental upgrades difficult: agencies must replace the entirety of their technology systems to assure compatibility. Incremental upgrades are further complicated by an agency's rolling seven to twelve-year vehicle replacement cycle: an agency that replaces less than one-fifth of its vehicles in a given year is likely to outfit them with aging technology that matches existing systems.

The effects of non-upgradable systems have already had a negative impact on transit in California. Stakeholder engagement activities during the 2012 and 2017 Statewide Transit Strategic Transit Plans revealed that transit agencies have had difficulty in producing GTFS data from proprietary (non-open) internal technology systems. This difficulty is particularly acute in producing the GTFS-RT real-time arrival information data which can help boost ridership. These current difficulties will compound as transit agencies and planners come to rely on additional standardized data formats, such as GTFS-Flex for demand responsive service and GTFS-ride or real-time occupancy information.

In the future, inconsistent system capabilities will mean increased time and expense to introduce upgrades on transit and other mobility services that are increasingly reliant on technology. For example, delay in upgrading how an agency's systems integrate with the statewide ticketing system could lead to stranded passengers or expose security vulnerabilities.

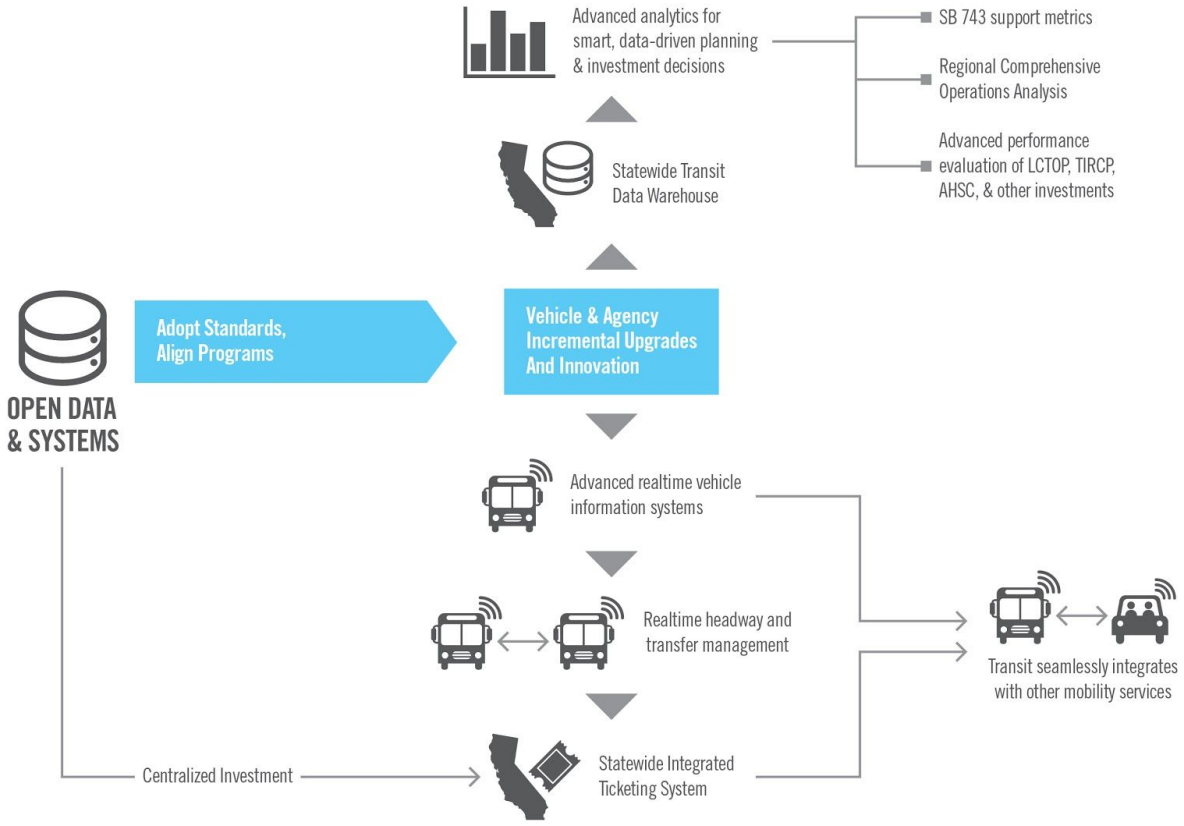
# Opportunity

California has the need, scale, and capabilities to overcome these barriers by assisting in the development of new standards and adopting standards and using funding programs to support accelerated and universal statewide implementation. California's transportation vision includes an integrated transit and high-speed rail system that allows for seamless regional and statewide travel without the need for a car. Ranked 2$^{nd}$ in total transit spending behind New York, California has the scale necessary to precipitate changes in the marketplace. California's highest transit ridership region is home to the global technology industry and the state has long been a hub for innovation.

This plan recommends the state pursues open, interoperable, standards-based systems and data for transit to maximize the effectiveness of investments in transit services. The goal is to provide

a more seamless passenger experience while creating data that enables advanced analytics for multi-agency transit optimization. A 2015 Report by the Rocky Mountain Institute[3] further details how open and interoperable transit data enables seamless mobility as a service.

Key among the motivations for this recommendation among is to enable future agility and narrow the gap between public and private mobility. This recommendation also is foundational for many strategies and action items identified in this plan.




The possibilities enabled by ubiquitous, standardized, statewide transit data will be transformative for transit. Planners will be able to combine two "big" and "open" data feeds to create facility & corridor-specific measures of person-delay: archived vehicle delay (from GTFS-RT) and vehicle occupancy (from GTFS-ride from the Statewide Transit Data Warehouse). These metrics could then be used to incorporate transit priority metrics into Congestion Management Law, or to evaluate the success of investments in transit improvements.

[3] https://www.rmi.org/insights/reports/interoperable-transit-data/

Caltrans has explored integrating standardized transit data into state highway planning[4]. The National Association of City Transportation Officials, the World Resources Institute, and World Bank are working on an Open Traffic Partnership to standardized traffic data information. Standard format data on current traffic conditions would enable a universal approach to accurate transit arrival predictions, even as traffic conditions change between vehicles trips. Current methods rely on historical data and data reported from the last vehicle on the route.

# Implementation Options

Three aspects of open systems apply to transit technology:

- Open source - software source code is available for others to edit
- Open architecture - interconnected subsystems from multiple vendors are interoperable
- Open data - the system's product (data) is freely accessible by the transit operator, other agencies, the public, and third-party applications in a standardized machine-readable format. The data may be available via an Application Program Interfaces (API).

Most transit systems contain a combination of hardware and software, with data flowing between.

## Transit systems interoperability standards

Transit vehicles have a number of on-board information technology components, including automated vehicle location, automated passenger counter, computer aided dispatch, farebox, mobile data terminal, network connection and router, and stop annunciator and signage. Many of these systems must interface with one another, and with the agency's transit management and planning software. Unlike with consumer electronics, where devices from a variety of manufacturers can work together seamlessly with "plug-and-play" interoperability (e.g. WiFi), most transit hardware and software is not standards-based. Integrating devices from multiple manufacturers requires additional customization and carries a risk of failure.

The need for interoperability standards is well known to transit technology professionals. For over two decades, transit professionals have worked through industry consortia to develop interoperability standards. Two of these efforts are described below.

[4] http://www.dot.ca.gov/research/researchreports/preliminary_investigations/docs/transit_data_integration_pi_7-2-12.pdf

### APTA-TCIP

With funding from the US DOT Intelligent Transportation Systems Joint Programs Office, the American Public Transportation Association worked to extend a national transportation systems protocol to transit in order to integrate on-board hardware systems with transit management systems, including passenger information, scheduling, and signal priority. The resulting standard, American Public Transit Association - Transit Communications Interface Profiles (APTA-TCIP) was first released in the mid-2000s. Development has since stalled[5], and adoption has been limited.

### ITxPT initiative

ITxPT, or information technology for public transport, is a partnership between transit agencies, vendors, and the International Association for Public Transport to create a working standard for a plug-and-play transit IT systems. The group's objective is to create an open standard for European-wide bus, coach, and tramway technology. The standards development effort began in 2014 and will build off of existing European Committee for Standardization specifications for Intelligent Transportation Systems standards.

## Data Standards

Data formats, like computer file formats, specify the structure of information. Proprietary data formats require conversion to be used by those without the proprietary software, like an Adobe Photoshop file. Standardized data can be read and passed between multiple software systems, like a text file. The power of standardized data lies in the ability to leverage third-party applications, which may be developed for a specific agency or use case but are universally useful to any agency producing data in the standardized format.

### GTFS

Originally started by Google to incorporate transit data into Google Maps. The General Transit Feed Specification (GTFS) has evolved into a family of standard formats for passenger information systems. The core GTFS standard describes scheduled transit service[6]. GTFS data feeds many existing passenger routing and analytical tools.

[5] The standard was last updated in 2011
[6] GTFS is decribed in detail in Chapter 9 of the 2017 STSP Baselines Report and on TransitWiki https://www.transitwiki.org/TransitWiki/index.php/General_Transit_Feed_Specification

| Passenger Routing | Analytical |
|---|---|
| • Google Maps<br>• Apple Maps<br>• OpenTripPlanner<br>• The Transit App | • Remix<br>• WalkScore/Transit Score<br>• Conveyal Analysis |

*See a list of over 80 applications at https://www.transitwiki.org/TransitWiki/index.php/Category:GTFS-consuming_applications*

GTFS has become a defacto standard in the United States. In March 2016, USDOT Transportation Secretary Anthony Foxx issued a "Dear Colleague" letter inviting the nation's transit agencies to contribute to a national repository of GTFS feed data.[7] 196 agencies responded with their GTFS sh GTFS data[8]. Research for the 2016-17 Baselines Report[9] identified 66 California agencies with GTFS feeds.

### GTFS-RT

GTFS-RT or realtime is a related data standard that describes schedule deviation. There are 3 components:

- Trip updates used to stop-specific predict arrival times
- Vehicle position used to display a vehicle on a map. Vehicle position data can be collected over time and used to analyze vehicle flow
- Service alerts, which allow distribution of static or real time alert information for a stop, route, or entire transit agency network

### GTFS-Ride

With more analytical tools using GTFS and GTFS-RT, there's become a greater need for a GTFS-compatible data standard to describe service consumption. The Oregon Department of Transportation is funding GTFS-ride specification to describe occupancy, boarding, and alighting data per stop. This will create a standards-compliant data stream for analyzing transit usage data. It is a prerequisite for assessing transit corridor person delay, a metric which can be used to prioritize investments in bus rapid transit projects.

[7] Accessible at http://maps.bts.dot.gov/Transit/downloads/DearColleague.pdf
[8] 196 U.S. transit agencies have provided GTFS to the USDOT's National Transit Map https://www.rita.dot.gov/bts/ntm/map
[9] pg 210

### GTFS-Flex

As more agencies and transit passengers turn to GTFS for information on fixed route, scheduled service, the lack of accommodation for flexible route, demand-responsive service has become an issue for paratransit and non-urban areas. The Vermont Agency of Transportation is working on a GTFS-flex specification to bring rural transit and paratransit to apps like Google Maps.

### SIRI

Service Interface for Real Time Information (SIRI) is a European standard for real-time information which has had limited adoption in the United States, but would be compatible with hardware and network systems which meet European standards. The GTFS family of standards could also be compatible with these systems.

# Recommendations

## Establish a taskforce to assess interoperability standards

A taskforce with membership from the State, California transit agencies, California Transit Association, California Association for Coordinated Transportation (CalACT), the American Public Transportation Association (APTA), ITS America, and others. Rather than developing new, ground-up standards, the task force will assess standards options (APTA-TCIP, ITxPT, and others) through the lens of California's transit vision. Key considerations would include:

- Which open interoperability and data[10] standards will best serve the public interest and be officially adopted in California?
- Which vehicle technology hardware upgrades are critical and should be prioritized?
    - To enable a statewide integrated ticketing system?
    - For vehicle-to-vehicle and vehicle-to-infrastructure communications (e.g. those upgrades which enable broadcast of Basic Safety Message to enhance safety).
- How do emerging ITS standards for V2X communications incorporate specifications for transit?

<u>Action items</u>

- State to provide a planning grant for multi-agency technology standards planning effort

[10]The plan recommends GTFS be adopted as a data standard.

## Adopt and further develop standards

The GTFS family of standards are clear leaders in the U.S. and should be adopted in California. Once the task force identifies an interoperability standard appropriate for California, the state can work to incorporate these standards so that they can be implemented through existing planning processes.

Action items

- Adopt data and interoperability standards in the ITS Transit Statewide Plan and regional/county ITS coordinating plans. Agencies wishing to use federal funding for transit IT systems must demonstrate consistency with these coordinating plans[11], and the state should adopt a similar requirement for its own funding
- A taskforce subcommittee or Caltrans' designee should participate in standards development
    - Work with Oregon DOT and partners to further develop GTFS-ride specification;
    - Work with Vermont Agency of Transportation and partners to further develop the GTFS-flex specification
    - Participate in the development of other open standards of strategic importance to the State of California.
- Incorporate advanced, standardized transit data into travel demand modeling modeling through future updates to the California Transportation Commission's Regional Transportation Plan Guidelines.

## Provide funding for adoption of standards-based hardware and software systems

Needed upgrades will take significant time, funding and effort to roll out to over 150 transit agencies with over 25,000 vehicles. The state should leverage existing funding and technical assistance programs to accelerate adoption of technology necessary for the next generation of transit in California. The availability of additional state funds, combined with the requirement that state and federal funds be used for standards-based technology systems, will signal to vendors that they need to offer compliant systems to compete in California and other states which follow California's lead.

[11] http://www.dot.ca.gov/drmt/docs/its/reqletter.PDF

For example, the Low Carbon Transit Operations Program (LCTOP) would require a new "IT systems" category for "Project Type"[12] or clarification that "upgrade transit vehicles" isn't limited to active transportation enhancements. This change would clarify existing guidelines, as the 2017 LCTOP awarded funds to Tulare County for a real time bus information integration project and The City of Tulare for fareboxes and other hardware systems.

Action items:

- Establish a factual basis for the connection between high-quality passenger information systems and reduced greenhouse gas emissions, via increases in ridership in order to enable the use of California Climate Investment funding for standards-based IT systems (completed).
- Explore additional funding program set-asides for hardware and software procurement.
- Set a deadline for all agencies to publish GTFS, GTFS-RT, and GTFS-ride data, which will be required for future data-driven planning and investment decisions.
    - Create incentives for early action by fund agencies to collect the data and report feed to State as pilot project for GTFS production and the Statewide Transit Data Warehouse
- Support multi-agency consortia to develop or fund open transit applications of strategic importance to the State of California.

[12]LCTOP Guidelines (page 49)

The widespread penetration of smartphones among the US population--estimated to have reached 60% of the US population by the year 2015[1]--makes mobile payment of transit fares an increasingly promising solution. A 2013 survey by Accenture found that 75% of transit riding respondents would pay a higher fare if they could use their smartphone for fare payment[2]. Mobile payment can reduce reliance on cash without requiring costly hardware installation. It also allows for the integration of transit ticketing with trip planning and real-time scheduling platforms. Major companies in the Mobile Ticketing Technology market in North America include Bytemark[3], Token Transit, Masabi[4], moovel North America, Gemalto[5] and Passport[6]. The five primary categories of mobile payment technology are Electronic Ticketing, 2-dimensional Barcodes, Near Field Communication, Bluetooth Low-energy Communication, and Short Message Service (SMS) Ticketing.

# Electronic and Barcode Ticketing

Mobile payment involves several distinct technologies. Electronic ticketing and barcode technologies store a customer's ticket in a software application. With barcode technology, the ticket can be stored as a 2-dimensional barcode, which fare inspectors electronically scan at the beginning of a journey. With electronic ticketing (also known as "flash pass" or "visual verification" ticketing), the customer activates the ticket at the beginning of their journey, prompting a countdown or a change of color (for a limited time frame[7]): A fare inspector can quickly determine a ticket's validity from these markers by means of visual inspection[8]. The

[1] Global Mass Transit Report. "Mobile Ticketing in the United States." https://www.globalmasstransit.net/archive.php?id=22861
[2]Tavilla, E. (February 2015). Transit Mobile Payments: Driving Consumer Experience and Adoption. Federal Reserve Bank of Boston. Retrieved from: https://www.bostonfed.org/-/media/Documents/PaymentStrategies/publications/2015/transit-mobile-payments.pdf
[3] Bytemark. Products. https://www.bytemark.co/products
[4] Masabi. "Mobile Ticketing." http://www.masabi.com/mobile-ticketing/
[5] See Gemalto. Transport and Ticketing: NFC takes Transport Experience to a New Level. http://www.gemalto.com/transport/mobile-nfc. Also a player in the SMS-based ticketing market through ownership of Netsize (http://www.netsize.com/messaging/secure-sms/).
[6] Passport (2017). Passport Products: Transit. https://passportinc.com/transit/
[7]Florida Department of Transportation (2016). "Assessment of Mobile Fare Payment Technology for Future Deployment in Florida." http://www.fdot.gov/transit/Pages/FinalReportMobileFarePayment20160331.pdf
[8] E.g. on Portland TriMet. Read National Academies of Sciences, Engineering, and Medicine. 2015. Preliminary Strategic Analysis of Next Generation Fare Payment Systems for Public Transportation. Washington, DC: The National Academies Press. https://doi.org/10.17226/22158

former type of ticketing is used for the New Jersey Transit's mobile ticketing application[9] while the latter category is used for ticketing on the Los Angeles Department of Transportation's bus services[10] and on the San Diego's Metropolitan Transit System[11]. Mobile ticketing applications developed by Masabi for railway operators in Great Britain include both visual verification and barcode components[12].

Both visual verification and barcode systems cost less to implement than traditional card-based fare validation systems,because they involve little to no hardware installation[13]. Although barcode validation traditionally required specialized machinery, mobile validation applications developed by Masabi[14] and Moovel[15] allow fare inspectors (on services that rely on proof-of-payment inspection) to validate barcodes with smart phones. Masabi's "Inspect Validator" and "Inspect Gateline" products also allow for attachment of barcode validators to electronic bus fareboxes and transit station turnstiles, with the latter product in use at certain railway stations in Great Britain[16]. Moreover, both systems can improve the rate of fare processing and collection over cash or paper ticket payment. However, limited wireless connectivity and poor lighting can impede processing of barcodes, delaying boarding on high volume transit routes[17]. Visual verification tickets also provide agencies with limited data on passenger boarding compared to other forms of mobile payment[18].

[9] Florida Department of Transportation. "Assessment of Mobile Fare Payment Technology for Future Deployment in Florida." http://www.fdot.gov/transit/Pages/FinalReportMobileFarePayment20160331.pdf
[10]See The App Store. "LA Mobile." https://itunes.apple.com/us/app/la-mobile/id949255982?mt=8
[11] San Diego Metropolitan Transit System. "Compass Cloud." https://www.sdmts.com/fares-passes/compass-cloud
[12] E.g. for the Greater Anglia Railway. See: https://www.greateranglia.co.uk/tickets-fares/daily-tickets/mobile-tickets
[13] Bakker, David. NFC VERSUS 2D BARCODES FOR MOBILE TICKETING IN PUBLIC TRANSPORT. https://blog.ul-ts.com/posts/nfc-versus-2d-barcodes-for-mobile-ticketing-in-public-transport/
[14] "Inspect Validation Suite." Masabi.com. http://www.masabi.com/inspect-validation-suite/
[15] "North American Products." Moovel. https://www.moovel-transit.com/en/na
[16] E.g. Arriva Trains Wales (https://www.arrivatrainswales.co.uk/Mobile-Tickets/) and Greater Anglia trains (https://www.greateranglia.co.uk/tickets-fares/daily-tickets/mobile-tickets)
[17] Florida DOT. 2016.
[18] As discussed on page 17 of Florida DOT, 2016.

## Near Field Communication

Near Field Communication (NFC) is a technology that stores financial data on a secure microprocessor chip (or "secure element") embedded in certain smart phone models[19]. The chip can transmit the data through radio waves[20] to communicate with any device that can read Contactless smart cards that meet ISO standard 14443[21], as well as with other NFC-enabled mobile devices[22]. Payment typically requires the download of a designated payment application like AndroidPay or ApplePay, and the processing of payments relies on an interchange of data[23] between the mobile payment application, secure microprocessor, transaction processor (the fare validator) and application acceptor (the "merchant," in this case, the transit agency). Riders can tap their phones to an NFC-enabled kiosk to download a fare product onto a particular payment application, then tap the phone directly to a ISO 14443-standard fare validator to "pay" the ticket from the application (as with a smart card)[24]. The phone-to-phone transfer of data permitted by NFC technology also allows for NFC-enabled phones to validate fares stored in the Secure Element of other NFC phones in situations (like on city busses) where no ISO 14443-standard validators are available[25].

As with mobile ticketing, a benefit of NFC technology is the perceived convenience and efficiency of purchasing fares. Only one or two taps of a phone are needed to load and pay a fare, reducing the time lost to passengers and vehicle operators on these activities[26]. Indeed, a trial of NFC fare payment on San Francisco's BART system in 2008 showed that 80% of participants found the technology easy to use[27]. NFC payment may have a particular advantage over barcode or electronic payments on urban rail and bus transit systems with high passenger throughput[28]. Moreover, Near Field Communication is compatible with "open" smart-card validators designed

[19]Smart Card Alliance Transportation Council. "Near Field Communication (NFC) and Transit: Applications, Technology and Implementation Considerations." February 2012. https://www.securetechalliance.org/resources/pdf/NFC_and_Transit_WP_20120201.pdf
[20] Gordon, Scott Adam. "What is NFC and how does it work on an Android?" AndroidPit.com. https://www.androidpit.com/what-is-nfc
[21]Smart Card Alliance Transportation Council, February 2012.
[22] Leal, Joao Pedro Santos Reis. Ticket Validation in Public Transportation Using the Smartphone. June 2015. Retrieved from: https://sigarra.up.pt/feup/pt/pub_geral.show_file?pi_gdoc_id=396719
[23]Smart Card Alliance Transportation Council, February 2012.
[24]Smart Card Alliance Transportation Council, February 2012.
[25] Leal, Joao Pedro Santos Reis. June 2015.
[26] Tavilla, 2015.
[27] Smart Card Alliance Transportation Council, 2012. Pps. 8-9.
[28] Tavilla, 2015.

to ISO 14443 standards. Nevertheless, Near Field Communication lacks widespread availability, with only 30% of android phones hosting the technology as recently as January 2016[29]. By contrast, all smartphones have the graphical screens[30] and camera functionality[31] capable of hosting barcodes or electronic tickets. In addition, many rail and bus rapid transit systems in America currently lack the ISO 14443-standard fare validators capable of reading NFC phones on urban rail systems. However, barcode ticketing, mobile ticketing and Near Field Communication ticketing do not have to operate exclusively. Bytemark's mobile ticketing application can simultaneously support Barcode, Visual Verification (i.e. electronic) and Near Field Communication tickets[32]. Bytemark's onboard ticket validators can inspect both barcodes and contactless smart cards (presumably including NFC-enabled phones[33]), as does Moovel's mobile Inspector App[34]. Masabi's product description for the Inspect Validator and Inspect Gateline products (for barcode tickets) emphasizes their easy configurability with "EMV, NFC and Bluetooth Low-energy technologies[35]."

## Bluetooth Low-energy

A third mobile payment method involves the use of low-energy bluetooth technology. Bluetooth low-energy "beacons", powered by USB or battery, emit low-power wireless signals[36] that can detect and communicate with any smartphone equipped with the technology that comes within a certain distance of the beacon. Bluetooth Low-energy utilizes less power than traditional bluetooth technology, allowing it to operate continuously[37]. Transit agencies could equip the entrances to their vehicles with Bluetooth Low-energy beacons programmed to "read" value on the mobile accounts of oncoming passengers, deducting a fare without requiring passengers to remove their phones[38].

[29] Bakker 2016.
[30] Bakker 2016.
[31] Leal, Joao Pedro Santos Reis. Ticket Validation in Public Transportation Using the Smartphone. June 2015.
[32] Bytemark. Products. https://www.bytemark.co/products
[33] Bytemark. Products. https://www.bytemark.co/products
[34] "North American Products." Moovel. https://www.moovel-transit.com/en/na
[35] "Inspect Validation Suite." Masabi.com. http://www.masabi.com/inspect-validation-suite
[36] Bluetooth. "How it works." https://www.bluetooth.com/what-is-bluetooth-technology/how-it-works
[37] Florida Department of Transportation, 2016.
[38] Florida Department of Transportation, 2016.

Bluetooth Low-energy technology appears to be more widespread than Near Field Communication, available on all apple operating systems of iOS 7 or higher and on Android operating systems more advanced than Android 4.3[39]. No deployments of the technology for transit payment have been conducted to date[40]. However, last June, Bytetoken (the UK division of Bytemark) tested a "KeyPass" system which utilized Bluetooth Low-Energy beacons, in conjunction with a 3-D camera monitor, to validate mobile tickets on the phones of boarding passengers: Once beacons detected a valid mobile ticket, and relayed the information to a back-office server, the server would instruct the transit fare gates to open[41]. The KeyPass system used the 3-D camera to track passengers' movement and detect their physical characteristics, allowing the system to associate mobile tickets with specific passengers and open the fare gates for these passengers for a length of time sufficient to enable their entry[42].

## SMS (text message)-based Ticketing

A final, less technologically-advanced form of mobile ticketing makes use of the phone's Short Message Service (SMS) function. On several urban transit systems in Europe (e.g. Stockholm[43], Helsinki[44]), riders can send a pre-determined code or phrase (representing a certain transit fare type) as a text message to a designated number, prompting a response with the ticket fare and travel details[45]. Rather than billing the customer directly, the transit agency charges the customer's mobile service provider, which then passes on the fare cost to the customer as part of their messaging fees[46].

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[39] Bluetooth Low Energy: Introduction. https://learn.adafruit.com/introduction-to-bluetooth-low-energy/introduction
[40] Leal, Joao Pedro Santos Reis, June 2015.
[41]Bytemark. "Bytetoken delivers KeyPass." 2017. https://www.bytemark.co/news/2017/02/07/bytetoken-delivers-keypass
[42] Railway Gazette UK. "Bluetooth-enabled ticket gates demonstrated." http://www.railwaygazette.com/news/single-view/view/bluetooth-enabled-ticket-gates-demonstrated.html
[43] "Fares and Tickets." SL. http://sl.se/en/fares--tickets/
[44] Helsingin Sendun Liikinne. "Tickets and Fares: SMS Ticket." *HSL/HRT*. https://www.hsl.fi/en/tickets-and-fares/sms-ticket
[45] National Academies of Sciences, Engineering, and Medicine. 2015. Preliminary Strategic Analysis of Next Generation Fare Payment Systems for Public Transportation. Washington, DC: The National Academies Press. https://doi.org/10.17226/22158
[46] E.g. National Academies 2012 and Netsize. "Mobile Ticketing by SMS." http://www.netsize.com/wp-content/uploads/2015/04/Netsize_ticketing_brochure.pdf

In contrast to the technologies discussed previously, a SMS-based ticketing system works with any mobile device (not just smartphones) and does not require possession of a credit card[47]. The simplicity and speed of the purchasing process (with no upfront billing required) may make this form of payment more amenable to customers than a mobile application for which one has to register[48]. Unfortunately, current deployments of SMS ticketing in Stockholm, Helsinki and Denmark[49] can only be used for purchases of single fares (as opposed to passes)[50], because of the messages' limited functionality. The billing of mobile companies, rather than individuals, impedes employer-based fare payment and excludes riders who do not subscribe to an approved service provider[51]. The technology's use of mobile billing also requires transit agencies to enter into partnerships with mobile providers[52]. Finally, SMS tickets lack secure encryption[53]. SMS ticketing can be made more secure through the use of Multi-media messaging, in which the agency sends a 2-dimensional barcode that can be validated like a regular barcode ticket[54].

# Benefits and Drawbacks

Mobile ticketing has the potential to improve the efficiency of transit operations in California. Whether involving a visually-verified color code, a text message, or payment storage on a microprocessor, mobile tickets can improve the speed and convenience of payment over

[47] Netsize. "Mobile Ticketing by SMS." http://www.netsize.com/wp-content/uploads/2015/04/Netsize_ticketing_brochure.pdf
[48] Juntunen A., Luukkainen, S., & Tuunainen, V. K. (2010, June). Deploying NFC technology for mobile ticketing services–identification of critical business model issues. In Mobile Business and 2010 Ninth Global Mobility Roundtable (ICMB-GMR), 2010 Ninth International Conference on (pp. 82-90). IEEE. http://ieeexplore.ieee.org/document/5494785/#full-text-section
[49] See Fynbus. https://www.fynbus.dk/
[50] E.g. in Helsinki: See Helsingin Sendun Liikinne. https://www.hsl.fi/en/tickets-and-fares/sms-ticket and Juntunen, A., Luukkainen, S., & Tuunainen, V. K. (2010, June). Deploying NFC technology for mobile ticketing services–identification of critical business model issues. In Mobile Business and 2010 Ninth Global Mobility Roundtable (ICMB-GMR), 2010 Ninth International Conference on (pp. 82-90). IEEE. http://ieeexplore.ieee.org/document/5494785/#full-text-section
[51] Juntunen, A., Luukkainen, S., & Tuunainen, V. K. (2010, June).
[52] Polite (Policy Learning in Information Technologies for Transportation Enhancement). "Analysis and Reporting of Best Practices." https://www.tsi.lv/sites/default/files/editor/science/Research_reports/polite_activity_3_2b_v0_23.pdf
[53] Ferreira, Galvo Dias and Cunha. "Design and Evaluation of a Mobile Payment System for Public Transport: The MobiPag Prototype." 2014. file:///C:/Users/Workstation%20User/Downloads/mobility_2014_3_50_70071.pdf
[54]As done on Malaga Spain's messaging service. https://www.ssatp.org/sites/ssatp/files/publications/Toolkits/ITS%20Toolkit%20content/its-technologies/electronic-fare-collection/sms-or-bar-code-on-smart-phone.html

payment by cash or contactless smart card[55]. Moreover, mobile ticketing systems' lack of hardware makes them for less expensive and time-consuming to install than traditional electronic fare payment systems. Whereas the Los Angeles County Metro's Universal Fare System (an electronic fare system on a contactless "TAP card") involved a base contract of $84 million[56], mobile ticketing systems installed in Columbia, South Carolina and Chicago, Illinois have had capital costs of $150,000 and $2.5 million, respectively[57]. According to the mobile application provider, Passport, mobile ticketing applications can be installed in as little as 60 to 90 days, compared to two years for card-based fare systems[58]. Moreover, mobile ticketing applications permit integration with trip planning and real-time scheduling applications[59].

Unfortunately, the two most widespread mobile ticketing technologies each exhibit drawbacks: electronic and barcode ticketing systems have slower processing times than NFC ticketing systems but are more widely accessible. SMS ticketing, the most widely accessible technology, has limited capacity to support multi-ride tickets and lacks a secure form of encryption. Fortunately, mobile ticketing companies like Bytemark[60] and moovel[61] now have mobile validation technology capable of supporting both mobile and Near Field Communication tickets. Transit agencies like the Stockholm Lokaltrafik[62] have supplemented their SMS-ticketing systems with visual verification or barcode-based mobile ticketing applications, to provide benefits for riders of all ticket types and technologies. Complemented by a transition to a standards- and account-based, open-loop fare payment system, mobile payment offers a promising future.

[55] See Bakker, David. NFC VERSUS 2D BARCODES FOR MOBILE TICKETING IN PUBLIC TRANSPORT.
[56] Brazilio Cobb Associates. Review of Metro's TAP Program. June 2013. http://media.metro.net/about_us/oig/images/13aud11_final_report_metro_tap_program_62613.pdf
[57] Florida Department of Transportation, 2016.
[58] As quoted in Carpenter, Andrew (October 25, 2016). "Growth of Mobile Ticketing offers Flexibility to Transit Solutions."*Mobility Lab*. https://mobilitylab.org/2016/10/25/mobile-ticketing-flexibility-passport/
[59] For example, see. Passport (2017). Passport Products: Transit. https://passportinc.com/transit/
[60] Again, see: Bytemark. Products. https://www.bytemark.co/products
[61] "North American Products." Moovel. https://www.moovel-transit.com/en/na
[62] http://sl.se/en/fares--tickets/

# Introduction

A statewide ticketing system will significantly improve the experience of traveling by transit in California. Commuters could purchase trips across large metropolitan areas (e.g. from Santa Monica to San Bernardino), that currently require cash or credit purchase of multiple fares and interagency transfers, in a single transaction — using payment information stored on a mobile application. A statewide fare system will also facilitate travel on California's High-speed Rail system (following its completion in the year 2029) — both as a mode of commuter[1] and intercity rail travel — by enabling passengers to smoothly transition between high-speed rail stations and local transit systems for their first- and last-mile connections[2]. A statewide ticketing system can be achieved in several ways, but this plan recommends a standards-based approach, that would require operators to upgrade their electronic fare payment systems to pre-defined interoperable standards and to integrate their systems with a common (account-based) back office, that would also be compatible with fare payment systems for public and private shared mobility providers. Such an approach would permit payment with multiple fare media — including contactless smart cards, mobile wallets and a mobile application — while maintaining compatibility with a broad array of existing fare payment technologies.

# Towards Open Fare Payment Systems

Fare payment systems range in complexity from cash fareboxes to electronic validators. Non-cash fare media (or forms of payment[3]) that are currently widespread include magnetic stripe cards (which store value on a magnetic stripe, much like traditional credit cards[4]) and

[1] Although fares will be high compared to traditional commuter rail, the price differential in housing between the coastal cities and the Central Valley may justify the costs for many. "Will America's first ever High-speed rail line become the Silicon Valley Express." http://www.govtech.com/fs/-Will-Americas-First-Ever-High-Speed-Rail-Line-Become-the-Silicon-Valley-Express.html

[2]Johnston, Angela (Feb. 13, 2017). Some Mega-commuters may not reap benefits of California High-speed rail. KALW Local Public Radio."

[3] National Academies of Sciences, Engineering, and Medicine. 2015. Preliminary Strategic Analysis of Next Generation Fare Payment Systems for Public Transportation. Washington, DC: The National Academies Press. https://doi.org/10.17226/22158

[4] Nashville MTA/RTA (2015). "Transit Strategies: Fare Collection and Fare Payment" in nMotion: Nashville MTA/RTA Strategic Plan. Retrieved from: http://nmotion2015.com/wp-content/uploads/2015/12/nMotion-Fare-Technology_151120_FINAL.pdf

contactless smart cards (which store value on a computer chip or antenna that communicates with the farebox through electromagnetic frequency[5]). In recent years, most larger transit systems in California (and around the Country) have upgraded their payment systems from magnetic stripe to contactless smart card technology given the latter technology's faster processing time, tighter security and improved performance[6].

Regardless of the technological parameters, all current electronic fare payment systems in California are "card-based" systems, in which customers load value onto a concrete fare media (see Figure C3-2). When customers pay for a fare with their card, the data transfers to the farebox, requiring manual removal of data from the machine's farebox on a routine basis in order to update the system's back office[7]. The majority of California (and most US) agencies, also currently have proprietary systems, where the media and validators are the property of a particular company: these systems often lack full interoperability of media or validators and the transit agency has to replace parts with materials from the company under contract[8]. Finally, all electronic fare payment systems in California (see Figure C3-2), and most in the US, currently have a closed payment architecture, in which the system only accepts a single, transit agency-specific media (such as a smart card).

By contrast, our proposal for a statewide fare payment system involves an "account-based," "standards-based" open payment system. In "account-based" systems, fare media merely link to a computerized customer account — that can be established online — and no actual processing of data occurs at the machine. When a customer swipes or taps a card against a machine, he/she induces a transaction/payment from the customer's account to the agency's, at the transit agency's central server (or "back office"). "Standards-based" systems use fare media and validators that conform to international standards in terms of transmissions frequency, security and data sequence and format[9]. For instance, ISO 14443 is the international standard governing communication frequency (set at 13.56 MHz) and physical design for contactless smart cards and smart card validators[10].

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[5] National Academies of Sciences, Engineering, and Medicine. (2015).
[6] E.g. Magnetic Stripe cards have a failure rate of 200 times a day where smart cards have a failure rate of only 6.7 times a day (Nashville MTA/RTA 2015).
[7] National Academies of Sciences, Engineering, and Medicine. (2015).
[8] Ibid.
[9] Ibid.
[10] Smart Card Alliance (March 2003). Contactless Payment and the Retail Point of Sale: Applications, Technologies and Transaction Models. https://www.securetechalliance.org/resources/lib/Contactless_Pmt_Report.pdf

Finally, systems with open architecture[11] accept media from multiple sources, including other agencies' fare media and non-transit specific forms of payment (e.g. contactless bank cards).

**Figure C3-1. Classification of Electronic Fare Payment Systems**

| Card- or account- based | Standards or Proprietary | Open or Closed |
|---|---|---|
| Is data stored on the fare media (i.e. smart card) or in a computerized linked ot (1 or more) fare media? | Is fare payment technology owned by a specific entity or does it adhere to international standards in the common domain? | Does the data only accept agency-issued, transit-specific fare media or does it also accept fare media for other agencies as well as non-transit-specific fare media? |

Where current payment systems limit transit payment to single electronic medium (or cash), account- and standards-based open payment systems could accept any media that meets frequency and security standards or links to a recognized account. For instance, farebox validators that conform to ISO-standard 14443 can communicate not only with other transit agencies' smart cards (that meet the standard), but with contactless bank cards[12], federal employee identification cards[13], and phones with Near Field Communication[14] technology[15]. An account-based back office could recognize payment accounts associated with any of these media (a mobile payment application in the case of the Near Field Communication-enabled phone) and bill transactions directly to these accounts. Although employee identification cards do not typically store monetary value, they could link to accounts with employer-subsidized transit passes, facilitating employee participation in such programs.

[11] Michigan Department of Transportation (MDOT). "Seamless Fare Integration Study for Detroit Region." January 2015. https://www.michigan.gov/documents/mdot/SeamlessFareIntegrationStudyforDetroit_Region_510643_7.pdf

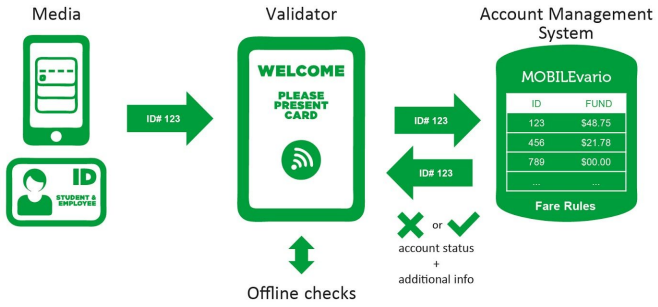
[12] For instance, see: "Cubic Receives Contactless EMV Bank Card Type Approval for Next-Generation Tri-Reader® 3." October 17, 2011. https://www.cubic.com/News/Press-Releases/ID/379/Cubic-Receives-Contactless-EMV-Bank-Card-Type-Approval-for-Next-Generation-Tri-Reader-3

[13] National Academies of Sciences, Engineering, and Medicine. (2015).

[14] Near Field Communication-enabled phones contain computer chips (microprocessors) that can communicate with ISO-standard 14443 validators and other Near Field Communciation-enabled phones.

[15] NFC Forum (January 2011). NFC in Public Transport. http://nfc-forum.org/wp-content/uploads/2013/12/NFC-in-Public-Transport.pdf

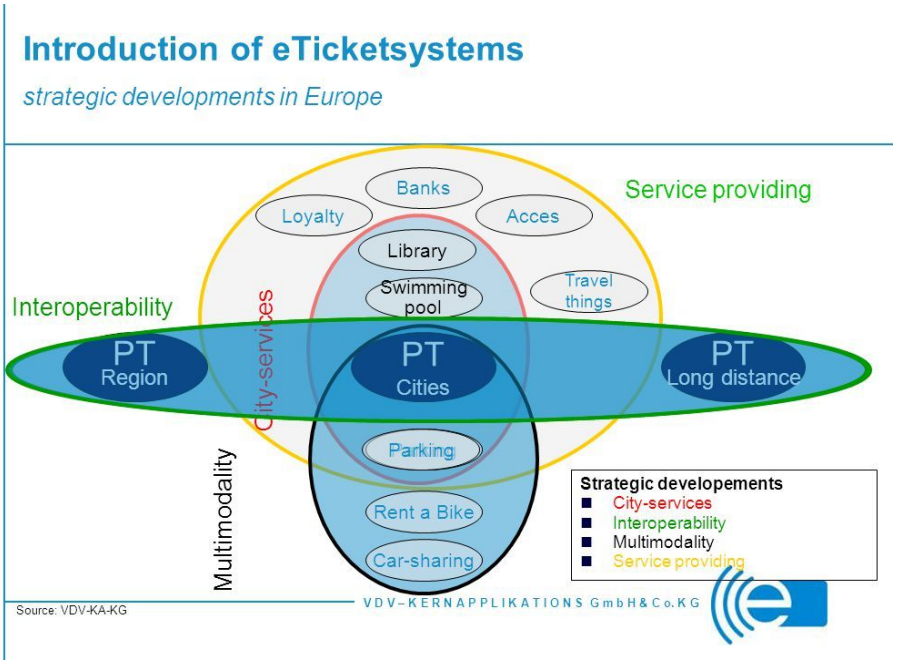
**Figure C3-2. Illustration of an Account-based Fare Payment System**




An account-based, open system could also link to mobile applications on non-Near Field Communication enabled phones, including both transit-specific applications and applications for rideshare or bikeshare services. For instance, mobile payment applications developed by the company Passport incorporate trip planning applications[16]: a future statewide ticketing application could recommend the quickest route between any two points involving a combination of transit and shared mobility services — and then direct the passenger to pay the cost of the trip (with the back office settling payments with multiple agencies and services). Eventually multiple media and a mobile application could link to a single statewide transportation account that could pay not only for public transportation and shared mobility but road tolls and parking[17]. Thus, account-based, standards-based, open payment systems facilitate interoperability not only between transit fare payment systems but between transit and other modes of shared mobility. At the same time, such systems have the potential to increase the convenience of fare payment by allowing riders to pay with whatever media they have available.

[16] Passport (2017). Passport Products: Transit. https://passportinc.com/transit/
[17] A capacity of Singapore's EZ-Link card. See: EZ-Link (2017). "Company Profile." http://www.ezlink.com.sg/about-ez-link/company-profile

**Figure C3-3. Illustration of Multi-modal, Multi-service ticketing enabled by account-based, open ticketing system (e.g. eTicket Deutschland)**




# Implementation Considerations

Previous studies of regional fare integration in the United States indicate that fare system integration tends to occur between agencies with pre-existing collaborative partnerships[18]. Foreign initiatives to develop multi-jurisdictional open fare payment systems, in Seoul, South Korea[19], the United Kingdom[20], and Europe as a whole[21], seem to have led by alliances or consortia between the principle transit agencies and governmental authorities involved (e.g. railways and transport authorities in the United Kingdom, and the agencies responsible for

[18] Iseki, H., Demisch, A., Taylor, B. D., & Yoh, A. (2008). Evaluating the costs and benefits of transit smart cards. Berkeley: California PATH Program, Institute of Transportation Studies, University of California. http://www.path.berkeley.edu/sites/default/files/publications/PRR-2008-14.pdf

[19] Audouin, M., Razaghi, M., & Finger, M. (2015). How Seoul used the "T-Money" smart transportation card to re-plan the public transportation system of the city; implications for governance of innovation in urban public transportation systems. https://www.researchgate.net/publication/290574722_How_Seoul_used_the_'T-Money'_smart_transportation_card_to_re-plan_the_public_transportation_system_of_the_city_implications_for_governance_of_innovation_in_urban_public_transportation_systems

[20] ITSO. "ITSO: About Us." https://www.itso.org.uk/about-us/who-we-are/

[21] Smart Ticketing Alliance (2014). B. Smart Ticketing Alliance. "Founding Members." http://www.smart-ticketing.org/category/alliance/membership/founding_members/

national ticketing standards in the case of the European Smart Ticketing Alliance[22]). Thus, Caltrans should develop sustained collaboration with regional public transit agencies, transit organizations (such as the California Transit Agency), and other shared mobility operators (e.g. city bikeshare systems, vanpool organizations) in developing a statewide ticketing system.

**Table C3-1: Card-based Electronic Transit Fare Payment Systems in California**

| Fare Program | Implementing Agency | Operable on | Technology and Design | Upgrade/Future Ini |
|---|---|---|---|---|
| **TAP** | Los Angeles County Metro Transportation Authority | All 26 transit agencies in LA County[23] | Cubic technologies proprietary NextFare Central Back office, Mifare contactless card [2425]. | Recently approved an upgrade to cloud-based back office[26]. |
| **ClipperCard** | Metropolitan Transportation Commission | 21 agencies in the San Francisco Bay Area[27] | MIFARE Desfire Card, Cubic NextFare back office[28]. | Upgrade to Next generation of clipper. RFP process begins this year[29]. |

[22] Ibid.
[23] Kudler, Adrian Glick (September 17, 2015). “There's Now One Card to Pay For Every Transit Ride in Los Angeles County.” https://la.curbed.com/2015/9/17/9920332/tap-card-los-angeles-county
[24] Williams, Andy. “Cubic Receives transit contracts for central computer and clearinghouse integration for Los Angeles region.” 14 April, 2005. https://www.secureidnews.com/news-item/cubic-receives-transit-contracts-for-central-computer-and-clearinghouse-integration-for-los-angeles-region/
[25] EE Times (6/1/2009). “L.A. Metro Taps NXP's MIFARE Plus for Contactless TAP Ticketing”. http://www.eetimes.com/document.asp?doc_id=1276540&page_number=2
[26] Attachment B to Metro File No. 2017-0272. “Procurement Summary: Universal Fare System.” file:///C:/Users/Huff/Downloads/Attachment%20B%20-%20Procurement%20Summary.pdf
[27] Goodwin, John (Monday, April 3 2017). Clipper Expands to Union City Transit. https://mtc.ca.gov/whats-happening/news/clipperr-expands-union-city-transit
[28] Lyne, Malcolm (2011). “Clipper: The History of a Successful Systems Integration Project.” http://www.apta.com/previousmc/rail/previous/2011/Papers/Clipper-Transition-Lyne.pdf
[29] Rudlick, Roger (February 2017). “Clipper Update and the Potential to Rationalize Fares.” http://sf.streetsblog.org/2017/02/14/clipper-update-and-the-potential-to-rationalize-fares/

| | | | | |
|---|---|---|---|---|
| **Compass Card** | San Diego MTS | San Diego MTS bus and light rail, NTCD busses, Coaster and Sprinter[30]. | Mifare Classic Card[31], Cubic farebox[32]. | Currently in processing of upgrading to new fare system (as old one near end of life. Considering Account-based processor, data warehouse back office, smart phone validators[33] |
| **Connect Card** | Sacramento Area Council of Governments (SACOG) | Sacramento Regional Transit (light rail and bus), El Dorado Transit, Etran, Folsom Stage Line, Placer County Transit, Roseville Transit, SCT/Link, Yolobus, Yuba-Sutter Transit [34]. | INIT ProxMobil passenger terminal, with MOBILevario back office processing system and Mifare Desfire card. Farebox and card ISO 14443 compliant but data encrypted, stored on card[35]. | |
| **Go Card** | Monterey-Salinas Transit | Monterey-Salinas Transit | Genfare Odyssey Farebox (ISO 14443 compliant but closed[36]) | |
| **Cruz Card** | Santa Cruz Metro Transit District | Santa Cruz Metro Transit District | Genfare Odyssey farebox (unspecified, ISO 14443 compliant technology but closed[37] ). | |

[30] San Diego Metropolitan Transit System (2016). “Compass Card.” https://www.sdmts.com/fares-passes/compass-card
[31] De Kozan, David (June 4, 2014). NFC Payment Solutions for Transit: Easing Regional Mobility. Presentation. https://www.securetechalliance.org/secure/events/20140602/dekozand.pdf
[32] San Diego Metropolitan Transit System Board of Directors — Minutes. April 14, 2016. https://www.sdmts.com/sites/default/files/2016-04-14_board_0.pdf
[33] San Diego Metropolitan Transit System (July 13, 2017). “Fare Collection Update,” Attachment C1 to MTS Executive Committee Meeting-MINUTES. June 1, 2017. https://www.sdmts.com/sites/default/files/2017-07-13_ec_-_ada_save_as.p
[34] Connect Transit Card (2017). Connect Card: It’s Here! https://www.connecttransitcard.com/Pages/HowItWorks
[35] C. Courtright personal communication.
[36] Monterey-Salinas Transit (2017). “Fares: Overview.” https://mst.org/fares/overview/
[37] Model based on 2012 joint procurement mentioned in: http://www.tamcmonterey.org/wp-content/uploads/2015/09/FY2011_13-TDA-Performance-Audit-MST.pdf

| | | | | |
|---|---|---|---|---|
| **GoCard** | Porterville Transit | Porterville Transit | Genfare Fast Fare Farebox (ISO 14443 compliant[38]) | Installing Genfare Link system: Stores data in cloud (rather than farebox) and updates from back-office-server[39]. |

At the same time, studies of fare integration in the United States show that unwillingness to relinquish control traditionally poses a barrier to integration of fare payment systems across agency jurisdictions[40]. A statewide ticketing program can accommodate agencies' desires to maintain local control (in upgrading to a standards-, account-based system) by focusing on specification (and requirement) of uniform and interoperable standards for agencies, rather than the adoption of a specific technology. For instance, in Europe, the Smart Ticketing Alliance's development of an open and integrated ticketing system involves a certification procedure, through which the alliance verifies that contactless ticketing technologies and fare media cohere to agreed-upon standards, based on European and international standards[41]. Similarly, the ITSO in Britain developed a national standard specification for contactless smart cards (including a microprocessor chip and a security key) and then worked to promote the standard's adoption[42]. In Germany[43] and Sweden[44], government agencies' development of national standards has included development of a central back office (or point of integration) for financial settlement and storage of data (by systems that join). Such a back office will comprise a core component of a statewide ticketing system in California, serving as a financial clearinghouse (for a multi-jurisdictional traveler) between different agencies' payment systems.

[38] Genfare (2016). Fast Fare Revolutionary Farebox. https://www.genfare.com/wp-content/uploads/2017/09/Genfare_Sell-Sheet_v9_farebox.pdf
[39] Tuckett, Richard (August/September 2016). "Genfare links with Porterville Transit." BusRide. http://www.genfare.com/sites/default/files/BUSRide_Porterville_Field_Test.pdf
[40] Yoh, A., Iseki, H., Taylor, B., & King, D. (2006). Interoperable transit smart card systems: Are we moving too slowly or too quickly?. Transportation Research Record: Journal of the Transportation Research Board, (1986), 69-77.
[41] Certification: General Information. Smart Ticketing Alliance. Retrieved from: http://www.smart-ticketing.org/category/ticketing/certification/
[42] Meal, Jeremy. "ITSO: Fulfilling the Ticketing Challenge." Systra. https://www.systra.co.uk/index.php/news-items/latest-thinking/138-itso-fulfilling-the-ticketing-challenge
[43] VDV e-ticket service. VDV Core Application. https://oepnv.eticket-deutschland.de/en/products-and-services/vdv-core-application/#
[44] Lofquist, L. (2017). Swedish Mobility Program. Samtrafiken. Powerpoint. http://www.hogiasystem.se/filarkiv/public_transport/user_conference/2017/presentationer/Swedish_Mobility_Program-Lars_Lofquist_Samtrafiken.pdf

Although local agencies' pre-existing investment in non-standardized architecture slowed the process of adopting ITSO standards in Britain[45], most California transit agencies with electronic fare collection systems have either adopted fareboxes that comply with international standards (as in the case of the Santa Cruz Metro Transit District) or plan to upgrade to account-based, standards-based open architecture systems in the near future (e.g. the San Francisco MTC, Los Angeles Metro[46] and San Diego[47]). This unique historical moment would allow a statewide ticketing program that continuously engages with agencies with existing electronic fare collection systems to develop in synchrony with local improvements to electronic fare collection systems. The adoption of interoperable, account-based technology by the principle transit fare collection systems in the state will encourage adoption by agencies in adjoining areas.

This "standards-based" approach is particularly well-adapted to serving the diverse size and scope of transit systems in the state. Small bus-only agencies in rural or exurban areas that currently lack electronic fare card systems can rely on mobile fare payment applications integrated with the state's back office, which do not require costly hardware purchases, for ticketing and validation. Such mobile ticketing applications might allow operators to visually inspect mobile tickets[48] that are color coded or to scan 2-dimensional barcodes (on smartphone tickets) with a smartphone application[49]. Mobile phones with Near Field Communication technology can be used to validate fares stored on other Near Field Communication phones or on contactless smart cards[50] [51]. By reducing the costs of integration, such mobile components of

[45] E.g the Treasury has had to spend 66 million pounds to upgrade London's Oyster Card program to the standard. See "World Bank. Removing Barriers to Public Transport Fare Integration in Poland. June 10, 2016."
https://openknowledge.worldbank.org/bitstream/handle/10986/24929/Removing0barri0irections0and0change.pdf?sequence=1&isAllowed=y"
[46] **Attachment B to Metro File No. 2017-0272. "Procurement Summary: Universal Fare System."
file:///C:/Users/Huff/Downloads/Attachment%20B%20-%20Procurement%20Summary.pdf
Background:
*Extends the contract with Cubic through 2024, with the condition that Cubic implement the Nextlink account-based system.
[47] As shown in **Figure 2**.
[48] Florida Department of Transportation (2016). "Assessment of Mobile Fare Payment Technology for Future Deployment in Florida."
http://www.fdot.gov/transit/Pages/FinalReportMobileFarePayment20160331.pdf
[49] For an example see "Inspect Validation Suite." Masabi.com.
http://www.masabi.com/inspect-validation-suite/
[50] Bytemark. Products. https://www.bytemark.co/products
[51] Leal, Joao Pedro Santos Reis. Ticket Validation in Public Transportation Using the Smartphone. June 2015. http://hdl.handle.net/10216/83481

a statewide ticketing system would facilitate participation by small agencies with limited budgets [52].

A statewide ticketing program can further facilitate agencies' adoption of standards by setting aside a budget to subsidize some of the costs of upgrading for cash-strapped agencies (that have can adequately justify their need). The working group managing the process can attach preconditions to these funds (e.g. disqualifying systems that do not upgrade by a certain date from eligibility) as a tool to incentivize agencies' compliance. State legislation that mandates agencies' adoption of technology with interoperable standard specifications (once these have been agreed upon) — similar to fare integration mandates imposed in the Netherlands[53]— can work in tandem with funding incentives to ensure the timely incorporation of agencies in the statewide ticketing system.

[52] Obstacle noted by Iseki, et. al. 2015.
[53] For example, read: "World Bank. 2016. Public Transport Automatic Fare Collection Interoperability Assessing Options for Poland. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/24931 License: CC BY 3.0 IGO."

# Fare Validation Models

The types of fare models used depends to a large extent on the enforcement and collection system used to validate fares. Broadly, there are two: open proof-of-payment systems and closed fare-gated or pay-upon-entry systems.

**Table C4-1: Fare validation models**

| Concept | Proof-of-payment (POP) | Faregate/Pay-upon-entry |
|---|---|---|
| **Rider experience** | A rider purchases a paper or digital ticket once and enters and transfers within transit system unimpeded | Rider taps, swipes, or enters fare medium into farebox or faregate at point of entry and often at point of transfer |
| **Fare media used** | Paper, card, smartcard or "activated" digital passes on smartphone app | Tokens, paper, card, smartcard, NFC-enabled smartphone |
| **Enforcement** | Random ticket checks at stations, stops, onboard vehicles | At faregate or point of entry; sometimes supplemented with random ticket checks |
| **Common use** | European transit systems, Portland Tri-Met and streetcar, most California light-rail and commuter rail systems | Most U.S. bus and heavy-rail transit systems |
| **Advantages** | • Much lower cost of installation, operation<br>• Simplicity for riders<br>• New rider friendly; makes paying for transit as easy as downloading an app (digital POP)<br>• Easier to integrate with multi-agency fare coordination (except smartcard)<br>• Quicker boarding; all-door boarding is possible<br>• Digital POP could be multi-vendor, avoiding vendor lock-in | • Robust trip data collection (with smart fare media)<br>• Compatible with "tap on, tap off" variable-distance pricing |
| **Disadvantages** | • Enforcement sometimes a concern | • High cost of faregate installation and operation; high cost of |

| | | |
|---|---|---|
| | • Paper POP is not "trackable" for analytical purposes | farebox collection<br>• Less convenient for riders; adds "friction" to transit experience<br>• Variable fares difficult to communicate at point of entry and with smartcards<br>• Complex; more difficult to achieve multi-agency coordination<br>• Vendor contracts can make changes to fare policy difficult<br>• Faregates require more station space<br>• Precludes all-door boarding<br>• Faregates must be staffed or monitored to assist passengers who cannot use them |
| **Fare model compatibility** | • Flat fares per boarding<br>• Flat fares with free transfers<br>• Multi-ride discount tickets<br>• Unlimited ride passes<br>• Group or family tickets<br>• Free or discounted fares for select groups<br>• Flat fares per pre-set duration (except paper POP)<br>• Variable fares (except paper POP) | • Flat fares per boarding<br>• Flat fares with free transfers<br>• Multi-ride discount tickets<br>• Unlimited ride passes<br>• Free or discounted fares for select groups<br>• Flat fares per pre-set duration<br>• Variable fares |
| **Fare model incompatibility** | • Flat fares per pre-set duration (if paper POP)<br>• Variable fares (if paper POP) | • Group or family tickets |

Proof-of-payment (POP) systems, common in Europe, allow users to purchase a simple paper ticket (or a digital pass on their smartcard or mobile devices) and enter and transfer within a transit system without needing to tap or swipe fare media, or pass through faregates. Enforcement is typically done through random ticket checks at stations, stops, or onboard vehicles. Digital passes are typically enforced by checking when the user "activated" the pass which displays as "active" for a pre-set amount of time. Compared with closed, faregated systems, POP systems offer agencies the advantages of much lower installation and administrative cost, as well as greater simplicity, flexibility, and compatibility with fare policies like family or group tickets. They also avoid some of the technical problems with smartcard

vendors, and are potentially much easier to integrate with regional, multi-agency fare coordination, since if digital media are used, POPs are compatible with all fare models. Although paper POP fare media and passes evade data-tracking, such as point and time of entry, digital POP fare media potentially offer the same (or better) ridership data that a smartcard system does. In addition, digital POP "lowers the bar" to entry for new transit riders: they need not have specific fare media and can instead just download an app. Portland's Tri-Met and Streetcar are examples of systems that use digital POP.

Closed, faregated systems can be used with many fare media (tokens, paper, card, smartcard, NFC smartphones, etc.) and are the most common method of fare collection among North American transit systems. They offer familiarity and (when used with smart fare media) robust data on rider point-of-entry (and exit, if "tap out" fare policies are in place). Closed, faregated systems do, however, have a number of drawbacks including their significant expense: faregates are very costly to install and operate. In addition, closed systems' complexity and peculiarity makes integrating fares across agencies more difficult, particularly when smartcard technology is used and vendor contract lock-ins are an issue. Closed systems also add "friction" to the transit experience, requiring riders to acquire or already have appropriate fare media specific to the operating agency, and then to swipe, tap, or enter the media at multiple points in a trip. On bus systems, in particular, this can lead to vehicle delay (note that closed systems also preclude all-door boarding). Although faregated systems are compatible with most fare models, group and family ticket fare models are precluded.

# Fare Pricing Models

Table C4-2 (below) summarizes the advantages and disadvantages of various fare structure models used by transit systems around the world

**Table C4-2: Advantages and Disadvantages of Fare Models**

| Fare Structure | Advantages | Disadvantages |
|---|---|---|
| **Flat fares** | | |
| **Flat fares per boarding** | • Simple, easy to understand and administer | • May penalizes passengers who have to transfer<br>• May underprice peak-hour, peak-direction, and long trips<br>• May overprice off-peak, |

| | | |
|---|---|---|
| | | off-direction, and short trips |
| **Flat fares with free transfers** | • More equitable than per-boarding fares for passengers who have to transfer | • Complex to understand and administer<br>• May underprice peak-hour, peak-direction, and long trips<br>• May overprice off-peak, off-direction, and short trips |
| **Flat fares per pre-set duration (e.g. 2 hours)** | • More equitable than per-boarding fares for passengers who have to transfer<br>• May be less complex to understand and administer than fares per linked trip | • May underprice peak-hour, peak-direction, and long trips<br>• May overprice off-peak, off-direction, and short trips<br>• Possibly higher out-of-pocket rider costs than flat fares per boarding or per linked trip |
| **Variable fares** | | |
| **Variable fares by mode** | • Better matches fares with costs of providing service, as compared to flat fares | • Increased complexity may cause rider confusion<br>• Underprices peak-hour trips (unless combined with variable fares per time of day) |
| **Variable fares by payment method** | • Can better match fares with costs of collecting fares<br>• Can differentiate prices between payment methods used by frequent riders vs. visitors | • Equity concerns for unbanked populations<br>• Underprices peak-hour trips (unless combined with variable fares per time of day) |
| **Variable fares per distance traveled** | • Better matches fares with costs of providing service<br>• Encourages more short trips | • Increased complexity may cause rider confusion<br>• Underprices peak-hour trips (unless combined with variable fares per time of day) |
| **Variable fares per time of day or day of week** | • Better matches fares with marginal costs of providing each trip<br>• Can properly price peak-hour trips | • Increased complexity may cause rider confusion<br>• Equity concerns |
| **Targeted fare discounts** | | |

| | | |
|---|---|---|
| **Multi-ride discount tickets** | • Offer discounts to frequent riders<br>• Offer fares at more affordable per-trip rates for those who rely on it most | • Large up-front costs may be unmanageable for low-income groups who rely most on transit<br>• Underprices peak-hour trips<br>• Discounts may be captured by higher-income individuals least in need of discounts |
| **Unlimited-ride passes** | • Reduced friction for frequent riders<br>• May speed boarding and fare collection procedures<br>• For passholders, encourages use of transit in place of automobiles | • Large up-front costs may be unmanageable for low-income groups who rely most on transit<br>• Underprices peak-hour trips<br>• Discounts may be captured by higher-income individuals least in need of discounts |
| **Group or family tickets** | • Makes transit cost-competitive with car travel for a group or family<br>• Increases ridership very cheaply (filling empty seats on off-peak hours)<br>• Reduces car dependence for families and encourages transit use for groups | • Works best with proof-of-payment systems; not compatible with some “one card, one user” systems<br>• Peak-hour, peak-direction trips would underprice marginal cost of providing those trips<br>• Concerns about fairness for those not traveling in groups |
| **Free or discounted fares for select groups** | • Make transit more affordable for those who rely on it most<br>• Address limited mobility for low-income and low-wealth groups | • Complex qualification or documentation procedures may make free or discounted fares difficult to obtain<br>• Lack of awareness prevents many qualifying individuals from taking advantage |
| **No fares** | | |
| **Free rides for all passengers** | • Easiest model to understand and administer<br>• Avoids costs and delays associated | • Lost fares must be made up through other revenue streams |

| | | |
|---|---|---|
| | with fare collection<br>• Maximizes ridership | • In some cases, free rides can reduce public respect for transit systems<br>• In some cases, open access can increase criminal activity on transit<br>• Vehicle crowding can lead to declining service quality |

## Fare-free programs

In particular, fare-free programs merit additional attention. A number of transit agencies in the United States and elsewhere currently have, or have previously piloted, fare-free programs, whereby most or all passengers may ride for free. These fall into three main categories:

1. Abandoned general fare-free pilot programs in large cities
2. Ongoing limited fare-free programs in large cities
3. Universal free fares in small cities and rural areas

Three major fare-free pilot programs were tested in U.S. cities in the late 20th century, in Austin, TX; Denver, CO; and Trenton, NJ.[1] All of these pilots brought significant increases in ridership but also caused problems with criminal activity and a degradation of the onboard environment. Another problem was crowding, and the increased costs from offering more trips to offset crowding. The Denver and Trenton pilots were limited to peak-period trips, which effectively subsidized higher-income commuters while continuing to charge fares of lower-income off-peak riders. Peak-only free fares also encouraged riders to shift trips to the peak, inverting any economic signal that would discourage riders from riding during the peak period, when marginal costs of trip provision are highest.

In Los Angeles County, the City of Commerce operates a transit service with free fares to all riders, which serves a small area of the urban Los Angeles area. Perhaps the broadest current free-fare scheme in a large city is in Talinn, Estonia, where all transit services are free to residents, as well as to nonresident students and seniors.

[1] Perone, J. S., & Volinski, J. M. (2003). Fare, Free, or Something in Between?.Available at https://www.nctr.usf.edu/wp-content/uploads/2015/10/473-13-2.pdf

Finally, fare-free systems operate in a number of small-city and rural areas around the United States. Among small cities with free transit, most are either university towns or resort towns.[2] Furthermore, some systems offer seasonal fare-free service to boost ridership during, (e.g. in the summer when schools and universities are closed). These systems demonstrate the long-term feasibility of offering fare-free transit, at least in specific cases.

# Sample Future Fare Structure

This appendix provides an illustrative example for a new fare structure that takes advantage of the new Accounts and Ticketing systems and meets the guidelines set in Topic SE-3, Fare Restructuring. These are:

1. Set fares low relative to the purchasing power of the individual transit rider
2. Where and when ridership is high, manage limited transit capacity by encouraging riders with flexibility to travel during off-peak times, or to bike and walk when possible.
3. Where and when ridership is low, introduce special fare policies such as discounted, one-way free fares, or group/family fares to fill excess capacity
4. Include a minimal number of fare models
5. Make fare media as easy to purchase, access, and use as possible

Fares structures and policies should be designed with the objective of increasing ridership in general, and in particular where it is most cost-effective to accommodate new ridership. To that end, the fare structure needs to distinguish between peak travel, where capacity constraints mean that providing additional seats is expensive (i.e, more vehicles are needed), and off-peak travel, where excess capacity exists and transit seats go unfilled. Fare structures serve to mediate demand and supply, and if designed well, are a transit agency's best tool for increasing ridership and avoiding excessive overcrowding. Simplified, coordinated fare structures designed for use statewide will facilitate an easy-to-understand, easy-to-use statewide transit fare program that allows riders to use, transfer within and to, transit systems across the state with ease.

A "menu" of fare models developed by the state for agencies to choose from would make transit systems easily comprehendible to riders across the state and would simplify the use of a single

[2] National Academies of Sciences, Engineering, and Medicine (2012). *Implementation and Outcomes of Fare-Free Transit Systems (TCRP Synthesis 101)*. Washington, DC: The National Academies Press. Retrieved from https://doi.org/10.17226/22753.

fare system. As shown below, the four models would include fares for single trips (single entry) for both peak and off-peak periods, distance-based fares, and zone fares.

- "A" fares would allow single-entry, single-trip one-way travel on any transit service during peak hours
- "B" fares would allow single-entry, single-trip one-way travel on any transit service during off-peak hours
- "C" fares would entail unitary credits for distance-based services (such as ferries and certain rail services which experience high demand peaking)
- "D" fares would provide unlimited off-peak travel within a certain number of zones (from rider's the point of entry)

The combination of these "letter" fare models and the increasing use of technology in fare media (cards, smartcards, smartphones, and apps) means that the State could also establish a common fare currency, as well, whereby riders pay with "points" instead of amounts in dollars and cents. A $2 fare, for example, would instead be 2,000 points. Such a currency, similar to airline miles, offers several advantages:

- Much easier fare adjustments: fares could be adjusted (up or down) incrementally on a more palatable scale to users.
- Fare adjustments can be much finer: a 1,000 point to $1 equivalency means more small incremental changes are possible than would be with with small-value cent values
- Transparency in fare changes is maintained and adjustments can be used to manage demand dynamically, i.e., points increase on busy routes and decrease on less busy times of day.
- Rebate and rewards program-style incentives ("earn 100 points to ride an hour later" or "ride line 91 today instead to get a seat and earn 200 points") would be easier to award. This can introduce gamification opportunities.
- More stable nominal fare values and simpler inflation adjustments: instead of changing point-fares over time, the exchange rate of dollars to points could be changed instead.
- Distinctive branding: like frequent flyer programs, a points program would give the statewide fare system a more distinct identity, and generate interest and user "buy in".
- Bulk discounts are easy: incentives to organizations and frequent users could include buying large number of points at a discount to encourage greater transit use.
- Discounts for seniors, students, and others could take the form of direct subsidies instead: rather than charging fewer points, their account could have points added at a preferential rate (e.g., $1 = 2,000 points instead of 1,000).

**Table 3: Advantages and Disadvantages of Fare Models**

| Context | Posted sign | Rider experience |
|---|---|---|
| **Ride on local bus in low-ridership area (e.g., Vallejo)** | Free rides at all times | Low-friction, low-cost experience |
| **Ride on local bus in low-crowding area (e.g., San Bruno)** | "A" Fares at all times<br>Cash fare: $2 | Similar to most local buses in California today, with more riders paying discount fares |
| **Ride on local bus in high-ridership area (e.g., San Francisco)** | "B" Fares: Mon-Fri, 7am-10am & 3:30pm-6:30pm<br>"A" Fares at all other times | Encouraged to travel during off-peak periods if possible |
| **Ferry service from San Francisco** | Fares to:<br>Oakland - 5000 points "C"<br>Vallejo - 10000 points "C" | Similar to most ferries in California today, with more riders paying discount fares |
| **Ride on BART, off peak** | From Embarcadero station to: (1 zone = 1500 points)<br>Civic Center - 1 zone "D" (1500 points)<br>Balboa Park - 2 units "D" (3000 points)<br>San Bruno - 3 units "D" (4500 points)<br>SFO Airport - 6 units "D" (9000 points) | Less expensive than off-peak BART travel today, with more riders paying discount fares |

## TNCs as Competitors

The rise of Transportation Networking Companies (TNCs) such as Uber and Lyft has been one of the most significant recent changes to citywide mobility. During our stakeholder engagement process, outreach to transit agencies[1] and the executive committee[2] both resulted in extensive discussion of TNCs as potential competition with transit as well as a possible new resource to improve transit. TNCs present several distinct challenges for transit agencies, some of which were touched on in the aforementioned outreach. TNC companies are largely unwilling to divulge data on trips, making it hard to understand these companies' size, scope, operability, and financial sustainability. The recent decline in transit ridership may be attributable to the increased success of TNCs as a mode and their ability to provide cheap service competitive with transit for short trips. Without adequate data, however, such claims can only be a matter of speculation. A 2016 study has shown that TNCs tend to substitute for automobile trips more than for transit trips.[3] The same study, however, did show that the low-income population sometimes replaced bus trips with TNC trips.

TNCs face far fewer regulations than taxis or transit agencies, and this is part of their competitive success. California courts have required Uber and Lyft to make plans to serve disabled populations in compliance with the Americans with Disabilities Act, but little has been accomplished by way of enforcement, and TNCs still take many liberties with this mandate. For instance, low-income populations may be vulnerable during surge pricing.[4] For the most part, TNC service is only available to smartphone users and those who have bank accounts. These privileges are convenient for TNC users, but also give TNCs an inherent competitive advantage over public transit providers because they can simply avoid serving customers who are more difficult to reach

## TNCs as Collaborators

Transit agencies are also excited, however, about the prospect of collaborating with TNCs to more cheaply provide select services to patrons. Current proposed uses of TNCs include first/last-mile service to and from transit stations, and using TNCs as a cost-efficient form of

[1] Statewide Transit Strategic Plan Stakeholder Engagement Report pg 24
[2] Statewide Transit Strategic Plan Stakeholder Engagement Report pg 21
[3] Murphy, C., and S. Feigon. (2016). Shared Mobility and The Transformation of Public Transit. TCRP J-11/TASK 21. [Report prepared for APTA].
[4] National Academies of Sciences, Engineering, and Medicine. (2016). Between Public and Private Mobility: Examining the Rise of Technology-enabled Transportation Services. (p. 47). Washington, DC: The National Academies Press. https://doi.org/10.17226/21875.

paratransit. Paratransit trip costs have more than doubled over the past two decades and trip requests have almost doubled ("Shared Mobility and the Transformation of Public Transit"). [5] Transit agencies usually are willing to subsidize TNCs to perform these services as such subsidies are cheaper than providing comparable services themselves. The Statewide Transit Strategic Plan Baseline Conditions report[6] covers existing (limited) collaborations in the Los Angeles metropolitan region.

Stakeholder engagement revealed that uncertainty about the limitations of existing insurance standards among TNC drivers presents a leading challenge to greater collaboration with transit agencies. For instance, paratransit drivers are expected to undergo drug and alcohol testing, but this does not necessarily take place when drivers are considered independent contractors .[7] Additionally, concerns about limited data availability can contribute to collaboration difficulties (see below). Generally, existing collaborations with TNCs have either been limited in scope or have failed to become adopted on a wider scale (such as the failure of Lyft's carpool pilot detailed in the baselines report).

Many researchers have pointed out, however, that TNC trips also complement transit. TNC services are most frequently used for social trips between 10 p.m. and 4 a.m., when public transit is infrequent.[8] TNCs, by providing trips hard to make via public transit, can make it easier for people to live without a car, and thus may encourage transit use from this growing population.[9] TNCs can also be used as a secure means of travel in case of emergencies.

## Data from their Service Provision & Use:

Currently, TNCs are only required to submit data to the California Public Utilities Commission to further public safety (2012 rulemaking). Without TNC data divulged to planning agencies, it is difficult to incorporate the mode into meeting regional planning goals or integrating efforts and investments into other modes with TNCs.TNCs generally are unwilling to give up their data because they claim to be entitled to such information as private companies. In legal battles, TNCs generally claim that divulging data is a violation of user privacy laws, especially data on origins and destinations that they claim may be able to be tied to specific individuals. They also consider data trade secrets that would be dangerous to give considering competition with other

[5] Murphy, C., and S. Feigon. (2016).
[6] Starting pg. 97
[7] Murphy, C., and S. Feigon. (2016).
[8] Statewide Transit Strategic Plan Baseline Conditions Report, pg. 196
[9] National Academies of Sciences, Engineering, and Medicine. (2016). Pg 18.

TNCs.[10] Current efforts by TNCs to divulge data have been limited to online web platforms and the limited results of legal action by cities such as Boston, San Francisco, Seattle, Portland, and Washington, D.C. San Francisco has also researched TNC data by sending requests to Uber and Lyft's APIs, which returns information on nearby vehicles but does not reflect a comprehensive set of data.[11]

Secure and anonymized data warehouses at universities could form part of the solution. These warehouses could provide crucial transportation-planning data (such as origin-destination data) without resulting in an invasion of privacy or compromising confidential business information. Universities are also uniquely equipped to handle such data requests because they can handle confidential data in a manner not subject to public disclosure.

# Opportunities

## Establishing a Framework for TNCs in Citywide Planning

More and more efforts have been made in California to help courts and public officials recognize the dramatic scope of TNC activities, and in order to accomplish regional planning objectives, planners need to have access to TNC data. In short, cities have sought to classify TNCs as a public nuisance in need of regulation, not just a private business. San Francisco recently released a set of guidelines stipulating the city's stance toward Transportation Networking Companies. In particular, San Francisco emphasizes that TNCs should adhere to the goals of Vision Zero and other traffic-safety programs, that they be accessible to low-income, non-English speaking, and disabled persons, that they contribute to congestion reduction, and that they support Climate Action initiatives. The city also officially declared that TNCs should not have a negative impact on public-transportation service delivery, though it is unclear how this will be measured. Data collection is stipulated as a requirement to achieve these criteria. While unconnected to clear laws that demonstrate how these principles will be supported, the guidelines stress that TNCs are a matter of public concern and deserve a coordinated transportation planning response as with other modes. Such guidelines could be adapted in other parts of California or on a statewide basis.

[10] Allred, N. and Tse, L. (2017). "Opening Comments of Rasier-CA, LLC on Phase III.B Scoping Memo and Ruling of Assigned Commissioner Track III (TNC Data)." Submitted to Service List for CPUC Rulemaking 12-12-011.
[11] San Francisco County Transportation Authority (2017). *TNCs Today: A Profile of San Francisco Transportation Network Company Activity.* Available at http://www.sfcta.org/sites/default/files/content/Planning/TNCs/TNCs_Today_061317.pdf

## Nonprofit TNCs in Rural Areas

See recommendations to implement TC-5.1: "Develop and support non-profit mobility services in rural areas and disadvantaged communities" and Appendix C-6.

## The Impacts of Shared, Autonomous Vehicles on Transit

The increasing likelihood of the arrival of autonomous vehicles for practical, everyday use poses further opportunities, and potential challenges, for transit. While estimates for adoption vary, many researchers predict rapid timetables; one of the most urgent comes from David Levinson[12], who predicts that drivers will be prohibited from roadways by 2040. Driverless vehicles make the experience of travelling by automobile closer to that of transit or taxis, as passengers do not need to focus on the road and can instead do work or engage in other activities while travelling. Driverless vehicles are also widely anticipated to be connected to other vehicles and signalization infrastructure, allowing for travel-time savings and safety benefits.

Conferences on autonomous vehicles generally agree that many will choose to use autonomous vehicles in a manner similar to transportation network companies. Rather than owning a vehicle, passengers will be able to call a shared autonomous vehicle on demand via an app-platform, picking the right vehicle for the circumstance. Because of the lack of a need to pay a driver (a labor cost), the option will be even cheaper than services like Uber or Lyft today. This could drive further competition with transit, whose cost-effectiveness may be further diminished by the cheap availability of on-demand vehicles.

Transit companies, however, also have the potential to benefit from autonomous vehicles.[13] In particular, one of the highest costs for transit companies is the labor costs of drivers. Eliminating drivers can help create more cost-effective service or even contribute to the elimination of fares. Additional collision-avoidance technology can help transit save money via reducing injury-related claims to agencies. As an alternative, driver positions could be transitioned to customer-service or security positions that most transit companies currently lack. Integrated planning with "cloud-based" shared autonomous vehicle services will be crucial to transit's success in a future dominated by autonomous vehicles. Transit would provide higher performing service in congested and dense corridors, transporting large groups of people and using smaller autonomous vehicles to seamlessly "feed into" that service. Without a better

[12] Levinson, D. (2015). Climbing Mount Next: The Effects of Autonomous Vehicles on Society. Minn. JL Sci. & Tech., 16, 787.
[13] Levinson 2015

impression of what autonomous mobility may look like, however, few concrete recommendations regarding transit specifically can be made at this time.

## Actions to Consider:

1) Establish a set of statewide guidelines stipulating policies supporting equity, accessibility, and safety and require that they be met by TNCs to receive state funding or administrative support.

2) Require TNCs to share aggregated, readily downloadable trip data (to be stored in university data warehouses) in order to receive city funding and/or administrative support.

3) Reduce barriers to TNC/transit collaborations by passing laws removing TNC companies from fleet stock requirements (such as Buy America) and allowing paratransit drivers to use their own auto insurance.

4) Provide subsidies to TNCs to provide trips for low-income or disabled passengers, especially in rural areas.

5) Either require TNCs have a higher level insurance for applications stemming from agreements with transit agencies or change state insurance law to indemnify transit agencies from TNC actions

Note**: This memorandum presents a preliminary example of a federated, non-profit mobility service focused on rural areas and other areas where for-profit TNC services do not serve. The example is provided for discussion purposes and is not a proposal.**

Successful implementation would require statewide scale and investment in a platform, new legislation, and revenues. Revenues may come from existing sources or a new, small fee on for-profit TNC rides in non-rural areas.

The objective for the service would be to achieve minimum efficient scale by combining existing and new shared ride trip types on a single platform:

- free, organization-enabled shared ride trips (existing)
- directly-subsidized social service mobility trips (existing)
- unsubsidized shared ride trips (TNC-like) (new)

## Actors

Two types of drivers will offer trips on the platform. The first type is incidental drivers who wish to perform a service or cover their costs on their way to existing destinations, such as school, work, or shopping. Compensation for these drivers are limited to the IRS mileage reimbursement rate. These will likely be part time drivers.

Others are demand-responsive drivers who seek to generate wages in excess of the IRS reimbursement rate. These drivers will be subject to additional regulatory requirements, modeled on or falling under the California Public Utilities Commission's regulation of Transportation Network Companies. These are more likely to be full-time drivers who may also participate in ancillary business opportunities facilitated by local coordinating organizations.

Both types of drivers would be driver types should be dispatched in such a manner that supply and demand is aggregated.

A diverse range of Californians would use the service. Some would only utilize fully-subsidized rides for trips to medical appointments, markets, and social services. Others would use the service exclusively for market-rate, unsubsidized rides.

Subsidy qualification would occur via integration with the user's account on the statewide ticketing system.

A Local Coordinating Organization manages drivers and users. Service may be branded by this local coordinating organization. In order to promote jobs or cross-subsidize for social service transportation, the organization may wish to create and market unsubsidized, ancillary business opportunities, such as scheduled trips for visitors to a national forest or package logistics arrangements with delivery companies.

A regional Administering Agency works with multiple local coordinating organizations. In most cases, this agency will be the local transit agency in an expansion of its mobility manager role. The regional Administering Agency can set locally-appropriate service standards that ensure a quality experience and sync supply and demand. For example, an agency may set a requirement for 24+ hour pre-booking with 30-minute arrival windows.

**Table C6-1: Example Structure for Nonprofit Mobility Service Model**

| | **Supply** | **Demand** |
|---|---|---|
| **Users** | • incidental rideshare drivers set destinations and schedule<br>• demand-responsive drivers set availability in advance | • request rides<br>• provide form of payment for unsubsidized and partially-subsidized rides |
| | • provide feedback | |
| **Local Coordinating Organizations *(nonprofits)*** | • recruit and train drivers<br>• inspect vehicle safety<br>• create and market additional, unsubsidized services | • advertise service availability to constituency<br>• override quota rules for certain trips (e.g. to place of worship) |
| | • monitor and act on feedback<br>• administer training | |
| **Administering Agency** | • establish geographic coverage area, span of service, and other local requirements for subsidized mobility<br>• recruit existing community-based and faith-based shared ride efforts | • work with medical, social, and service providers to adopt integrated appointment-mobility booking and third-party billing<br>• establish quota of subsidized rides per time period, with |

| | | |
|---|---|---|
| | as local coordinating organizations<br>• establish new coordinating organizations<br>• provide assistance and grants to local coordinating organizations<br>• perform vehicle safety and financial audits | sensitivity to age, abilities, program eligibility, etc.<br>• create rules for rides not counting against quota, e.g. medical appointments billed elsewhere or timed based on shared ride availability |
| **State** | • establish insurance & safety regulations<br>• accredit local coordinating organizations for regulatory inspections | • raise revenues<br>• fund subsidies |
| | • acquire and provide software code and necessary IT systems for operation<br>• update and maintain software and IT systems as necessary<br>• establish and operate primary or overflow contact center<br>• create common training platforms<br>• provide mobile devices as needed for subsidized services | |

**Existing Non-Profit and Rural Innovative Mobility Services**

- Nonprofit TNC: RideAustin (www.rideaustin.com) is a 501(c)3 nonprofit corporation started after national TNC providers exited the city in May 2016. The service retains a lower percentage of trip revenues than for-profit TNCs (10%), accepts tax-deductible donations, and allows users to round up fares with the balance going to a local nonprofit.
- Rural mobility service: Liberty Mobility Now (libertymobilitynow.com) seeks to bring the technology-enabled rideshare experience to rural areas and smaller urban areas. Transit providers can arrange rides via software provided by Liberty.
- Nonprofit, rural rideshare: Independent Transportation Network America (www.itnamerica.org) has a non-profit, rural, app-based ridesharing model which assumes drivers will volunteer at least a portion of their time.

| Metric | Cause for Concern |
|---|---|
| **Mode share by disadvantaged group** | Low mode share among disadvantaged groups suggests inadequate or mismatched transit service. |
| **Per-capita linked trips by disadvantaged group** | Few per-capita linked trips among disadvantaged groups suggests inadequate or mismatched transit service. |
| **Transit travel time and cost by disadvantaged group** | Longer transit travel times or higher costs among disadvantaged groups suggests inadequate or mismatched transit service. |
| **Onboard crowding by demographics of geographies served by each transit line** | High levels of crowding on transit lines serving disadvantaged groups suggests inadequate or mismatched transit service. |
| **Actual maximal headways** | Long maximal headways in geographies where disadvantaged groups are well represented may suggest inadequate or mismatched transit service, especially where job or housing densities are high. Such factors should be assessed by transit mode (e.g., bus versus rail), by time of week (e.g., peak, midday, evening, late night, weekends), by geography, and by demographic group. |
| **Per-capita line and stop density** | Low per-capita line or stop density in geographies where disadvantaged groups are well represented may suggest inadequate or mismatched transit service, especially where job or housing densities are high. Such factors should be assessed by transit mode (e.g., bus versus rail), by time of week (e.g., peak, midday, evening, late night, weekends), by geography, and by demographic group. |

**Survey Questions to Assess Equity**

**Rider Perspective:**
Whether the needs of disadvantaged groups are satisfied is best determined directly by surveying disadvantaged communities to gauge their opinion of transit service offered to them. Example survey questions include:

- How would you rate the public transit service in your neighborhood? (Terrible–Excellent)
- Would you consider the public transit service in your neighborhood to be safe / reliable / fast / convenient/ family-friendly/ affordable?
- Is it practical for you to take public transit to work/ to run errands/ to social or family destinations such as parks, schools, and homes of friends or relatives?

"Bus-on-shoulder" transit refers to policies that designate use of the left or (more commonly) right shoulder on arterial or grade-separated highways, exclusively for bus use[1]. By making use of existing infrastructure, such policies can improve transit performance along freeway corridors for a significantly lower cost than traditional designated bus lanes. Already implemented in metropolitan areas in five countries, bus-on-shoulder programs boast an outstanding safety record and demonstrable positive effects on rider satisfaction. Freeway congestion in California's metropolitan areas impedes the movement of buses as much as automobiles. As long as sprawling, suburban-style dwelling patterns continue to characterize the state's metropolitan areas, bus-on-shoulder transit offers strong potential for improving bus ridership and service in the state of California.

**Bus-on-Shoulder Transit: Characteristics and Opportunities**

Bus-on-shoulder transit programs have been implemented in 13 metropolitan areas in the United States, as well as in metropolitan areas in Canada, New Zealand, the United Kingdom, and Ireland[2]. One of the longest-running and most extensive programs is in the Twin Cities region, where more than 270 miles of lanes have been implemented since 1991 (Zuehlke, et. al. 2015). Although most bus-on-shoulder operations utilize the right (or outer) shoulder[3], shoulder operations in Cincinnati and Chicago operate on the left (or inner) shoulder[4]. In the United States, bus-on-shoulder programs typically restrict bus use of the shoulder to periods when the speed in mixed-flow lanes drops below a particular threshold (35 miles per hour in the Twin Cities), and prevent buses from traveling more than 10 mph (San Diego) to 15 mph (Twin Cities) faster than the general-purpose lane, for safety purposes[5]. In California, San Diego implemented a pilot bus-on-shoulder program in December 2005 along the I-805 and SR-52 freeways[6], and recently considered[7] another bus-on-shoulder demonstration project on the I-805 and SR-94 freeways. In the last two years, Monterey-Salinas Transit and the Santa Cruz Metropolitan

[1] National Academies of Sciences, Engineering, and Medicine. (2012). A Guide for Implementing Bus on Shoulder (BOS) Systems. Washington, DC: The National Academies Press. https://doi.org/10.17226/22809.
[2] Zuehlke, J., Kaba, F., McElduff, K., Ho, L. S., & Machemehl, R. (2015). PEAK PERIOD BUS USE OF FREEWAY SHOULDERS. The University of Texas at Austin. unpublished results. https://library.ctr.utexas.edu/ctr-publications/iac/bus_use_frwy_shoulders_201506.pdf
[3] National Academies of Sciences, Engineering, and Medicine. (2012).
[4] Florida Department of Transportation (2016). "Implementing Bus on Shoulder in Florida." http://www.fdot.gov/transit/Pages/Bus_on_shoulders_Guidance_013117.pdf
[5] National Academies of Sciences, Engineering, and Medicine. (2012).
[6] National Academies of Sciences, Engineering, and Medicine. (2012).
[7] Outcome unclear. No articles discuss this since June 2015. See Palen, James (Friday July 24, 2015). "SANDAG approves 'bus-on-shoulder' pilot project." The Daily Transcript. http://www.sddt.com/News/article.cfm?SourceCode=20150724czh#.WbrJbMiGOUl

Transit District have initiated a feasibility study[8] for a bus-on-shoulder transit facility along State Highway 1, between Castroville and Monterey[9].

Despite the fact that they enable only modest speed improvements, bus-on-shoulder programs have improved on-time performance in the Twin Cities, San Diego, and Miami[10]. Riders in particular seem to perceive a significant time savings from the lanes (possibly because they notice the bus moving relatively quickly past congested lanes). Bus riders in Ohio, San Diego, and the Twin Cities have given positive feedback on the lanes[11]. Costing only $1,500 to $100,000 per mile to implement in the Twin Cities[12], bus-on-shoulder lanes have proven less costly to implement than either highway lane additions (which cost $2 million to $10 million per lane mile on average[13]) or mixed-lane bus rapid transit systems (which cost $1 - $7 million per mile on average[14]), with arguably greater effects on performance. In addition, bus-on-shoulder lanes in the Twin Cities might have also improved performance for bus services that don't use the freeway by allowing out-of-service buses to deadhead more quickly[15].

| City | State or Province and Country | Year Started | Length (as of 2015) |
|---|---|---|---|
| Seattle | Washington, US | 1970s | 4.9 miles |
| Minneapolis/St. Paul | Minnesota, US | 1991 | over 270 miles |
| Auckland | New Zealand | 1991 | length unknown |
| Ottawa | Ontario, Canada | 1992 | 14 miles |
| Dublin | Ireland | 1998 | 50 to 70 miles |
| Vancouver | British Columbia, Canada | year started unknown | |

[8] "Revised Agenda for TRANSPORTATION AGENCY FOR MONTEREY COUNTY." January 27, 2016. Pps. 258-259. http://www.tamcmonterey.org/wp-content/uploads/2016/01/TAMC-Meeting-01_27_2016-09_00AM-AgendaPacket-REVISED.pdf

[9] The "Request for Proposals RFP #17-01" (http://mst.org/wp-content/media/FINAL-RFP-17-01-Bus-on-Shoulder-Study.pdf) lays out the detailed parameters of the study.

[10] Zuehlke, J., Kaba, F., McElduff, K., Ho, L. S., & Machemehl, R. (2015).

[11] Ibid.

[12] Douma, F. (June 2007). "Bus-Only Shoulders in the Twin Cities." http://www.dot.state.mn.us/metro/teamtransit/pdf/Bus-Only-Shoulders-Report.pdf

[13] Texas A&M Mobility Institute. "Adding New Lanes or Roads." https://mobility.tamu.edu/mip/strategies-pdfs/added-capacity/technical-summary/adding-new-lanes-or-roads-4-pg.pdf

[14] TCRP Report 118. "Bus Rapid Transit Practitioner's Guide." https://nacto.org/docs/usdg/tcrp118brt_practitioners_kittleson.pdf

[15] Metaxatos, P., & Thakuriah, P. (2009). Planning for Bus-on-Shoulders Operations in Northeastern Illinois: A Survey of Stakeholders. Transportation Research Record: Journal of the Transportation Research Board, (2111), 10-17.http://trrjournalonline.trb.org/doi/pdf/10.3141/2111-02

| | | | |
|---|---|---|---|
| Washington, D.C. area | Maryland, US | year started unknown | 3 miles |
| Fairfax County | Virginia, US | at least 2000 | 1.3 miles |
| Toronto | Ontario, Canada | 2003 | 3 miles |
| Atlanta | Georgia, US | November 2005 | 12 miles |
| San Diego | California, US | December 2005 | 4 miles |
| Columbus | Ohio, US | November 2006 | |
| Old Bridge | New Jersey, US | December 2006 | 3 miles |
| Miami | Florida, US | March 2007 | |
| Cincinnati | Ohio, US | July 2007 | |
| Cleveland | Ohio, US | June 2008 | |
| Birmingham | United Kingdom | 2006 | |
| Durham County | North Carolina, US | 2013 | |
| Calgary | Alberta, Canada | 2012 | |
| Kansas City | Kansas, US | 2011 | |

*List of BOS implementations around the world, as of 2015. (Zuehlke, et. al. 2015)*

**Bus-on-Shoulder in California: Implementation Challenges**

A specific hurdle to the feasibility of bus-on-shoulder transit in California is the state's vehicle code, which currently prohibits buses from traveling or stopping in freeway shoulders[16]. SANDAG's pilot program redefined the hard shoulder as a (legally permissible) "transit lane" prior to operation[17], while Monterey-Salinas Transit and the Santa Cruz Metropolitan Transit District's current bus-on-shoulder project required a formal legislative exemption.[18] In 2016, State Assemblymember Mark Stone proposed legislation that would permit eight additional transit agencies in the state (all of which derived authority from the state legislature) to implement bus-on-shoulder programs, in cooperation with Caltrans and the California Highway Patrol[19]. His bill, Assembly Bill 1746, passed the State Assembly but died in the State Senate.[20]

[16] Matute, Juan and Stephanie Pincetl. Bus-on-shoulder treatment on Controlled-access highways. California Center for Sustainable Communities. http://next10.org/sites/next10.org/files/11.%20Barriers%20to%20Express%20Bus%20Service.pdf
[17] National Academies of Sciences, Engineering, and Medicine. (2012).
[18] As obtained through the passage of Assembly Bill 946 (Stone) in 2013. See http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201320140AB946
[19] AB 1746. CA State Assembly 2015-2016 Regular Session. (CA 2016). https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201520160AB1746
[20] See "Transit Buses" Analysis. Senate Committee on Transportation and Housing. file:///C:/Users/The%20Lewis%20Center/Downloads/201520160AB1746_Senate%20Transportation%20And%20Housing-%20(1).pdf

Thus, legislation permitting bus use of the shoulder lanes remains a prerequisite for their implementation.

A primary factor in opposition to bus-on-shoulder transit in California, has been concern for the technology's safety[21]. The State Senate tabled Assembly Bill 1746 based on concerns that such operations posed a hazard to law enforcement and emergency-vehicle operations on the right shoulder[22]. Caltrans also appears to have quashed a proposed bus-on-shoulder operation in San Luis Obispo County based on safety concerns[23]. However, more than two decades since the first bus-on-shoulder lane opened in the twin cities, very few accidents (mostly minor) have been reported on North American Bus-on-Shoulder lanes[24]: a 12-mile bus-on-shoulder lane along Georgia highway 400 in the Atlanta suburbs--that hosts 12 buses/hour during peak hours--has experienced no accidents after a decade of service. Pilot programs in San Diego and Miami (8 and 9 miles in length, respectively) also achieved perfect safety records[25]. The more extensive bus-on-shoulder program in the Twin Cities had only 20 accidents — none involving fatalities — occurring in the first decade of the lanes' implementation[26]. Bus-on-shoulder programs can accommodate emergency-response and enforcement vehicles by creating additional pull-outs on the right side of the shoulder for these uses (as done in Atlanta[27]). Dynamic electronic ("smart") signage can signal a shoulder's transition to a bus lane (in response to changes in traffic conditions), alerting emergency and enforcement vehicles to the bus's presence in the shoulder and facilitating bus drivers' transition to the shoulders.

[21] Miller, M. A., & Buckley, S. M. (2000). Institutional aspects of bus rapid transit: a macroscopic examination. California PATH Program, Institute of Transportation Studies, University of California at Berkeley.
[22] The California Transit Association's "2017 State Legislative Program." https://caltransit.org/cta/assets/File/2017%20State%20Legislative%20Program.pdf
[23] King, Ed (2017). "Ed King. Stakeholder Input."
[24] Florida Department of Transportation (2016).
[25] Florida Department of Transportation (2016).
[26] Douma, F. (June 2007).
[27] Florida Department of Transportation (2016).


*Dynamic electronic signage (like that depicted above the carpool lane in this illustration) can be used to signal the shoulders' transition to bus use.*

Lack of cooperation between agencies is another impediment to bus-on-shoulder systems' implementation in California. Existing bus-on-shoulder programs in the United States have traditionally required, at a minimum, collaboration between a metropolitan transit agency, the agency in charge of the road (often a State DOT), and an enforcement agency (e.g. the highway patrol). In Minnesota, a collaborative partnership titled "Team Transit," bringing together the Minnesota Department of Transportation, the regional transit authority (Metro Transit), city governments, and the state highway patrol, has spearheaded the regional bus-on-shoulder project[28]. The shared interests of Team Transit's members (in particular, between the Department of Transportation and Metro Transit) and their formalization of the partnership by appointing an independent project manager have been credited with the system's smooth and steady implementation[29]. To date, bus-on-shoulder programs in California (i.e. in the San Diego and Monterey areas) have only involved temporary collaborations, in which transit agencies work with Caltrans on specific projects. Moreover, the bus-on-shoulder programs in Monterey and Santa Cruz appear to have primarily drawn initiative from local agencies, with Caltrans taking a passive stance. A statewide bus-on-shoulder program will require a long-term collaborative planning framework, involving both state agencies (like Caltrans) and local stakeholders.

[28] Douma, F. (June 2007).
[29] Ibid.

The State Highway Design guide recommends a minimum shoulder width of 10 feet along freeways and expressways with 4 or more lanes[30], a figure that corresponds to the minimum permissible width for shoulders used by buses in the Twin Cities. However, the Design Guide only recommends a minimum width of 8 feet for shoulders on freeways and expressways with 2 or 3 lanes, and shoulders on older freeways may not comply with the guide's standards. Shoulder widening and repairs can be relatively expensive compared to lane designation (at $42,000 to $66,000 per lane-mile on average[31]), but still economical compared to Bus Rapid Transit and light rail projects. More intensive maintenance of the shoulders will also be necessary to accommodate more frequent use[32].

**Criteria and Recommendations**

To justify implementation costs, corridors selected for bus-on-shoulder service should have predictable congestion delays at least one day a week on average (Pappas 2009) and should serve at least six buses a day (both thresholds used in the Twin Cities and by the Florida Department of Transportation (MnDOT, FDOT 2016)). For local and regional bus service, eligible corridors could include those with commuter express bus services (e.g. LADOT Commuter Express or Golden Gate Transit) in urbanized areas, regional bus services in rural areas (e.g. Route 10 in San Luis Obispo County (link)), and urban corridors containing segments of Bus Rapid Transit services.

Outside of metropolitan areas, California has several freeway corridors with at least 6 intercity bus services a day that are subject to regular congestion. These include Interstate 15 from the Cajon Pass to the Nevada State Boundary and Interstate 5 from Irvine to San Diego. Designating shoulder use for bus services on these routes can help reduce travel time and increase ridership on intercity bus service from Los Angeles to Las Vegas, Los Angeles to San Diego, and San Francisco and Sacramento. A precedent for intercity bus use of highway shoulders can be found in Ireland, where the long-haul bus operator, Bus Eireann, can use shoulders on highways approaching Dublin (Independent 2004). Given the needed for unimpeded travel over a long distance, use of the left shoulders would be preferable on these routes. With these considerations in mind, we make the following recommendations.

**Recommendations:**

- Establish an urban bus-on-shoulder task force bringing together representatives of

[30] California Department of Transportation (2015). Chapter 300. "Geometric Design." California Highway Design Manual. pps. 300-302.
[31] Pappas, E. H., & Machemehl, R. B. (2010). Predicting the Incremental Effects on Transit Ridership Due to Bus-On-Shoulder Operations (No. SWUTC/10/476660-00073-1). Southwest Region University Transportation Center, Center for Transportation Research, University of Texas at Austin. https://static.tti.tamu.edu/swutc.tamu.edu/publications/technicalreports/476660-00073-1.pdf
[32] Metaxatos, P., & Thakuriah, P. (2009).

Caltrans, the heads of all Metropolitan Planning Organizations in the state, the California Highway Patrol, and heads of state transit agencies that operate freeway bus service to devise operational standards and implementation procedures.

- Promote legislation that would amend section 148.1 of the state vehicle code, to allow buses to travel in freeway shoulders on segments designated by this task force.
- Prioritize freeway corridors that have at least 6 scheduled bus services per day, experience congestion at least once a week, and are at least 10 feet wide
- Incorporate next-generation intelligent transportation systems into bus on shoulder operations to improve bus safety and bus flow.

# The Issue:

Safety and security are frequently mentioned by passengers of transit as pressing issues that impact the quality of their transit ride and their choice to use transit. Safety was a top point of discussion for several questions asked during our stakeholder engagement process, including how individuals choose a mode of travel and the quality of their experience both on and off board. A recent study[1] looked closely at the off-board experience of waiting at bus stops specifically. The authors took a survey of transit users and found that most rated elements of safety and security highest in importance for their satisfaction with waiting at a transit stop. Safety during both night and day, adequate bus stop lighting, means to notify help in case of an emergency, and the presence of security guard all ranked as much more important factors than those that transit companies often focus on improving, such as stop cleanliness, available seating, and accessing route information at the station.

At the same time, many misperceptions exist about transit and safety. Generally, passengers taking transit are safer than passenger taking cars; transit drivers tend to be more experienced than regular drivers and tend to travel on safer roadways and denser areas where traffic is slower.[2] By serving as an alternative form of transportation for those consuming alcohol, transit also helps to reduce drunk driving.[3] Transit also provides alternatives for seniors after they are no longer able to drive (and accordingly reduce the risk of an unsafe choice to drive by a senior). Safety also is more frequently mentioned as an issue by non-riders than riders, possibly a reflection of the desire not to associate with those that take the bus as much as a real safety threat. Studies of crime statistics furthermore show that major crimes like homicide, rape, and aggravated assault are very rare on-board.[4]

That said, there are still plenty of legitimate safety concerns for transit riders. While smaller crimes like simple assault, larceny, drunk behavior, and sexual crimes like groping still are reported only occasionally, this is likely because these crimes are underreported. Security

[1] Taylor, B. D., Iseki, H., Miller, M. A., & Smart, M. J. (2009). Thinking outside the bus: Understanding user perceptions of waiting and transferring in order to increase transit use. California PATH Program, Institute of Transportation Studies, University of California at Berkeley.
[2] American Public Transportation Association (2016). The Hidden Traffic Safety Solution: Public Transportation. Available at https://www.apta.com/resources/reportsandpublications/Documents/APTA-Hidden-Traffic-Safety-Solution-Public-Transportation.pdf
[3] American Public Transportation Association (2016). The Hidden Traffic Safety Solution: Public Transportation. Available at https://www.apta.com/resources/reportsandpublications/Documents/APTA-Hidden-Traffic-Safety-Solution-Public-Transportation.pdf
[4] Frazier, E. (2015). Policing and Security Strategies for Small- and Medium-Size Public Transit Systems. TCRP Report 180. National Academies Press, Washington, DC. (p. 28)

presence or even the availability of emergency hot lines continues to be very rare on-board vehicles. Employees of transit companies (mostly drivers) continue to be at a high risk of injury or intimidation, much higher than comparable levels of risk for passengers. Many complications with drivers result from fare-related matters (such as disagreements about fare payment, refusing to pay the fare, or attempts to rob fares) but some can result from simple dissatisfaction with traffic, driving ability, navigation, or any other petty concern.

Most transit-related fatalities occur off the bus at stops and stations. Bus stops pose a special challenge for transit agencies because safety at these stops is typically the responsibility of the local police, even though waiting at stops is a crucial component of the transit experience.[5] Crime occurs at transit stops because they tend to be located near high crime generating locations such as bars and ATMs, and bus passengers sometimes travel through and transfer at higher crime neighborhoods than the ones that they live or work in.[6] Design of transit stations to increase visibility and decrease hidden areas can partially help to reduce the risk of crime, as well as avoiding placement in vacant lots or intersections with liquor stores.[7]

## Opportunities:

At the federal level, the FTA is required to create safety criteria for vehicle performance standards and create a public transit safety certification program. Current security protocols include the TSA's BASE assessment strategy and the FTA's Public Transportation System Security and Emergency Preparedness Planning Guide.

Many current safety and security plans emphasize issues of terrorism and company resilience in the face of emergencies. However, these incidents are extremely rare, especially for small and medium-size transit companies. Safety plans should more frequently deal with the everyday rider experience. Security and safety plans at transit companies can foster a "safety culture" which can encourage transit drivers to disrupt normal patterns of behavior in the case of high pressure situations.[8]

Security plans, while promising, do pose complications. Security presence on transit lines can be extremely expensive. Furthermore, some populations may be threatened by the presence of

[5] Frazier, E. (2015). Policing and Security Strategies for Small- and Medium-Size Public Transit Systems. TCRP Report 180. National Academies Press, Washington, DC.
[6] Iseki, H., Smart, M., Taylor, B. D., & Yoh, A. (2012). Thinking outside the bus. Access Magazine, 1(40).
[7] American Public Transportation Association (2010). Bus Stop Design and Placement, Security Considerations. Recommended Practice Report. APTA SS-SIS-RP-008-10
[8] Roberts, H., Retting, R., Webb, T., Colleary, A., Turner, B., Wang, X., ... & White, C. (2015). Improving safety culture in public transportation.

security personnel, and the presence of an openly armed person can in some cases escalate tension and damage rather than decrease it. As transit is frequently relied upon by low-income individuals and minorities, thinking critically about security presence is a crucial equity issue in transit policy.

Several other methods of promoting safety and security, other than hiring additional security personnel, are available. “Panic buttons”, or emergency hot lines, tend to have low installation costs but can create a burden on security departments due to the frequency of use for low-pressure situations. At the most basic level, divulging information publicly in buses and stops about steps to take in the case of unwanted behavior or threatening situations has been shown to moderately improve passenger comfort with the transit experience. Other solutions include the presence of onboard security cameras and physical barriers protecting bus operators. Operators, as usually the only officially employed presence on board, should go through appropriate safety training both to protect themselves and passengers.

Standards can help to increase transit security significantly. Exact fare laws, removing the requirement that drivers carry change, reduced robberies and violence against transit employees considerably.

## Considerations:

1. Require standardized vehicle operator security training.
2. Encourage and fund multiple modes of private, hassle-free emergency notification and reporting.
3. Require safety plans by transit companies that specifically address minimizing non-severe (“petty”) criminal activity.
4. In cases (such as rail transit) where vehicle functions are mostly automated, hire operators who can also act as customer service agents or ambassadors for transit companies.
5. Collaborate with transit companies to market and promote employment search services and homeless services to on-board passengers, as in Sacramento’s “Wheels to Work” program.
6. Incident reporting app integrates with ticketing system to send reports and evidence to appropriate authorities.
7. Make transit comforting for women. Use technology to streamline security/police requests.

This technical memo reviews academic studies of how real-time information affects transit ridership, system satisfaction, and transit user experience. While there is some variability in expected ridership effects and need for future before/after studies of how real time information affects ridership, this memo can be used to establish a scientific basis for the direction and approximate magnitude of the effect of real-time transit information on greenhouse gas emissions. Based on calculations the LCTOP model and the California Household Travel Survey, the presence of high-quality real time transit information can reduce greenhouse gas emissions statewide by 0.88 MTCO2 per 1000 current bus riders, through a 2% increase in ridership. This figure increases for regions with bus trip lengths higher than the state average, and increases further if ridership increases on rail transit are included.

The link between real-time information services and increased transit ridership-absent increases in service is well established in the literature. Real-time information can increase ridership through multiple mechanisms, including increased transit user satisfaction and decreases in actual and perceived wait time. There are various themes among the literature. First, the vast majority of studies linking RTI and ridership levels use bus as he study subject, reasoning that train travel typically adheres to a published schedule and typically high-reliability.[1] Second, a divide exists between earlier studies of arrival time indicators at stations, and later advances in RTI including smartphone apps.[2] Thirdly, only limited of number of studies look at ridership before and after the implementation of RTI, while most focus on how RTI changes riders' perception of bus travel and system operations.

# Measuring Ridership Increases

Tang and Thakuriah (2012)[3] used route-level longitudinal data to study ridership levels following the system-wide implementation of RTI throughout the entire Chicago Transit Authority bus system. CTA Bus Tracker was introduced between August of 2006 to May 2009, with staggered installation across the system. The study included ridership levels from 2002-2010 to establish ridership base-levels and control for other factors (for example,

[1] Diab, E. I., Badami, M. G., & El-Geneidy, A. M. (2015). Bus transit service reliability and improvement strategies: Integrating the perspectives of passengers and transit agencies in North America. Transport Reviews, 35(3), 292-328.
[2] Brakewood, Candace, Gregory S. Macfarlane, and Kari Watkins. "The impact of real-time information on bus ridership in New York City." *Transportation Research Part C: Emerging Technologies* 53 (2015): 59-75.
[3] Tang, Lei, and Piyushimita Vonu Thakuriah. "Ridership effects of real-time bus information system: A case study in the City of Chicago." Transportation Research Part C: Emerging Technologies 22 (2012): 146-161.

population increase, employment levels, and gas prices). They find that the installation of RTI increased weekday bus ridership 1.8-2.2% on each line when RTI was instituted, and that the average riders increase for all lines with RTI of 126 more riders per day compared bus routes without RTI. They note that ridership increased more on the routes with later RTI installation, and posit that familiarity with the system, increased interconnectivity between lines with RTI, and the advent of services real-time smartphone services such as Google Maps led to the temporal variance.

Brakewood et al (2015) study the effect on ridership resulting from RTI bus tracking available from mobile devices in New York City. The program was launched gradually, and the authors used panel regression to evaluate ridership changes over a three-year period while controlling for other factors. They found an increase of 118 trips per route each weekday, a median increase of 1.7% of weekday ridership. They also found that greatest percentage increase in ridership increased on the quartile of routes with the largest ridership (340 additional trips, a median increase of 2.3%).

Fen, Shen and Clifton (2008) measured the impact of the recent implementation of a RTI system for the University of Maryland (College Park) shuttle service. Researcher found that RTI increase passengers' level of satisfaction, but did not find ridership increase. They posit that the lack of ridership increase could be due to the fact that recent implementation has not allowed for passengers to yet adjust their travel behavior. Additionally, this study looks at a campus shuttle system, in which increases in ridership would like result from increased trip frequency rather than mode choice.[4] Indeed the need for marketing an adjustment time to new RTI technologies has been noted by many researchers.[5]

## RTI and Transit System Satisfaction

It is well established frustration and anxiety with uncertain wait times discourage transit usage, People prize reliability in transportation, and will often choose to drive to avoid the uncertainty

[4] Zhang, Feng, Qing Shen, and Kelly Clifton. "Examination of traveler responses to real-time information about bus arrivals using panel data." Transportation Research Record: Journal of the Transportation Research Board 2082 (2008): 107-115.
[5] Kamga, Camille, M. Anıl Yazıcı, and Abhishek Singhal. "Implementation of interactive transit information kiosks at New York City transit facilities: Analysis of user utilization and lessons learned." Transportation Research Part C: Emerging Technologies 35 (2013): 218-231. Kristof, Taryn, Michael B. Lowry, and G. Scott Rutherford. *Assessing the benefits of traveler and transportation information systems*. Vol. 597. Washington State Department of Transportation, 2005.

of wait time, even if the overall trip time is longer.[6] Many researchers hypothesize that reducing the uncertainty associated with transit wait time will lead to increased satisfaction with transit, and therefore increase ridership.

In a study of bus systems in two Spanish cities, Adres, Hernandez and Cascaio (2013) measures passenger satisfaction with resulting from the introduction of real time information, using surveys[JL1] conducted both before and after the introduction of RTI. They found that in one study city, the introduction of RTI increased rating or perceived quality of service by 13% and perception of bus system of the whole by 14%. In Madrid, the perceived quality of service increased 6%, and ridership increased, even though the actual quality of service decreased[JL2] .[7]

William, Block-Schachter, and Hick (2014) studied changes in ridership and rider satisfaction after the implementation of RTI signage in Metropolitan Boston Transportation Authority (MBTA) train stations. The researchers surveyed over 4000 random rush-hour commuters across the MBTA system, both before and after RTI implementations (though not the same person). They found that real-time signage reduced overestimation of wait time by 50%. Overall satisfaction increased on MBTA lines with shorter headways, but decreased on those with headways greater than 9 minutes. Using a fixed-effects model, the authors found a 1.7% ridership increase due to the installation of countdown timers, but make conclusions as to whether system approval caused increased ridership.[8]

## RTI and Perception of Waiting

Multiple studies show that transit users overestimate their wait time for transit, which leads to decreased satisfaction and ridership of transit. Many studies of RTI compare people's perception of wait time compared to actual wait time, linking these findings to satisfaction before and after RTI implementation.

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[6] Yoh, A., Iseki, H., Smart, M. and Taylor, B.D. 2012. Hate to wait: the effects of wait time on public transit travelers perceptions, Transport. Res. Record, 2216, 116–124. Diab, Ehab I., Madhav G. Badami, and Ahmed M. El-Geneidy. "Bus transit service reliability and improvement strategies: Integrating the perspectives of passengers and transit agencies in North America." *Transport Reviews* 35, no. 3 (2015): 292-328.

[7] Diab, Ehab I., Madhav G. Badami, and Ahmed M. El-Geneidy. "Bus transit service reliability and improvement strategies: Integrating the perspectives of passengers and transit agencies in North America." Transport Reviews 35, no. 3 (2015): 292-328.

[8] Chow, William, David Block-Schachter, and Samuel Hickey. "Impacts of Real-Time Passenger Information Signs in Rail Stations at the Massachusetts Bay Transportation Authority." *Transportation Research Record: Journal of the Transportation Research Board* 2419 (2014): 1-10

Lei and Thakiriah (2001) investigated the direct link between perceptions and attitudes in response to RTI and increased trips. In a stated preference study of Chicago found that 76.1% of responded that they would increase trips if RTI were implemented, with a stated average increase of 0.89 one-way trips per week. The authors acknowledge that the study was hampered by a small non-random sample size.[9]

Edison et al. (2011) study the impact on both perceived and actual wait time for bus riders in the Seattle using a OneBusAway, an RTI smart phone application. Researched both surveyed riders on perceived wait time while measuring objective wait time. The study found that riders with access to RTI decreased perceived wait time by 0.7 min (13% of actual wait time). Researchers found that actual wait time is reduced by almost an average of 2 min for people with RTI-access (For example, users "*routinely comment about their ability to grab a cup of coffee because they know there is a 10-min delay one particular day or that they should literally run to the stop because their bus is on time and they are running late.*"[10] Brakewood, Candace, Sean Barbeau, and Kari Watkins (2014), also found a 2 min reduced wait time for bus riders used smart-phone based RTI apps on Tampa area buses.[11]

While most studies look at short-term perception and ridership impacts of RTI implementation, Gooze, Wtakings, and Borning (2013), in a follow up to Edison et al. (2001 used a survey to determine user reactions after three years of experiences with RTI. They found that over 30% of users stated that they took 1-3 more trips as a result of RTI, but caution that the sample included users of OneBusAway that volunteered for the study. But, this study also found that the positive impacts of RTI are tied to its reliability. Users who found that RTI did not accurately reflect wait times reported lower satisfaction with the bus service overall and reduced trips.

[9] Information Systems Lead to Ridership Gain?." *Transportation Research Record: Journal of the Transportation Research Board* 2216 (2011): 67-74.
[10] Watkins, Kari Edison, Brian Ferris, Alan Borning, G. Scott Rutherford, and David Layton. "Where Is My Bus? Impact of mobile real-time information on the perceived and actual wait time of transit riders." Transportation Research Part A: Policy and Practice 45, no. 8 (2011): 839-848.
[11] Brakewood, Candace, Sean Barbeau, and Kari Watkins. "An experiment evaluating the impacts of real-time transit information on bus riders in Tampa, Florida." Transportation Research Part A: Policy and Practice 69 (2014): 409-422.

# Limitations of Existing Studies

## Who are the new transit riders?

One limitation of the ridership studies reviewed here is that intercept surveys of riders before and after RTI implementation is that different people are being surveyed as opposed to a random sample.[12] Conversely, studies that examine a given person's usage of transit both before and after RTI implementation often rely on stated preference to measure a change in the number of trips taken. Another limitation is that many studies take place soon after implemented changed, while multiple authors acknowledge that the impact of RTI may increase as people gain familiarity with the system.

## Limitations on New Riders

Various authors comment that limited gains in ridership associated with RTI implementation may be that the majority of existing transit users are transit dependent, and would not be likely to increase their trips solely due to improved RTI. This limitation increases in significance as RTI is acquired through smartphone apps.[13] Similarly, studies based on university shuttles systems also measure ridership among users who are unlikely to have other transportation options.

Studies have also shown that RTI can lead to larger increases in less-frequent users.[14] Increased ridership among commuters was small, but the research shows the potential of RTI to increase transit usage for household and leisure trips. Non-commuter increases were uneven across lines, and researchers hypothesize that higher traffic "main lines" may see larger increases. Overall research is needed to determine which riders are more likely to use transit with RTI, for what trip purpose, and on which lines.

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[12] Ibid.
[13] Ibid.
[14] Tang, Lei, and Piyushimita Thakuriah. "Will Psychological Effects of Real-Time Transit Information Systems Lead to Ridership Gain?." *Transportation Research Record: Journal of the Transportation Research Board* 2216 (2011): 67-74., Kamga, Camille, M. Anıl Yazıcı, and Abhishek Singhal. "Implementation of interactive transit information kiosks at New York City transit facilities: Analysis of user utilization and lessons learned." *Transportation Research Part C: Emerging Technologies* 35 (2013): 218-231.

# Conclusion

Multiple studies show ridership increases of up to 2% after the implementation of RTI technologies, controlling for other factors. Furthermore, much of literature demonstrates that RTI decreases actual and perceived wait times, which have been shown to be one of the greatest deterrents to transit use. Transit users can reduce actual wait time by 2 minutes by using smartphone-based RTI application. Furthermore, the perception of wait time is greatly reduced (though results depend on headways), and corresponding increase in transit use satisfaction can increase up to 20%. Overall, the research shows that real-time information can both increase ridership and improve the experience of existing users, at a relatively low cost to transit providers.

The research shows that providing high quality real-time information is a low-cost way to increase transit ridership, which in turn reduces GHG. In order to reach GHG reduction goals, transit agency should target RTI information to encourage new riders who would otherwise take trips by automobile. This can best be achieved through smartphone apps that allowed users to make mode choices before they arrive at the bus stop or transit station, and can save overall travel time be reducing wait time. Secondly, real time information can encourage transit ridership by reducing the uncertainty of wait time-one of the largest deterrent of transit usage-and has been shown to increase satisfaction with transit usage. While the research shows this is applicable to all forms of transit, RTI for bus travel will result in a higher ridership gain due to the comparatively uncertain arrival time of buses as opposed to train. Lastly, research shows that RTI achieves the largest transit usage increase on non-commute trips. As such, transit agencies can achieve the quickest gains in ridership by first targeting lines that are heavily used for leisure and household shopping.

California transit agencies vary greatly in the technology and design of their fare payment systems. Currently, seven fare payment systems based on smart card ticketing operate in the state. Four of these systems are regional, covering numerous agencies across a county or regional planning area, and three are restricted to a single transit agency. All seven systems are closed payment systems that can only process agency-issued fare media. However, the implementation of card readers compatible with international standards by Porterville Transit, Monterey-Salinas Transit and the Santa Cruz Metropolitan Transit District (the most recently-implemented systems), and the intention of agencies in the Los Angeles, San Francisco and San Diego areas to upgrade to account-based or (account- and standards-based) open architecture ticketing systems creates the potential for interoperability between smart card systems in the near future.

Four of California's major metropolitan areas have regional fare payment systems based on contactless smart cards. These are the Metropolitan Transportation Commission's Clipper Card (covering 21 transit agencies in the San Francisco Bay Area), the Los Angeles County Metro's Transit Access Pass or TAP (covering all 26 transit agencies in Los Angeles County), the Metropolitan Transit System's Compass Card (covering the two main transit[1] agencies in San Diego County) and the Sacramento Area Council of Government's Connect Card (covering nine agencies in the Sacramento area)[2]. All four systems coexist with cash fares and transfer passes.

The first three of the four metropolitan systems use software from Cubic Corporation. These include specially-designed computerized back office systems (MASS for Clipper Card[3] and NextFare Central for Los Angeles and San Diego[4]) for financial settlement and clearinghouse functions (e.g. validation) and MIFARE-based contactless cards[5] as the fare medium or mechanism of payment: Clipper Card uses Mifare Desfire while Compass Card and TAP use MIFARE Classic. The MIFARE technology can be characterized as "card-based" (in that information is mainly stored on the card, with shadow data available from a back office[6]) and "proprietary" in that it does not completely cohere to the international standards on contactless smart cards[7]. This means that expansion of these smart card systems can only occur through the

[1] https://www.sdmts.com/fares-passes/compass-cash
[2] See Figure 2 on page 5 for list of agencies participating in each of the 4 multi-agency fare payment systems.
[3] Lyne, Malcolm. "Clipper: The History of a Successful Systems Integration Project." 2011. http://www.apta.com/previousmc/rail/previous/2011/Papers/Clipper-Transition-Lyne.pdf
[4] See Figure 2.
[5]De Kozan, David. "NFC Solutions for Transit. June 4, 2014." https://www.securetechalliance.org/secure/events/20140602/dekozand.pdf
[6]However, Clipper Cards can be registered online. For more, see Birch, et. al. "Tomorrow's Transactions The Transit Reader." 2013. http://www.chyp.com/wp-content/uploads/2015/01/The-Transit-Reader.pdf
[7] Mifare classic cards used on TAP and compass seem to comply with certain components of ISO 14443 but are not fully compatible with ISO 14443-standard card readers. See Acumen Building Enterprise, Inc, United States.

installation of specialized hardware. It should be noted, however, that both Clipper Card[8] and Compass Card[9] are currently in the process of reviewing and soliciting bids for fare system upgrades (respectively). The former system wishes to incorporate more agencies and create an enhanced customer experience, while the latter seeks to replace aging hardware. Both systems are interested in transitioning to an account-based, open architecture model, with media that can be used for non-transit applications[10] or validators that can accept a variety of fare media. Moreover, in May 2017, the Los Angeles County Metro approved a contract modification with Cubic technologies, extending the company's contract (for the TAP card system) through the year 2024 on the conditions that Cubic upgrade the system to the cloud-based "Nextlink" model, illustrated in **Figure 1**[11], which stores customer information in a computerized account (rather than in a specific card). The account-based system will allow customers to pay for non-transit modes (including freeway toll lanes and bikeshare) with their transit account/fare media[12].

The Sacramento region's Connect Card system, on the other hand, uses hardware and software developed by INIT (Innovations in Transportation) Incorporated. These include ProxMobil passenger terminals (on light rail trains and busses), EVENDpc retail sales terminals, and a MOBILEvario sophisticated back-office fare management system[13]. The ProxMobil terminal is compatible with ISO 14443 A/B cards[14] used on smart cards nationwide. However, the fareboxes used to validate Connect Cards contain an additional level of encryption that is only compatible with the Agency-issued Connect Card (a Mifare Desfire product)--which receives the additional encryption when activated[15], making the system closed-loop[16]. The system is also card-based[17], with changes in data at the back office requiring a manual update of fareboxes.

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Federal Transit Administration, Transit Cooperative Research Program, Transit Development Corporation, & Booz Allen Hamilton. (2006). Smartcard Interoperability Issues for the Transit Industry (Vol. 115). Transportation Research Board.

[8] Clipper Executive Board Meeting Agenda. May 13, 2017. http://mtc.ca.gov/whats-happening/meetings/meetings-archive/clipper-executive-board-13

[9] "Fare Collection Update," Attachment C1 to Metropolitan Transit System Executive Committee Meeting-MINUTES. June 1, 2017. https://www.sdmts.com/sites/default/files/2017-07-13_ec_-_ada_save_as.pdf

[10] Ibid.

[11] Attachment B to Metro File No. 2017-0272. "Procurement Summary: Universal Fare System."

[12] *Wattenhoffer, Jeff. "Metro's TAP Card System is Getting Major Upgrade." https://la.curbed.com/2017/5/26/15701664/metro-tap-card-phone-pay-fare

[13] *MassTransit Mag. "Sacramento Partners with INIT for Electronic Fare Collection Solution." MAR 18, 2014 http://www.masstransitmag.com/press_release/10297095/sacramento-partners-with-init-for-electronic-fare-collection-solution

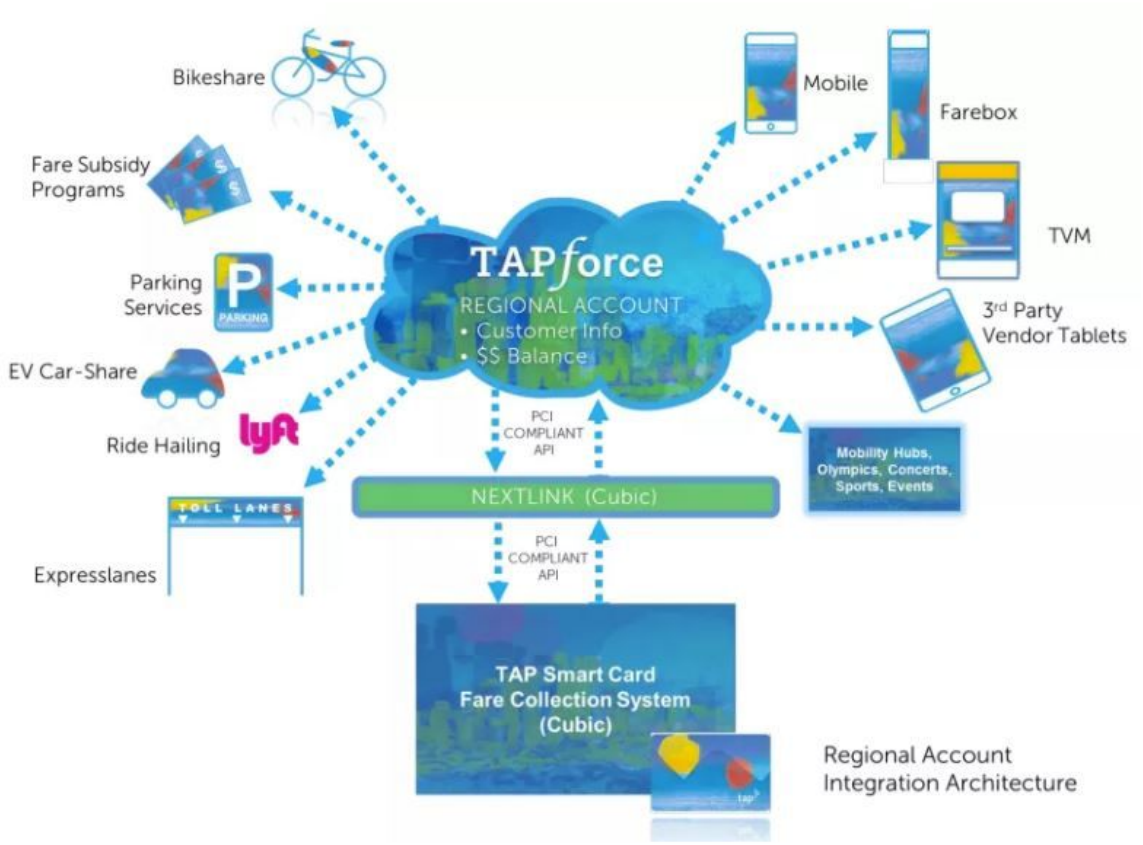
[14] *APTA Buyer's Guide. "INIT-Innovations in Transport". http://apta.officialbuyersguide.net/Mobile/Listing.asp?MDSID=ATA-147&AdListingID=980627

[15] C. Courtright, Personal Communication, September 19, 2017.

[16] "Seamless Fare Integration Study for Detroit Region." January 2015. https://www.michigan.gov/documents/mdot/SeamlessFareIntegrationStudyforDetroit_Region_510643_7.pdf

[17] C. Courtright, Personal Communication, September 19, 2017.

**Figure 1.** Illustration of Cloud-based "TAP 2.0" Ticketing System.




*Source: Curbed Los Angeles*

Outside of the main metropolises, the city of Porterville's Porterville transit currently uses Genfare's Fast Fare electronic farebox, that processes fare payments by both cash and the contactless "GoCard" smart card, an agency-issued fare media that can be registered and loaded online[18]. The farebox appears to be standards-based, with the capacity to read all ISO 14443-standard cards, NFC-enabled mobile phones, mobile barcodes and magnetic cards[19]. Currently, a "GoCard Mobile Ticketing" app allows customers to buy and store passes on a mobile platform and activate them prior to boarding (resembling a "flash pass" type of technology)[20]. However, the city is in the process of upgrading to the Genfare Link farebox, a cloud-based fare card reader that would accept smart cards and contactless bank cards. The

[18] Genfare (2016). Fast Fare Revolutionary Farebox. https://www.genfare.com/wp-content/uploads/2017/09/Genfare_Sell-Sheet_v9_farebox.pdf
[19] Ibid.
[20] Porterville Transit. "Fares and Passes". http://www.ci.porterville.ca.us/depts/PortervilleTransit/#section2

farebox would be account-based (with data stored in the cloud) and, likely open[21]. This makes Porterville Transit the most advanced system in California in terms of fare payment architecture.

Monterey-Salinas Transit also uses a Genfare Farebox. The agency issues its own contactless stored-value smart card, called the "Go Card," which can be reloaded at several outlets in the area: the agency gives a 10% discount to passengers using the card each time they reload[22]. The agency's farebox was jointly procured with the Santa Cruz Metro Transit District and Santa Clara VTA and at least at the time of purchase, the system's Smart Cards were interoperable with the former agency's fareboxes[23][24]. However, both Monterey-Salinas Transit and Santa Cruz Metro Transit District currently operate closed fare payment systems: Monterey-Salinas Transit's fareboxes only accept the agency's own GoCards and (magnetic stripe) paper passes[25], in addition to cash, and the Metro Transit District's fareboxes only accept contactless "Cruz Cards", disposable Magnetic Stripe Metro Passes, cash[26] and Clipper Cards issued through the VTA's Express EcoPass program[27].

In addition, a number of smaller transit agencies throughout the state have electronic fareboxes that are compatible with magnetic stripe fare cards, usually used for monthly or daily passes. These cards are the most basic non-cash fare and media, and relatively easy to procure, but have limited data storage and insufficient security.

My study of smart card-based transit fare payment systems throughout the state reveals the predominance of closed, proprietary and card-based systems. Although these characteristics ostensibly pose a structural roadblock to interoperability, recent upgrades of contactless fare card systems in the San Francisco and San Diego areas, the adoption of new fare card technology in the Sacramento area and the acquisition of mobile payment technology by operators across the state provide potential opportunities for convergence. Caltrans should coordinate with and build off of local agencies' efforts in developing an integrated statewide, multi-modal fare

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[21] Tuckett, Richard (August/September 2016). "Genfare links with Porterville Transit." BusRide. http://www.genfare.com/sites/default/files/BUSRide_Porterville_Field_Test.pdf
[22] Monterey-Salinas Transit (2017). "GoCard." https://mst.org/fares/gocard/
[23] PMC Consultants (December 2014). FYs 2011-2013 Triennial Performance of Monterey-Salinas Transit. http://www.tamcmonterey.org/wp-content/uploads/2015/09/FY2011_13-TDA-Performance-Audit-MST.pdf
[24] Agenda 12-5. MST Board of Directors April 2011 meeting. https://mst.org/wp-content/media/AprPacket-2011.pdf
[25] Monterey-Salinas Transit (2017). "Fares: Overview." https://mst.org/fares/overview/
[26] Santa Cruz Metro Transit District (2017). "Buy Passes Online." http://www.scmtd.com/en/fares/buy-passes-online
[27] Unclear as to whether the clipper cards are tapped to the fare reader. Santa Cruz Metro Transit District (2017). "Fares." http://www.scmtd.com/en/fares/fares

payment system.

**Figure 2: Card-based Electronic Transit Fare Payment Systems in California**

| Fare Program | Implementing Agency | Operable on | Technology and Design | Upgrade/Future Initiative |
|---|---|---|---|---|
| **TAP** | Los Angeles County Metro Transportation Authority | All 26 transit agencies in LA County[28] | Cubic technologies proprietary NextFare Central Back office, Mifare contactless card[2930]. | Recently approved an upgrade to cloud-based back office[31]. |
| **ClipperCard** | Metropolitan Transportation Commission | 21 agencies in the San Francisco Bay Area[32] | MIFARE Desfire Card, Cubic NextFare back office[33]. | Upgrade to Next generation of clipper. RFP process begins this year[34]. |
| **Compass Card** | San Diego MTS | San Diego MTS bus and light rail, NTCD busses, Coaster and Sprinter[35]. | Mifare Classic Card[36], Cubic farebox[37]. | Currently in processing of upgrading to new fare system (as old one near end of life. Considering Account-based processor, data warehouse back |

[28] Kudler, Adrian Glick (September 17, 2015). “There's Now One Card to Pay For Every Transit Ride in Los Angeles County.” https://la.curbed.com/2015/9/17/9920332/tap-card-los-angeles-county
[31] Attachment B to Metro File No. 2017-0272. “Procurement Summary: Universal Fare System.” file:///C:/Users/Huff/Downloads/Attachment%20B%20-%20Procurement%20Summary.pdf
[29] Williams, Andy. “Cubic Receives transit contracts for central computer and clearinghouse integration for Los Angeles region.” 14 April, 2005. https://www.secureidnews.com/news-item/cubic-receives-transit-contracts-for-central-computer-and-clearinghouse-integration-for-los-angeles-region/
[30] EE Times (6/1/2009). “L.A. Metro Taps NXP's MIFARE Plus for Contactless TAP Ticketing”. http://www.eetimes.com/document.asp?doc_id=1276540&page_number=2

[32] Goodwin, John (Monday, April 3 2017). Clipper Expands to Union City Transit. https://mtc.ca.gov/whats-happening/news/clipperr-expands-union-city-transit
[33] Lyne, Malcolm (2011). “Clipper: The History of a Successful Systems Integration Project.” http://www.apta.com/previousmc/rail/previous/2011/Papers/Clipper-Transition-Lyne.pdf
[34] Rudlick, Roger (February 2017). “Clipper Update and the Potential to Rationalize Fares.” http://sf.streetsblog.org/2017/02/14/clipper-update-and-the-potential-to-rationalize-fares/
[35] San Diego Metropolitan Transit System (2016). “Compass Card.” https://www.sdmts.com/fares-passes/compass-card
[36] De Kozan, David (June 4, 2014). NFC Payment Solutions for Transit: Easing Regional Mobility. Presentation. https://www.securetechalliance.org/secure/events/20140602/dekozand.pdf
[37] San Diego Metropolitan Transit System Board of Directors — Minutes. April 14, 2016. https://www.sdmts.com/sites/default/files/2016-04-14_board_0.pdf

| | | | | |
|---|---|---|---|---|
| | | | | office, smart phone validators[38] |
| **Connect Card** | Sacramento Area Council of Governments (SACOG) | Sacramento Regional Transit (light rail and bus), El Dorado Transit, Etran, Folsom Stage Line, Placer County Transit, Roseville Transit, SCT/Link, Yolobus, Yuba-Sutter Transit [39]. | INIT ProxMobil passenger terminal, with MOBILevario back office processing system and Mifare Desfire card. Farebox and card ISO 14443 compliant but data encrypted, stored on card[40]. | |
| **Go Card** | Monterey-Salinas Transit | Monterey-Salinas Transit | Genfare Odyssey Farebox (ISO 14443 compliant but closed[41]) | |
| **Cruz Card** | Santa Cruz Metro Transit District | Santa Cruz Metro Transit District | Genfare Odyssey farebox (unspecified, ISO 14443 compliant technology but closed[42] ). | |
| **GoCard** | Porterville Transit | Porterville Transit | Genfare Fast Fare Farebox (ISO 14443 compliant[43]) | Installing Genfare Link system: Stores data in cloud (rather than farebox) and updates from back-office-server[44]. |

[38] San Diego Metropolitan Transit System (July 13, 2017). "Fare Collection Update," Attachment C1 to MTS Executive Committee Meeting-MINUTES. June 1, 2017. https://www.sdmts.com/sites/default/files/2017-07-13_ec_-_ada_save_as.p
[39] Connect Transit Card (2017). Connect Card: It's Here! https://www.connecttransitcard.com/Pages/HowItWorks
[40] C. Courtright personal communication.
[41] Monterey-Salinas Transit (2017). "Fares: Overview." https://mst.org/fares/overview/
[42] Model based on 2012 joint procurement mentioned in: http://www.tamcmonterey.org/wp-content/uploads/2015/09/FY2011_13-TDA-Performance-Audit-MST.pdf
[43] Genfare (2016). Fast Fare Revolutionary Farebox. https://www.genfare.com/wp-content/uploads/2017/09/Genfare_Sell-Sheet_v9_farebox.pdf
[44] Tuckett, Richard (August/September 2016). "Genfare links with Porterville Transit." BusRide. http://www.genfare.com/sites/default/files/BUSRide_Porterville_Field_Test.pdf

# Encourage Transit-Supportive Congestion Pricing in California's Most Gridlocked Areas

**Only dynamic pricing can achieve *and* maintain congestion relief in California's most gridlocked, economically productive areas. How and to what extent California chooses to price and manage motor-vehicle use will determine transit's future role in the state.**

When deciding which mode to use for a given trip, travelers generally consider the generalized marginal cost: they compare the time, monetary, and uncertainty costs of using each for that particular trip. When deciding whether to drive their car, travelers usually do not consider the fixed and sunk costs of purchase, insurance, and maintenance, and focus mostly on the travel time and variability, fuel, and any tolls or parking costs. For transit, travelers typically weigh the costs of fares and the uncertainty of transfers and waiting much more heavily than the in-vehicle time.[1] As a result, most auto owners view the time, monetary, and uncertainty costs of auto travel as lower than those of transit travel, even if their total costs of vehicle ownership and use are much higher — unless the trip entails significant toll and/or parking costs.[2] The result is to make personal auto travel appear more attractive.

Thus, for most travelers the decision of whether to use transit is intimately tied to the out-of-pocket costs of driving: gas, tolls, and parking. If those out-of-pocket costs are low, transit use tends to be low; when they go up, so does transit ridership.

This is important because private vehicle usage produces extensive negative externalities; that is, costs imposed on others that are not borne by the driver. Some of the most significant externalities produced by vehicle usage include roadway congestion, the risk of crashes, the cost of building and maintaining roadway infrastructure, greenhouse gas emissions, and air, soil and water pollution. However, it is possible to mostly internalize external costs through the use of pricing, which has been shown to significantly influence driving and transit use.[3]

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[1] Iseki, H., Smart, M., Taylor, B. D., & Yoh, A. (2012). Thinking outside the bus. *Access Magazine*, *1*(40).
[2] Harvey, G. W. (1994). Transportation pricing and travel behavior. Transportation Research Board Special Report, (242). Chicago
[3] Anas, A., & Lindsey, R. (2011). Reducing urban road transportation externalities: Road pricing in theory and in practice. *Review of Environmental Economics and Policy*, *5*(1), 66-88.

Among these externalities, traffic congestion is especially acute because millions of people experience it daily. The aim of vehicle pricing is not punitive, but rather to increase efficiency, efficacy, and equity of the road network. Pricing roadway use increases efficiency and smooths traffic flows by shifting when, where, and how people travel. Pricing fuel increases efficacy by encouraging the use of cleaner vehicles and other modes that reduce emissions per mile traveled. And pricing the use of roadways and parking spaces increases equity by charging people in proportion to the social and environmental costs their choices impose on society, encouraging them to make choices that have fewer societal impacts.[4] By smoothing traffic flows, pricing can actually move *more* people, and in some cases more vehicles, but with less wasted time and lower emissions.[5]

Pricing negative externalities from private vehicle usage through roadway tolling, cordon tolling, fuel and energy taxes, vehicle-miles or vehicles-hours charges, parking charges, or other means, has been shown to alter the demand for solo driving, making carpooling, cycling, walking, and transit use more attractive in the process. London, Singapore, and Stockholm have used pricing to achieve success with reduced congestion, better transit-schedule adherence, and increased transit ridership.

Pricing can help travelers identify the costs of their private automobile use and weigh those costs against the benefits. This, in turn, reduces many of the external costs that private automobile use currently imposes on common infrastructure. In particular, the congestion caused by private vehicle slows transit vehicles and limits the effectiveness of transit service.[6] Consequently, a transit-supportive roadway pricing program could both make transit travel more reliable and attractive, as well as significantly increase funding for transit and other socially desirable mobility options.

Revenues from pricing could be used for any purpose identified by the State, could be distributed to local governments that host priced facilities, used to increase funding for transit and other alternatives to solo driving, or directed to other mobility programs that will help the State to meet its transportation, climate, and equity goals.

[4] Schweitzer, L., & Taylor, B. D. (2010). Just road pricing. ACCESS Magazine, 1(36).
[5] Verhoef, E. T. (2005). Speed-flow relations and cost functions for congested traffic: Theory and empirical analysis. Transportation Research Part A: Policy and Practice, 39(7), 792-812.
[6] Costly bottleneck expansion projects in built-out urban areas command an increasing share of state and local transportation funding, with increasing revenues coming from general taxes rather than transportation user fees

## Enhanced transit service is an essential complement to automobile pricing

Pricing automobile use has important benefits to, and implications for, transit. In general, pricing moderates demand for peak-hour demand of roadway facilities, as prices serve to encourage people to drive only when their personal benefit from the trip exceeds society's cost to accommodate the trip. Where pricing is in place, and when prices exceed the value of a car trip to the user, the would-be driver will choose different routes, different travel times, and/or different modes of travel. The benefit to transit is that the consequent reduction in congestion on roadways means transit vehicles can operate more quickly (reducing the number of vehicles needed to maintain headways) and more reliably adhere to their schedules (improving rider satisfaction).

While pricing provides an impetus for travelers to consider their travel options more carefully, pricing roadway use on its own is not enough to manage overall travel demand. More and enhanced transit service (as well as other modal options) will be needed to provide a meaningful travel choice to travelers who have opted not to drive alone, so as not to inhibit Californians' mobility. With enhanced transit and roadway pricing in place, a "virtuous cycle" emerges whereby pricing reduces the demand for driving and allows for better and faster transit operations. With greater reliability and faster speed, transit is then able to attract more riders and serve them more efficiently. To capture rising demand and serve as an alternative, transit service needs to be enhanced and expanded. Congestion pricing revenues should be used to fund this expansion. Pricing can also enable urban, transit-friendly places to grow more dense without choking on traffic.

Transit agencies, regional planners, and State officials will need to pay careful attention to take full advantage of the opportunities afforded to transit by automobile pricing. The State should encourage any congestion pricing systems (on highways or in cordoned areas) to be dynamically priced so that congestion can be more effectively managed through prices that correspond to real-time demand and provide better, more reliable travel times for toll-payers (and transit users). Transit agencies and regional planners should work together to ensure that key transit routes are apply served in areas targeted for congestion relief. Transit agencies can then make improvements in service frequency and quality to provide attractive alternatives to the private automobile in, around, to, and from congestion-tolled areas. In order to fund these needed improvements, State and regional planners should ensure that a share of automobile-pricing revenues is allocated to transit agencies that serve the priced and complementary corridors.

## Automobile pricing in California today

California currently prices automobile usage through:

- Bridge and highway tolling
- High-occupancy toll (HOT) lanes, known as Express Lanes or value-pricing
- Motor vehicle fuel taxes and fees
- Annual registration and vehicle licensing fees[7]
- Municipal parking charges

Revenues collected via these sources provide only a partial share of the funds needed to maintain the State's automobile infrastructure, and do not offset other external costs.[8] The State's cap-and-trade program prices greenhouse gas emissions from motor vehicle fuels and therefore partly offsets the external costs of climate change emissions from private vehicles.[9] Other externalities of auto travel, however, such as congestion and noise, remain largely unpriced (and are effectively subsidized).

Road pricing in California is more common than many might imagine. AB 194 (2015) amended the Streets and Highways Code to allow RTPAs and Caltrans to apply to the California Transportation Commission to develop and operate high-occupancy toll (HOT) lanes. Before this bill, tolling authority was only granted through specific legislation. The bill facilitates the process for counties and regions that wish to implement new high-occupancy toll lanes. Tables C12-1, C12-2, and C12-3 below summarize existing congestion-priced roadways and plans for the future.

**Table C12-1: Existing Automobile Congestion Pricing in California**

| Region | Examples |
|---|---|
| **MTC** | Express Lanes (HOT): I-580, I-680, CA-237<br>Variable Bridge Tolls: San Francisco - Oakland Bay Bridge |
| **SANDAG** | Express Lanes: I-15 |
| **SCAG** | Express Lanes: I-10 HOT, I-110 HOT, CA-91 HOT<br>Toll roads with fixed peak surcharges and off-peak discounts: CA-73, CA-133, CA-241, CA-261 |

**Table C12-2: Automobile Congestion Pricing in State Planning Documents**

[7] California is also exploring mileage-based usage fee through a limited pilot program.
[8] Section 1 of SB 1 (2017) identifies a $137 billion 10-year shortfall and proposes $52 billion towards that shortfall. General revenue sources — like general obligation bonds retired from general revenues, or transportation sales taxes levied by counties — form an increasing share of funding for transportation.
[9] The U.S. EPA estimates the social cost of carbon dioxide at $36 or greater per metric ton (https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html). California's August 2017 auction priced carbon dioxide at $14.75 per metric ton.

| | |
|---|---|
| **Caltrans Smart Mobility Framework (2010)** | Pricing of parking and roadway capacity included as a "likely priority" for urban centers (p. 33). |
| **Proposed 2017 Climate Change Scoping Plan Update** | Explores, as a "potential additional action", "developing pricing mechanisms such as road user/VMT-based pricing, congestion pricing, and parking pricing strategies." |
| **California Transportation Plan 2040 (2016)** | Explores road user charges and congestion pricing; models an increase in urban area automobile operating costs designed to simulate a theoretical urban county congestion fee. The urban congestion pricing charge would increase vehicle operations costs by an average of 16 cents per mile on top of anticipated statewide increases in vehicle operations, maintenance, fuel, and user costs of 16 cents per mile. |
| **Caltrans System Plan for Managed Lanes on California State Highways (2016)** | A report that summarizes the likely expansion of managed lanes (HOV, HOT, ExpressLane) in California due to their improved performance, a desire to shift travel demand to transit, and as regional and county agencies respond to funding constraints. |

**Table C12-3: Congestion-based Automobile Pricing in Regional Transportation Plans**

| | |
|---|---|
| **SCAG 2016 Regional Transportation Plan** | • Regional expansion of Express Lanes, including I-10, I-15, I-105, I-405, and I-605<br>• Plans cordon pricing demonstration projects (100 Hours Project) |
| **MTC Plan Bay Area 2040 (2017)** | • Expansion of Express Lanes throughout the region<br>• Cordon pricing zone in downtown San Francisco |

## Automobile pricing options

Pricing driving in California so that more external costs are borne by drivers will reduce pollution, greenhouse-gas emissions, congestion, and the need for costly automobile infrastructure; and will increase the mode share of high-occupancy vehicles, transit, walking, and bicycling.

Various options exist for improving automobile pricing in California. Table C12-4, below, assesses whether each option can:

- Remove transit from traffic congestion and increase vehicle speeds and reliability.
- Encourage transit ridership by increasing the relative attractiveness of transit.
- Be technically feasible for widespread implementation.
- Be equitable for rural areas, which typically lack meaningful transit alternatives.

**Table C12-4: California's Options for Pricing Motor Vehicle Use**

| Pricing Mechanism | Removes transit from congestion? | Encourages transit ridership? | Technically feasible? | Equitable for rural areas? |
|---|---|---|---|---|
| 1. Gas tax increases | ✘ | ✔ | ✔ | ✘ |
| 2. VMT charges | ✘ | ✔ | ✔ | ✘[10] |
| 3. Vehicle-hours-traveled charges | ✘ | ✔ | ✘ | ✘ |
| 4. **Expanded Express Lanes program** | ◑[11] | ◑[12] | ✔ | ✔ |
| 5. **Local cordon-area tolling** | ✔ | ✔ | ✔ | ✔ |
| **All-lane highway tolling** | ◑[8] | ✔ | ✔ | ✔ |
| **Comprehensive congestion tolling** | ✔ | ✔ | ? | ✔ |
| **Demand-based on-street parking pricing** | ◑[13] | ✔ | ✔ | ✔ |

[10] Assumes a mileage charge is additional to motor vehicle fuel taxes. Rural travelers are better off than urban travelers when motor vehicle fuel taxes are replaced by VMT fees that use the same rate in urban and rural areas. Rural drivers drive more miles than urban drivers, but typically in vehicles which are older and less fuel efficient (because they are larger). Weatherford, B. (2011). Distributional implications of replacing the federal fuel tax with per mile user charges. *Transportation Research Record: Journal of the Transportation Research Board*, (2221), 19-26.
[11] Only 13.5% of California's transit vehicle revenue miles traveled are on commuter buses and vanpools which could use managed lanes.
[12] Only 1.4% of California's transit trips and 7.5% of passenger miles traveled are on long-distance commuter bus and vanpool services which might utilize managed lanes.
[13] Demand-based parking pricing like SFPark and LA Express Park can reduce surface street congestion and a desire to avoid the charge can increase demand for alternatives to private automobile travel (including transit). However, these are both second-order effects, would not be universal, and are limited by the impacts of a vast off-street private parking supply.

The first three options could impose disproportionate costs on rural areas, where low population density and higher average vehicle speeds mean that external costs are lower per mile traveled or per unit of energy consumed. Alternatives to single-occupant vehicle travel are also less robust in rural areas. The third option, vehicle-hours-traveled charges, also poses logistical implementation challenges and may be politically unpalatable due to the unpredictability of charges (since travel time cannot be known with certainty in advance). The seventh option, comprehensive congestion tolling or what economists refer to as "first-best" congestion tolling, has more substantial political, technological, and practical challenges for implementation and therefore is not considered here. The eighth option, demand-based on-street parking pricing, applies only to on-street parking, and depending on implementation may not remove transit vehicles from congestion.

The remaining three options, expanded Express Lanes, cordon-area tolling, and all-lane highway tolling, are more equitable for rural areas, more supportive of transit, and are technically-feasible. These three are explored further below.

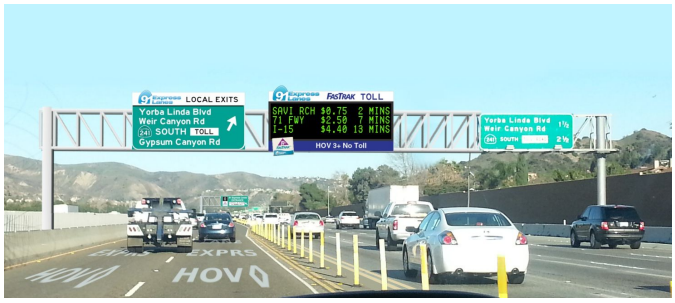
## Highway-based congestion tolling

### Expanded Express Lanes program

An expanded Express Lanes program, as envisioned by the System Plan for Managed Lanes on California State Highways, would implement HOT lanes across more of California's highways system, targeting the most congested roadways and regions.

While Express Lanes provide benefits to certain lower-capacity long-distance forms of transit such as express buses, commuter services, and vanpools, they are often not conducive to high-capacity local transit services due to the inherent design requirements that separate HOT lanes from freeway entry and exits (with multiple general purpose lanes in-between) and make it difficult for transit vehicles to access them. Although direct access to HOT lanes is possible with purpose-built ramps and level-separations, such improvements require more space than is often available, and can be cost-prohibitive. Implementing these transit-supportive elements will likely require higher initial capital costs.

The increased speeds of Express Lanes make express bus services that operate between suburbs and downtowns



attractive and may increase ridership on those low-capacity services, but Express Lanes' effects on ridership within a freeway corridor are limited except in certain cases where transit stops can be located adjacent to the freeway, with easy access for passengers to board, alight, and wait. Most freeway designs and contexts are not conducive to providing the types of facilities that provide passengers with a useful, safe, and reasonably comfortable station area, and therefore have constrained ridership expansion potential. Foothill Transit's Silver Streak is a notable exception, and an example of a service that operates as a collector commuter bus and then as an express on a HOT corridor. It serves several stops on freeway ramps, and exits the freeway to serve adjacent transit centers, one of which has a recently-built nearby housing TOD.

### All-lanes highway congestion tolling

All-lanes highway congestion tolling would entail pricing some the State's freeways with either incremental charges at periodic tolling stations, or distance-based tolling assessed based on freeway entry and exit points for each vehicle. The Toll Roads in Orange County offer an example of all-lanes highway congestion tolling, though with pricing that is less dynamic than with current HOT facilities.[14]

As is already done at existing HOT facilities, specific prices could vary by vehicle type (with heavier vehicles paying more) by with time of day and day of week (with more congested time periods having higher costs). Time-of-day charges could be set in advance based on historical congestion levels or could be adjusted in near-real time (e.g., every 5 minutes) based on actual congestion. Prices could be set so as to achieve a target free-flow traffic speed on freeways, such as 45 miles per hour. During low-demand periods, highway usage could be unpriced (free). With a sufficiently advanced system, prices could be adjusted so as to virtually eliminate congestion, except in the case of vehicle crashes, when refunds could be provided to motorists for getting stuck in traffic.

All-lanes highway congestion tolling would be most effective when implemented across all freeways (and potentially expressways or other major highways) in a given region. This would have the effect of pricing all long-distance automobile travel, since long-distance travel on lower-speed facilities is usually unattractively time-consuming. Such a program could thereby reduce congestion for transit on both freeways and on surface streets and increase demand for transit—especially for longer distance services during peak-pricing periods, such as the morning and evening peak commute hours and weekend and holiday travel periods—all while generating

[14] CA-73, CA-133, CA-241, CA-261 offer fixed peak surcharges and off-peak discounts

revenues which would not need to fund costly HOT lanes infrastructure and which could therefore fund significant transit service expansion.

## Cordon-area congestion tolling

In contrast to freeway tolling, cordon-area tolling programs price all roadways in a geographic area. Once a tolled area is defined (its borders are the "cordon"), vehicles must pay either:

1. once for every entry into the tolled area;
2. once for every crossing of the cordon, whether entry or exit; or
3. a single daily fee for the right to drive in and out of the cordon area.


Due to this structure, cordon-area pricing works best when cordons encompass single or multiple adjacent neighborhoods rather than entire large cities or county subregions. However, multiple, adjacent or nearby cordon areas could also be established. Tolls could be adjusted to achieve a target maximum number of vehicles within the cordon area, a target free-flow speed on select surface streets within the cordon area, or target queue lengths or vehicle wait times at select intersections within the cordon area.

While forms of cordon pricing have been established in cities around the world, such as London, Stockholm and Singapore, efforts to implement cordon pricing in the United States have met with significant political resistance.[15] Cordon pricing will likely be most attractive in areas of

[15] http://articles.latimes.com/2008/dec/30/local/me-sanfrancisco-traffic30 http://roadpricing.blogspot.com/2010/12/san-francisco-congestion-pricing-debate.html Wachs, M. (1994). Will congestion pricing ever be adopted?. ACCESS Magazine, 1(4).; Roth, M. (2010). Congestion Pricing Fracas Shows Lamentable Ignorance of Facts. Streetsblog San Francisco http://sf.streetsblog.org/2010/12/03/congestion-pricing-fracas-shows-lamentable-ignorance-of-facts; Snyder, T.(2013). Confronted with Congestion Pricing, People Clamor for Transit, Gas Tax. Streetsblog USA usa.streetsblog.org/2013/01/24/confronted-with-congestion-pricing-people-clamor-for-transit-gas-tax/

California with the greatest congestion on surface streets where walking, bicycling, and transit are robust mobility options. [16]

**Table C12-5: Summary of Transit-supportive Tolling Options**

| | Expanded ExpressLanes | All-lanes highway congestion tolling | Cordon-area tolling |
|---|---|---|---|
| **System design** | • Add HOT lanes to existing freeways<br>• Toll single-occupant vehicles in HOT lanes with variable congestion- and distance-based charges.<br>• Adjust prices dynamically to achieve reliable 45+ mph speeds. | • In congested regions, price all freeways and highways with variable congestion- and distance-based charges.<br>• Adjust prices dynamically to achieve reliable 45+ mph speeds. | • Establish cordon tolling in high-congestion areas<br>• Levy tolls for entry, exit, and/or daily driving privileges within designated cordoned areas, neighborhoods and downtowns |
| **Transit Performance Improvement** | • Significant for transit routes operating on HOT lanes for long, uninterrupted distances.<br>• No improvement for other services. | • Significant performance improvement and cost reduction in transit operations on tolled highways.<br>• More modest improvements on nearby streets. | • Substantial performance and cost reduction in transit operations within cordon pricing zones.<br>• More modest improvements for operations on corridors leading to/from cordon areas. |
| **Transit Ridership Benefit** | • Largely limited to services utilizing HOT lanes during peak demand periods. | • Increased medium- and long-distance transit ridership due to toll avoidance. | • Increased transit ridership to, from and within cordon pricing zones due to toll avoidance. |
| **Transit Funding Benefit** | • Revenues may fund transit | • Revenues may fund increased transit | • Revenues may fund increased transit |

[16] See SCAG's Express Travel Choices Study Phases 1 and 2. Available at http://transfin.scag.ca.gov/Lists/Express%20Travel%20Tabs/AllItems.aspx

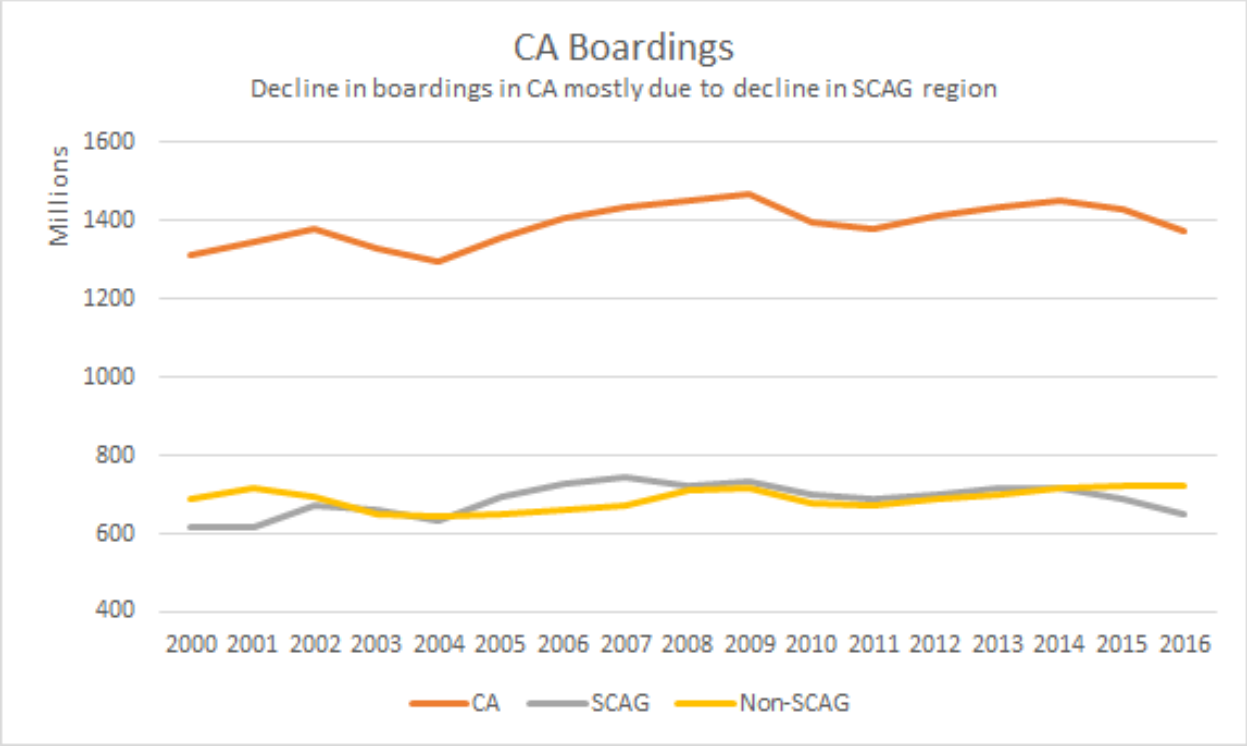
| | | | |
|---|---|---|---|
| | service utilizing HOT lanes. | service. | service. |
| **Effects on complementary modes** | • Expanded highway facilities and direct access ramps may decrease attractiveness of walking and bicycling. | • Increased demand for shorter trips that may be feasible by walking or bicycling.<br>• Revenues can fund improvements to pedestrian and bicycle infrastructure. | • Increased walking and bicycling within cordon areas.<br>• May catalyze road diets and improvement of pedestrian and bicycle infrastructure in and around cordon areas.<br>• Revenues can fund improvements to pedestrian and bicycle infrastructure. |

## Are Current Patronage Declines Cyclical or Long-Term?

In individual interviews with Advisory Committee members (described in the Stakeholder Engagement Report), transit professionals expressed concern that the downward trend in ridership is not cyclical but rather a long-term phenomenon that will continue to result in declining market share for transit unless dramatic steps are taken.

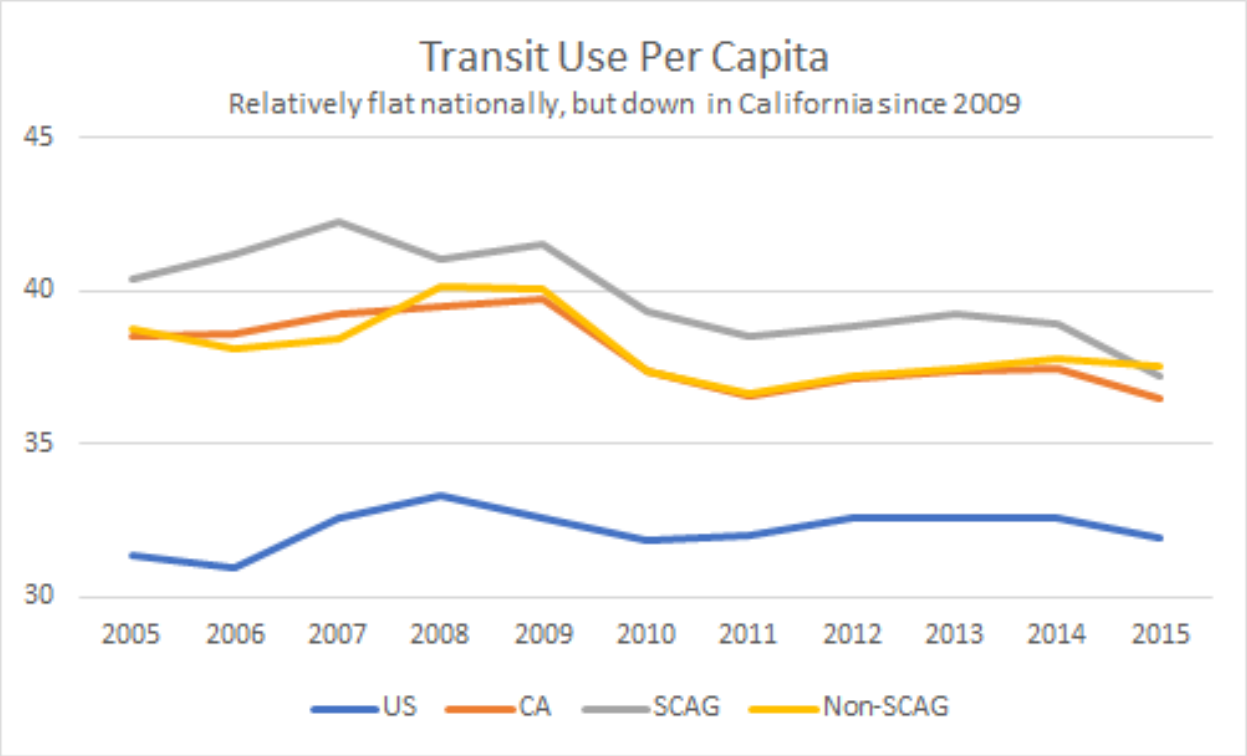
Transit use nationwide generally increased through the first decade of the 21st century, but has been more volatile since then. In California, transit patronage dipped during the depths of the Great Recession, particularly in 2010 and 2011, only to recover between 2012 and 2014. But since 2014, transit use has declined sharply, driven mostly be steep drop in transit use in Southern California — and in particular on some of the Southland's most heavily patronized rail and bus routes.

**Figure C13-1: California Transit Boardings in and Outside of SCAG**




In contrast to the absolute transit ridership trends show above, transit use per-capita trends show transit use trends controlling for changes in population. In general, transit use per capita has declined over the past decade across the U.S., in California, and particularly in the Southern California (SCAG) region as shown in Figure C13-2.

**Figure C13-2: Transit Use Per Capita**




What's causing transit patronage to erode so alarmingly over the past few years? Arguments offered by various observers include:

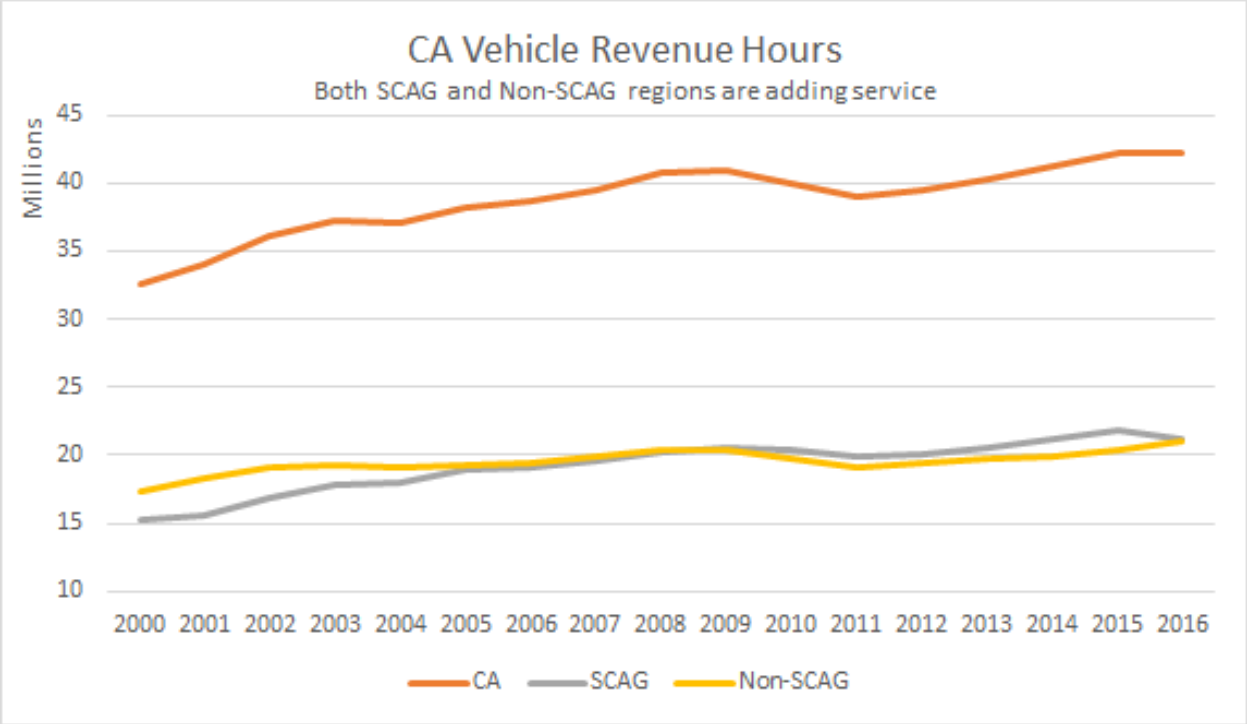
1. cuts in transit service,
2. falling gas prices,
3. increasing auto ownership,
4. more driving by immigrants, and
5. new services like Lyft and Uber.

We briefly consider each of these in turn, with a particular focus on Southern California where patronage losses have been steepest.

## Is it due to falling transit service?

*Not really*. The figure below shows California trends in vehicle hours of transit service since 2000. In general, overall service levels have been climbing. Transit service dipped noticeably with the onset of the Great Recession in 2009, but has been gradually increasing since 2011, except for some very recent service cuts in the SCAG region that followed, not led, a decline in ridership that began two years earlier.

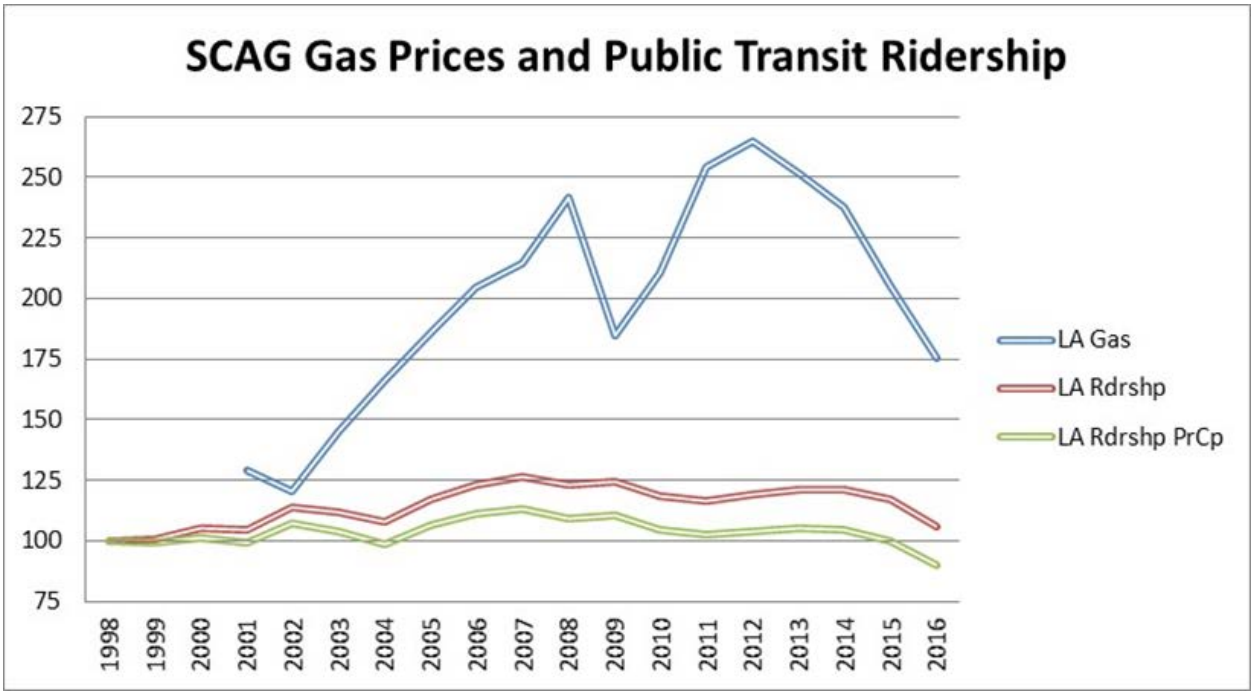
**Figure C13-3: California Vehicle Revenue Hours**




## Is it due to low gas prices?

*Probably somewhat*. The figure below compares trends in gas prices and transit use in Southern California (excluding San Diego), which indicates a correlation – albeit a relatively weak one – between fuel prices and transit trips. Note, however, that per capita transit use in Southern California declined between 2009 and 2012, when fuel prices increased dramatically, which suggests that other, more influential factors, were at play.

**Figure C13-4: Gas Prices and Public Transit Ridership**




## Is it due to increasing vehicle ownership?

*This is almost certainly the biggest factor*. The single best predictor of whether a traveler uses public transit for a given trip is whether that person is licensed to drive and has a personal vehicle available for that trip. Put simply, people who live in households with no vehicles or with more drivers than vehicles tend to be the most frequent and reliable transit users.
I The table below shows the percentage change in zero-vehicle and auto-deficit households between 2000 and 2015 in Southern California (excluding San Diego) and paints an unambiguous picture: Auto access has increased – dramatically – which auspiciously suggests rising incomes in these households, but also significant erosion of Southern California's most reliable transit users.

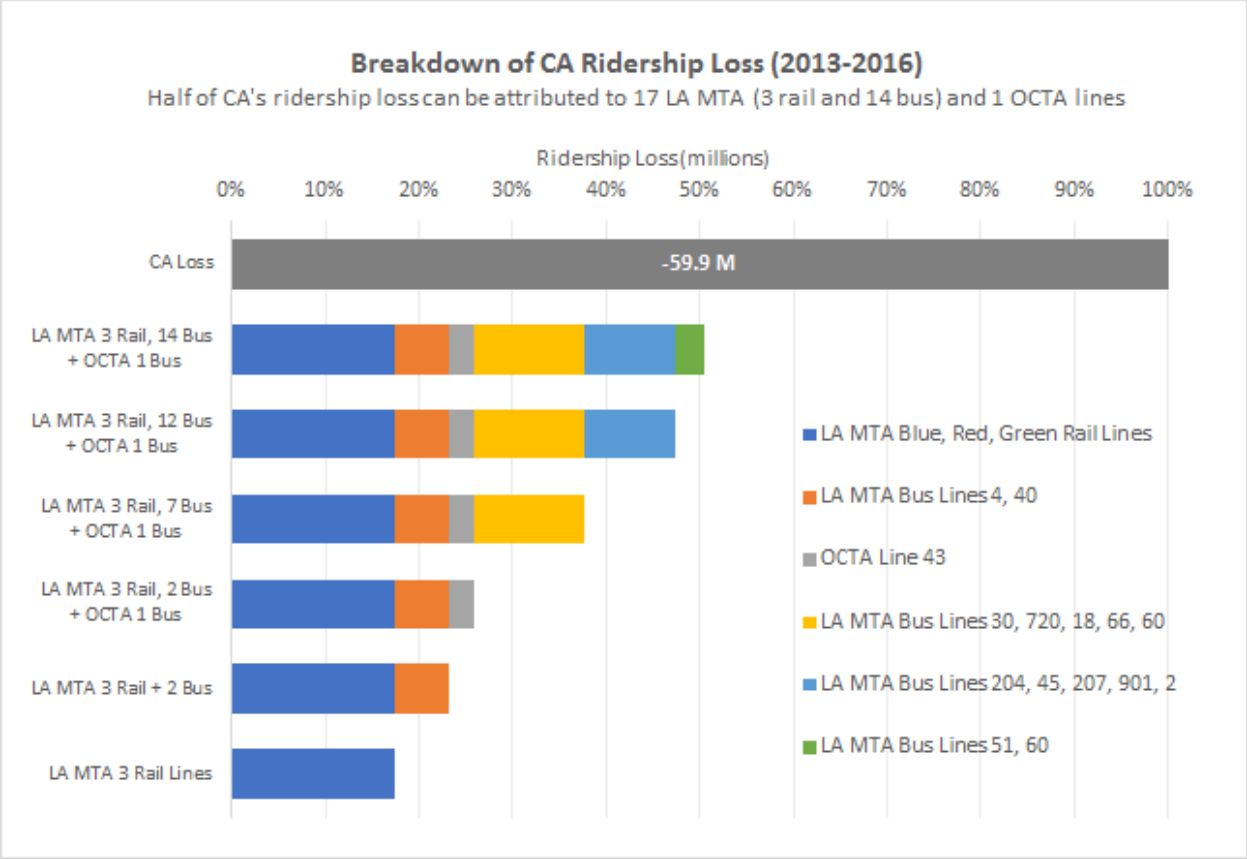
**Table C13-2: Dramatic Declines in Low Auto Access Households in the SCAG Region between 2000 and 2015**

| | |
|---|---|
| *Among All Households* | |
| Households with no vehicles | - 46% |
| Vehicle deficit households | - 16% |
| *Among Foreign-Born Households* | |
| Households with no vehicles | - 52% |

| | |
|---|---|
| Vehicle deficit households | - 23% |
| *Among Mexican Foreign-Born Households* | |
| Households with no vehicles | - 66% |
| Vehicle deficit households | - 28% |

Further, the figure below shows the remarkable geographic concentration of transit patronage declines in California since 2013. More than a quarter of all of the 60 million lost California transit riders between 2013 and 2016 were on three LA Metro Rail lines, two LA Metro bus lines, and one OCTA bus line. Further, over *half* of California's total lost ridership losses were on 17 LA Metro and one OCTA bus line. These routes have all been among the most heavily patronized lines on these Southern California systems, running through many of the region's lowest income and highest immigrant neighborhoods.

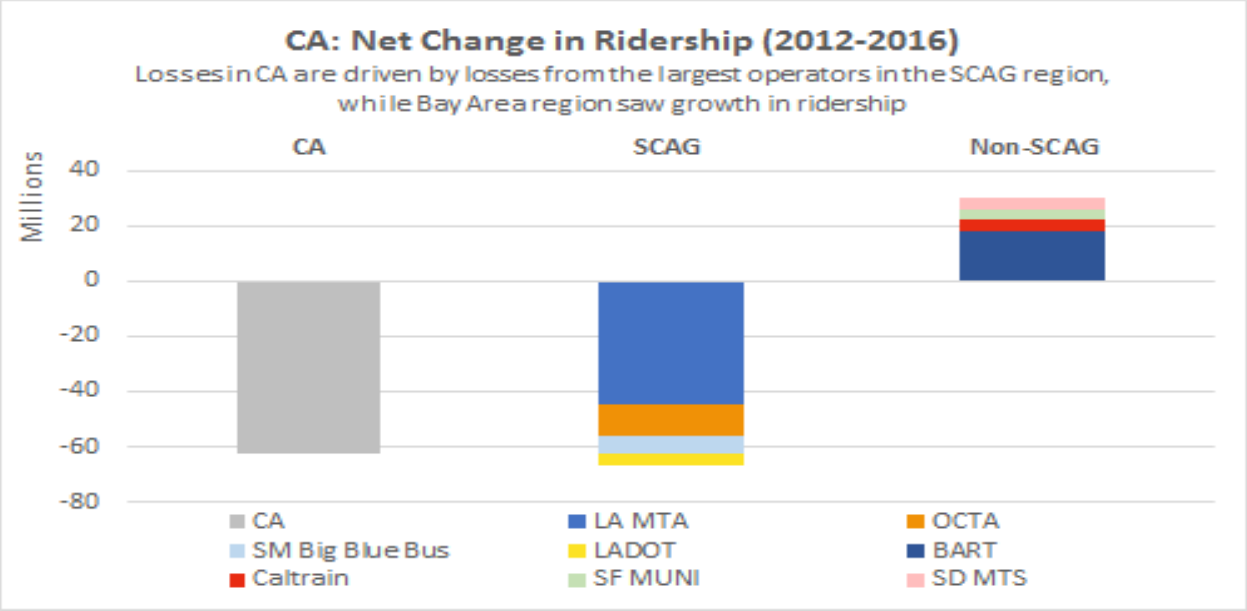
**Figure C13-5: Breakdown of Transit Ridership Losses in California**




At the same time, ridership in California outside the SCAG area actually increased 20 percent in the years 2012-2016, due mostly to gains in the Bay Area (see figure below). Ridership on Bay

Area Rapid Transit (BART) services alone accounted for 28.4 percent of the state's increased transit ridership. (By 2017, however, BART ridership had also started to decline.)

**Figure C13-6: Net Change in Ridership in California**




## Is it due to more driving by immigrants?

*Yes, this too.* As noted above, transit is heavily used by immigrants, particularly during their first years in the U.S. But immigration has slowed and shifted in recent years[1], which may be reducing the supply of new transit riders. As immigrants assimilate, they are more likely to shift from transit to driving over time .[2] In addition, more recent immigrants to the U.S. tend to be more affluent than those who arrived in the late 20th century, and less likely to be heavy transit users on arrival as a result.[3] Further, California and some other high-immigrant states have

[1] U.S. Department of Homeland Security (2000). 2000 Yearbook of Immigration Statistics. Washington, DC: Office of Immigration Statistics.; U.S. Department of Homeland Security (2015). 2015 Yearbook of Immigration Statistics. Washington, DC: Office of Immigration Statistics.

[2] Blumenberg, E., & Evans, A. E. (2010). Planning for demographic diversity: the case of immigrants and public transit. Journal of Public Transportation, 13(2), 2.; Chatman, D. G., & Klein, N. (2009). Immigrants and travel demand in the United States: implications for transportation policy and future research. Public Works Management & Policy, 13(4), 312-327.; Myers, D. (1996, April). Changes over time in transportation mode for the journey to work: Aging and immigration effects. In Conference on Decennial Census Data for Transportation Planning sponsored by the Transportation Research Board, Federal Highway Administration, Federal Transit Administration, and the Bureau of Transportation Studies.

[3] Pew Research Center (2015). Modern Immigration Wave Brings 59 Million to U.S., Driving Population Growth and Change Through 2065. Views of Immigration's Impact on U.S. Society Mixed. Washington, DC: Author, September.

made it easier for undocumented immigrants to obtain driver's licenses[4], which may accelerate transitions from transit to automobiles among immigrants.

## Is it due to new services like Lyft and Uber?

*Probably at least a little, and perhaps even a lot, but is hard to know for sure.* Over the past decade, carshare and bikeshare services have been established in most of the most transit-rich California cities, while transportation network companies (TNCs) have become ubiquitous competitors to both taxis and public transit.

TNC use in low-income neighborhoods may be especially relevant for the future of public transit. Assuming they have a smartphone and a credit account (which not all low-income travelers do), users can now purchase automobile trips one at a time — in close to real time and typically at costs (particularly for shared ride options) well below those charged by taxicabs. The TNCs, in essence, let people to enjoy auto access without the high upfront costs of auto ownership. While these companies, particularly Lyft, have partnered with several transit California transit operators to offer first-mile, last-mile connections to line-haul transit service, their net effect on transit use remains uncertain.

To be clear, the effects of TNCs on traditional fixed-route, fixed-schedule transit are certainly knowable, but TNCs have generally been loath to publicly release their ridership data.[5] But while TNCs like Lyft and Uber may today be taking customers away from public transit, particularly in areas with lower levels of household automobile access, we note that per capita transit use in California began falling before the TNCs started aggressively expanding. Further, collaborative efforts between TNCs and transit operators are just getting underway, so that any transit ridership benefits from TNCs have yet to materialize.

[4]National Conference of State Legislatures. (2016). States Offering Driver's Licenses to Immigrants. Available at http://www.ncsl.org/research/immigration/states-offering-driver-s-licenses-to-immigrants.aspx

[5] While they do regularly report to the California Public Utilities Commission for regulatory compliance purposes, these data are not generally available to local, regional, or state transportation agencies for planning purposes.

## Assessing Transit's Performance

Transit will play a central role in achieving many important state goals, including California's low-carbon metamorphosis, but only to the extent that people actually use it. So ridership is the nexus and, along with mode and market, serve as critical *intermediate* measures that mostly, but not perfectly, gauge transit's success or failure in providing seamless, sustainable, and affordable mobility. Ridership in particular is the most straightforward, consistent, and regularly measured metric that can be used to assess the overarching performance of transit in California on various geographic scales: routes, neighborhoods, regions, and statewide.

The 2015-2020 Caltrans Strategic Management Plan adopted a goal to double transit's share of trips made in the state between the 2010-2012 California Household Travel Survey and the next expected survey based on 2020. While data from multiple sources have shown falling transit ridership since 2013, California does not have surveys and analyses in place to track how this trend affects transit's share of all trips in the state. With the 2018 release of the 2016 National Household Travel Survey, California will have its first comprehensive estimate of transit's modal share since 2012 and last until the 2020 California Household Travel Survey. While a changing mobility landscape should motivate California to conduct more frequent travel surveys, these surveys are unlikely to occur frequently enough for modal share to serve as an annual performance indicator.

In establishing a statewide performance indicator for transit ridership, California should seek:

- A performance metric based on data that are frequently and reliably collected
- A metric both available and meaningful for various geographic scales: corridors, neighborhoods, regions, and statewide
- A metric easily understood by riders, the general public, public officials, and the media

Common measures of patronage include unlinked passenger trips (or boardings), linked passenger trips, passenger miles, and passenger hours; each has strengths and weaknesses (see table C14-1).[1]

[1] Fielding, G. (1985). Managing Public Transit Strategically. Jossey Bass.

**Table C14-1: Strengths and Weaknesses of Transit Ridership Metrics**

| Metric | Strengths | Weaknesses |
|---|---|---|
| **Unlinked Trips** | • Easily and reliably measures each transit *boarding* as a trip<br>• Easily understandable.<br>• Most common ridership metric. | • Does not account for transfers or trip length.<br>• More direct service (without transfers) could reflect a decrease in the number of unlinked trips, even if it increased the number of transit passengers. |
| **Linked Trips** | • Because a transit trip from origin to destination is a single trip, it is considered the gold standard of patronage metric.<br>• More difficult to understand, especially when passengers use multiple transit agencies for a linked trip. | • Trip data are very difficult and expensive to reliably collect (though this would change with a Statewide Ticketing and Accounts System). |
| **Passenger Miles** | • Measures the total distance traveled by transit passengers so that, for transit trips displacing an automobile trip, it is correlated to avoided VMT. | • Privileges longer trips over shorter ones.<br>• Privileges operators of commuter services in outlying areas over operators of local services in dense, congested, climate-efficient urban areas where transit use per capita is highest. |
| **Passenger Hours** | • Measures the amount of transit service capacity consumed, given that a one hour transit trip occupies as much seat- or standing-capacity as three 20 minute transit trips.<br>• Tends to equalize comparisons between slower urban service in congested areas and higher-speed service suburban and non-metro services. | • Privileges longer duration trips over shorter ones, which advantages services which are slowing over time and runs counter to other mobility goals. |

Regardless of the passenger metric chosen, it must be applicable to wide array of geographies, ranging from a neighborhood or district, to a county, to a region, to the entire state. To do this, the measure needs to be normalized by the total number of people in a given geography, the

number of working-age adults, the number of vehicles, the number of miles traveled, or another metric.

Given the three criteria above for (1) easy and reliable collection, (2) scalability, and (3) widely understood, *Transit Boardings[2] per Capita* meets all of the aforementioned objectives:

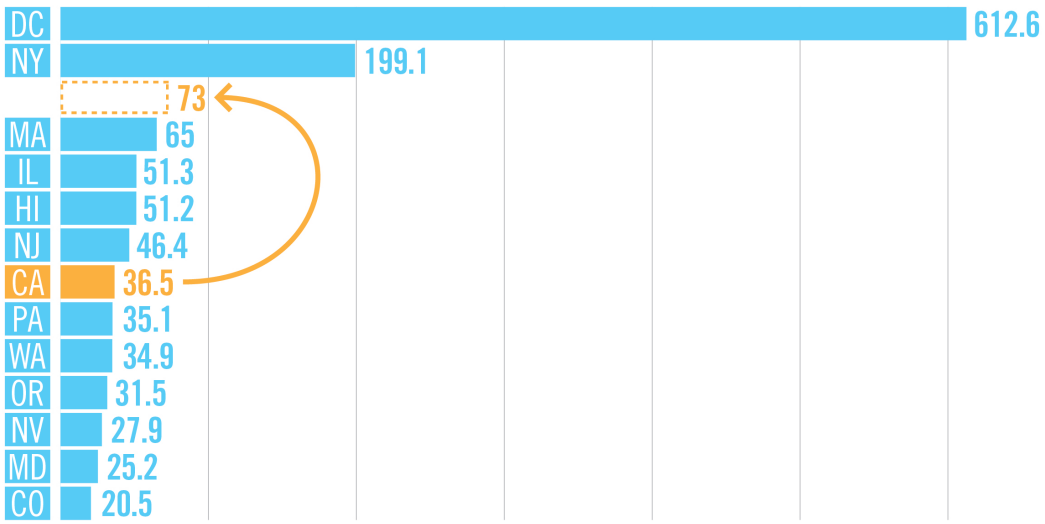
- Transit boarding estimates are reported monthly for transit agencies representing roughly 98% of statewide ridership and annually for all transit agencies
- Population estimates are reported annually by the U.S. Census Bureau and California Department of Finance, which also produces county-level population projections
- Population and boardings estimates are available at a variety of geographic scales (city, county, region, and statewide), allowing the comparative assessment of performance at various scales

When setting a target, the following criteria are imperative:

- A target level that is both ambitious and achievable
- A horizon year near enough to motivate action but sufficiently distant to allow for transformative changes to take form

For these reasons, California will adopt an overarching performance target to double transit boardings per capita in the state between 2015 and 2030, from 36.5 unlinked passenger trips (UPT)/person to 73. Achieving such a target would put California's per-capita transit ridership third among U.S. states and districts, as illustrated in Figure C14-1 below.

**Figure C14-1: Transit Boardings Per Capita by State, 2015**




[2] Again, boardings and unlinked passenger trips are interchangeable terms.

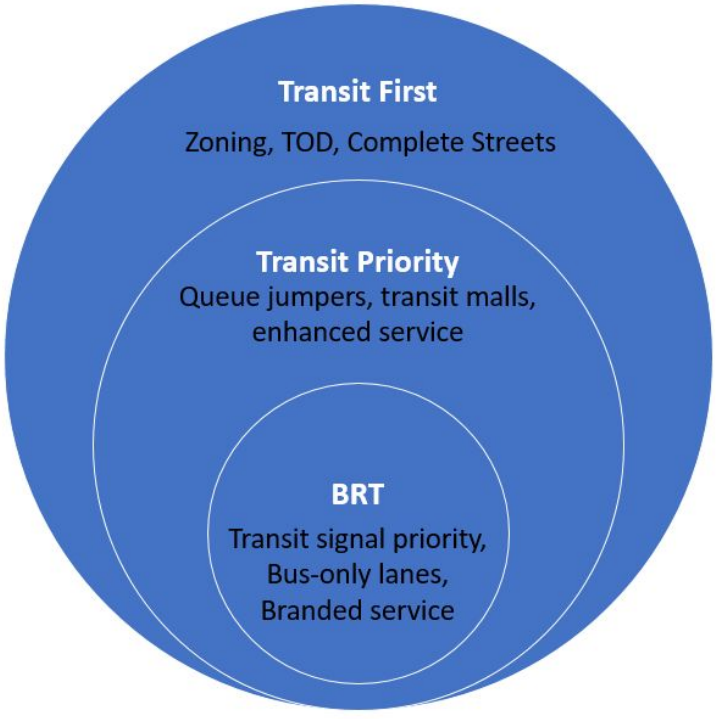
# Transit Priority

"Transit priority" refers to projects implemented through "transit first" policies. As discussed in Chapter 4 ("Transformative Changes"), transit first policies promote the use of transit, walking, bicycling and sometimes taxis and shared-ride services in the adoption of transportation plans and the implementation of roadway and other infrastructure projects. The goal of "transit first" is to elevate non-solo driving modes of travel to a level of convenience and ease-of-access that parallels driving, particularly in areas and corridors in which automobiles exact especially high externalities on non-drivers, such as in dense cities and congested boulevards.

Transit priority projects encompass those that increase vehicle speeds or reduce dwell time, from relatively simple spot implementations such as transit signal priority to "all in" initiatives such as bus-only lanes. In the past decade, a growing number of cities have implemented transit priority projects in response to a greater need to improve transit's effectiveness while working with (in many cases) constrained resources. At the same time, transit priority projects have also themselves been the focus of successful mobility tax measures, contradicting received wisdom that only large capital projects generate voter enthusiasm.

## Benefits of Transit Priority

Transit priority projects generally have the advantage of being relatively quick to deliver and apply in areas where they are most needed ("pinch points"). Transit priority constitutes an approach that is responsive to existing needs and works within an existing context to transform mobility options, in contrast to more capital-intensive interventions that attempt to entirely re-form or recreate contexts beyond mobility (such as transit-oriented development).



Research shows that relatively small improvements in transit speeds are correlated with increased ridership[1].

Where improvements are targeted to specific, dense and congested areas, they can have the most significant impact. Such improvements to transit as a travel option make it more likely that travelers will a) make the trip to an area they might otherwise not have, and b) make the trip with transit.

## Trends in Transit Priority

When transit priority projects are centered on goals of making transit faster, easier to get to, and easier to understand, riders respond. Bus rapid transit (BRT) projects in particular have generated significant ridership gains. While not all transit priority projects are BRT, all BRT installations constitute transit priority projects: they increase vehicle speeds and reduce dwell times, and are typically installed in dense corridors where demand for high-capacity, high-frequency is strongest and where it can be provided most cost-effectively, especially with transit priority tools such as bus-only lanes, and transit signal priority, described in the next section.

## Transit Priority Toolbox

### Bus-only lanes

Bus-only lanes can increase the ease of access, reliability and appeal of transit service particularly within dense, congested areas. In recent years, cities have experimented with painting bus-only lanes to further distinguish the lanes for exclusive transit use and to elevate awareness of transit generally. Bus-only lanes are commonly used in BRT projects, but also exist in other applications such as transit corridors, and queue jumpers, which are described in the next section.

Bus-only lanes can be full-time or have hours of operation (e.g., during peak hours). Some allow taxis and/or bicycles; others are exclusive to transit vehicles and right-turning vehicles. Commonly, bus-only lanes are curbside, which necessitates their sharing intersection-adjacent space with right-turning vehicles, which can add significant congestion and transit vehicle delay, particularly where turning vehicles in front of transit vehicles must wait for crossing pedestrians. Median bus-only lanes are rarer as they require boarding islands, but have the advantage of eliminating traffic conflicts and maintaining lane exclusivity for transit vehicles. Contraflow bus lanes are rarer still, and involve a transit-only lane on a one-way street, with

[1] Litman, T. (2008). Valuing transit service quality improvements. *Journal of Public transportation*, 11(2), 3.

transit vehicles running in the opposite direction as traffic. Table C15-1 lists the advantages and disadvantages of bus-only lanes.

While grade-separated busways generate the greatest travel time savings, at-grade segregated busways and exclusive mixed use bus lanes also produce significant reductions in travel time.

Table C15-1: Examples of Bus-only Lanes

| | Benefits | Challenges | Remediations |
|---|---|---|---|
| **Curbside Lanes** | No extra space needed for stops | Often congested due to illegal parking/waiting and right-turning vehicles | Use curb lane for parking/turns and adjacent lane for bus only; use automated enforcement; reserve spots for deliveries; restrict delivery hours |
| **Median Lanes** | Less likely to be congested than curbside lanes | Requires more space for platforms<br>Lanes conflict with left-turning traffic<br>Pedestrians must cross traffic to reach platform | Ban left turns or create separate signal phase |
| **Contraflow Lanes** | Lanes are "self-enforcing"; Violations are rare and easy to spot | Prevents use of curb for deliveries | Reserve curb lane for deliveries and use next lane over for transit |

Adapted from: Federal Transit Administration (2016). *"Bus Lanes"* https://www.transit.dot.gov/research-innovation/bus-lanes

### Painted Bus-Only Lanes

A number of cities have experimented recently with painted bus-only lanes, to visually distinguish the lanes from general traffic lanes. San Francisco's red paint reduced bus-only violations by 48-55%, better enabling transit vehicles to maintain schedule adherence[2]. Transit travel times even as car traffic increased, thereby saving operating costs and increasing the ratio of transit travel time to traffic travel time, thus increasing transit's appeal. The painted lanes are also credited with being most strongly correlated among the factors that reduced transit vehicle

[2] San Francisco Municipal Transit Agency. (2017). Red Transit Lanes Final Evaluation Report. https://www.sfmta.com/sites/default/files/reports/2017/Red%20Transit%20Lanes%20Final%20Evaluation%20Report%202-10-2017.pdf

collisions by 16%[3]. Benefits accrued to non-transit users, too. A study by Zendrive found that, where lanes were painted, a 36% reduction in speeding, 30% reduction in acceleration, 21% reduction in hard braking were found[4].

## Traffic Signal Priority (TSP)

**Transit signal priority (TSP)**, too, can improve the traffic flow of transit vehicles through a congested area, thus giving travelers to and from a busy city area a quicker and more attractive travel option than they would otherwise have. While TSP can be used with bus-only lanes for greater effectiveness, it can also be implemented on its own where bus-only lanes are infeasible or not yet developed.

TSP involves programming traffic signals to be actively responsive to transit vehicle movement, allowing transit vehicles to pass through the corridor more quickly than they otherwise would. TSP strategies include extending green lights for approaching transit vehicles (detected through in-pavement sensors and/or through on-board transponders), making red lights shorter for waiting transit vehicles, and adding or changing traffic signal phases to favor transit vehicle movement. Some TSP systems can be developed to use a context-specific algorithm to determine when and how long to trigger a TSP request, such as the individual transit vehicle's schedule adherence, which improves TSP performance 3-6%.[5] Theoretically, TSP algorithms could also be set to consider passenger occupancy, as well.[6]

Improvements from TSP can be significant. Seattle's Rainier Avenue TSP system, installed in 2000, resulted in a 57% reduction in average delay for prioritized buses, a 50% reduction in stops at signals, and a 35% reduction in bus travel time variability.[7] With little traffic on cross-streets and programming that did not interrupt cross-street signal phases, average intersection vehicle delay did not change. In other words, the benefits accrued to transit riders without affecting other roadway users. Tacoma, Washington's implementation of TSP and signal optimization was similarly successful, with a 40% reduction in transit signal delay in two corridors.[8] Likewise, Portland's TriMet found the use of TSP precluded the need to add additional buses in order to maintain schedules. Other cities using TSP have realize travel time

[3] Ibid.
[4] San Francisco Municipal Transit Agency. (2017). Red Transit-Only Lanes Work. https://www.sfmta.com/blog/red-transit-only-lanes-work-two-new-studies-show-their-benefits
[5] Liao, Chen-Fu and Gary A. Davis. (2011). "Field Testing and Evaluation of a Wireless-Based Transit Signal Priority System." University of Minnesota: Intelligent Transportation Systems Institute Center for Transportation Studies.
[6] Chada, Shireen and Robert Newland. (2002). Effectiveness of Bus Signal Priority: Final Report. https://www.nctr.usf.edu/wp-content/uploads/2012/07/416-04.pdf
[7] Ibid.
[8] Smith, Harriet, Brendon Hemily, and Mlomir Ivanovic. (2005). Transit Signal Priority (TSP): A Planning and Implementation Handbook. https://nacto.org/docs/usdg/transit_signal_priority_handbook_smith.pdf

savings of 15-25% with TSP.[9] TSP benefits do, however, diminish with higher volume/capacity ratios.[10]

### Other Transit Priority Tools

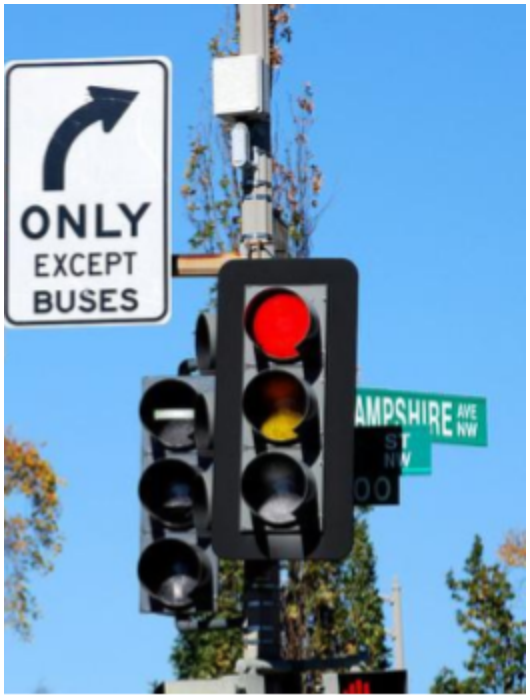
Other tools in the transit priority "toolbox" that improve the passenger experience and raise transit's profile include **consolidated or reduced transit stops**, **improved streetscape**, **improved bicycle and pedestrian access**, **frequent headways**, and **branded service** (e.g., "The Swift" or the "Metro Orange Line"). These are elements that are used in various transit priority applications, discussed in the next section.

## Transit Priority Applications

Transit priority projects can take many forms. Usually, the greatest benefits accrue from their application in dense, congested areas. Transit priority projects include queue jumps, transit malls, and transit corridors.

### Queue Jumps

**Queue jumps** refer to a specific type of transit signal priority used at signalized intersections that gives transit vehicles a special signal to "jump ahead" before other traffic gets a green light. Queue jumps typically are installed where a bus has its own lane (or bus bay stop) at the near side of the intersection, but not the far side. They are, essentially, very short bus-only lanes with a single TSP installation. The "head start" that queue jumps give transit vehicles obviates the need for them to merge with traffic and helps keep them on schedule.




Bus queue jump signal next to traffic signal (Photo: BeyondDC via Flickr, CC BY 2.0)

### Transit Malls

Typically stretched over a couple blocks, transit malls constitute urban space given over primarily to transit service. They have exclusive transit only lanes and are sometimes closed to all vehicle traffic. Importantly, they are designed around easy and safe pedestrian access and are usually retail or mixed-use areas.

[9] Ibid.
[10] Ngan, Vikki, Tarek Sayed, and Akmal Abdelfatah. (2004). Impacts of Various Parameters on Transit Signal Priority Effectiveness. Journal of Public Transportation. 7 (3). 71-93.

Among the best known examples is Nicollet Mall in Minneapolis, the first transit mall in the U.S., constructed in 1967[11]. Nicollet Mall served as an example for many others that followed, though not all have been successful. The concern, particularly from merchants, that transit operations can predominate and crowd out pedestrian street life, has doomed some malls. Transit malls built with greater consideration for pedestrians' access and user experience have fared better.

## Transit Corridors

Transit corridors are streets in dense, urban areas in which a public investment in transit service is visibly established even in the absence of transit vehicles. Often, transit corridors have an improved streetscape amenable to pedestrians, enhanced street furniture particularly at bus stops, bicycle facilities, and restrictions on curbside parking. Some have part-time or even full-time bus-only lanes. Frequent, high-quality transit service serves the corridor. While transit corridors can have much in common with transit malls (pedestrian-friendly environment, bus-only lanes) and with BRT (frequent transit service, TSP), they are typically longer than malls and shorter than BRT routes (the Institute for Transportation and Development Policy [ITDP] defines BRT as being at least 3 km/1.9 miles). In addition, bus routes often extend beyond the corridor unlike BRT corridors which usually coincide with their routes (i.e, the corridors are more often built for or around the route).

Table C15-2 illustrates several examples of transit corridors.

[11] Transportation Research Board. (1998). TCRP Report 33: Transit-Friendly Streets: Design and Traffic Management Strategies to Support Livable Communities.

Table C15-2: Examples of Transit Corridors

| | Seattle Third Avenue[12] | San Francisco Market St. | Chicago Loop Link |
|---|---|---|---|
| **Installed** | 2007 (in current form) | 2014 | 2015 |
| **Lane configuration** | All lanes during peak hours | Median with island stations[13] | Median lane with island stations |
| **Access** | Transit buses | Transit buses, Taxis | Transit buses |
| **Lane treatment** | Signage | Red paint | Red paint for buses; green for adjacent cycletrack |
| **Hours** | Peak-hour only; full-time being considered | 24/7 | 24/7 |
| **Picture** |  *Photo: IDTP* |  *Photo: Sergio Ruiz, CC BY 2.0* |  *Photo: Nate Roseberry* |

## Bus Rapid Transit (BRT)

The extent to which BRT projects incorporate transit priority elements varies. Optimally, a BRT project would include all elements, but fiscal, political, and geographical constraints mean not all BRT projects use all available transit priority tools, with the result that the quality of service to the rider can vary from system to system. The New York-based Institute for Transportation and Development Policy (ITDP) has established a "BRT Standard" as an evaluation tool, to codify best practices in BRT design and operations worldwide. The Standard establishes a 100-point scorecard with which BRT corridors (defined as being at least 3 kilometers/1.9 miles in length, with dedicated lanes) are rated against design, service, communications, access, and operations criteria. Systems that score highly (85-100 points) are "BRT Standard Gold"; "BRT

[12] When, during peak hours, all lanes become bus-only, Third Avenue could also be considered a transit mall.
[13] SFMTA also uses curbside and curbside-adjacent bus-only lanes on other nearby corridors.

Standard Silver" and "BRT Standard Bronze" exist as categories for systems that score 70-84.9 and 55-69.9 points, respectively.[14]

The Scorecard distinguishes systems that have elements that improve the passenger experience and establishes benchmarks and standards for high-quality bus rapid transit. The scoring gives particular weight to systems' having dedicated right-of-way, busway alignment, off-board fare collection, intersection treatments, and platform-level boarding. The Scorecard also deducts points for problems with operations, such as low speeds, low ridership, lack of right-of-way enforcement, infrequent headways, overcrowding, bus bunching. Poorly maintained infrastructure is particularly heavily weighted. A negative category emphasizes the importance of good service after implementation and illustrates that capital improvements can be undone by poor operations. Table C15-3 outlines the Scorecard's criteria.

Table C15-3: Bus Rapid Transit Category of Criteria and Scorecard Points

| Category | Examples of Criteria | Points |
|---|---|---|
| BRT Basics | Dedicated right-of-way; busway alignment; Off-;board fare collection; Intersection treatments; Platform-level boarding | 38 |
| Service Planning | Multiple routes and corridors; express, limited, and local service; control center; hours | 19 |
| Access and Integration | Pedestrian access and safety; Bicycle parking/lanes/sharing; Integration with other transit | 15 |
| Infrastructure | Passing lanes; Center stations; Pavement quality | 13 |
| Stations | Distance between stations; Safety and comfort, Number of bus doors; | 10 |
| Communications | Branding; Passenger information | 5 |
| Operations *Deductions* | Speeds; Low ridership; Lack of right-of-way enforcement; Platform-bus boarding gaps; Overcrowding; Poor maintenance; Infrequent headways; Bus bunching | -63 |

Adapted from IDTP Scorecard: https://www.itdp.org/library/standards-and-guides/the-bus-rapid-transit-standard/

[14] Institute for Transportation and Development Policy (2017). The Bus Rapid Transit Standard. https://www.itdp.org/library/standards-and-guides/the-bus-rapid-transit-standard/

Table C15-4 below illustrates how the categories of transit priority applications differ by typical length, context, and characteristic.

Table C15-4: Delineation of Transit Priority Applications

| | Queue jump | Transit mall | Transit corridor | Urban BRT |
|---|---|---|---|---|
| **Typical length** | <1 block | 1-3 blocks | 3+ blocks | 1.9+ miles |
| **Typical context** | Congested intersection | Dense, walkable retail environment, often where many routes meet | Dense, high-traffic roadway with many transit routes | Dense to moderately dense areas |
| **Example** | Washington, DC (see queue jump picture above) | 16th Street, Denver; Third Ave Seattle (during bus-only hours) | Market Street, San Francisco | RapidRide, King County (Seattle) Metro |
| **Bus only lane(s)** | Usually | Yes | Usually | Usually |
| **Transit signal priority (TSP)** | Yes | No | Usually | Usually |
| **Enhanced stops/stations** | No | Sometimes | Sometimes | Yes |
| **Enhanced ped/bike access** | No | Yes | Usually | Yes |
| **Streetscape improvements** | No | Yes | Sometimes | Usually |
| **Reduced stops** | No | No | Sometimes | Yes |
| **Branded service** | No | No | No | Yes |

## Seattle: A Case Study

Seattle's transit expansion of the past decade and its corollary increase in ridership is exemplary. While many transit systems saw a dip in boardings between 2010 and 2014, Seattle had the biggest increase in bus ridership of any major US city.[15] Its 2006 "Bridging the Gap" levy approved by voters generated $365 million in property tax revenues to address a transportation system maintenance backlog. While most funds were streetscape and paving improvements, the levy added 50,000 hours of transit service and developed three transit corridors (RapidRide service). The levy also paved the way for a larger and more ambitious $965 million levy called "Move Seattle" that passed in 2015. The vision of Move Seattle, developed with public input before appearing on the ballot, combines maintenance and repair (45% of its budget) with congestion relief (33%) and safe routes (22%). Although Move Seattle is not itself a transit-specific plan, it has transit-first principles that enable successful transit priority projects to be built and operated in conjunction with projects that achieve symbiotic objectives, such as improved traffic management, improved pedestrian safety, increased bike lanes and greenways, safer routes to school, and more inviting streetscape.

### Seattle's Transit First-type Policy

The City's Move Seattle focuses capital improvements in places and on routes where the most residents are served. "Always on time" is the vision's explicit goal to "ensure that 75% of Seattle households are within a 10-minute walk of bus routes with service every 15 minutes or better." This goal directs resources to a very specific and measurable rider-oriented outcome.

### Seattle's Transit Priority Projects

Seven new multimodal corridors are part of the Move Seattle plan that will add to the three previously built under "Bridging the Gap". These corridors will have upgraded paving and signals in preparation for the addition of RapidRide service (King County Metro's branded rapid, limited-stop bus service), as well as improvements to freight access, parking management, the urban forestry and placemaking. The comprehensive mix of improvements will make the street more functional and attractive, while at the same time likely drawing more transit riders, and serving existing riders better.

Other transit priority projects that Seattle plans include:

- Synchronizing the downtown signal system
- Implementing adaptive signal control along several corridors
- Installing red bus-only lanes and transit signal priority at "pinch points"

[15] Institute for Transportation and Development. (2016). "Seattle Continues to Grow Its Bus Ridership". https://www.itdp.org/seattle-grows-bus-ridership/

- Enforcing bus-only lanes
- Upgrading street furniture and adding real-time information at bus stops and stations
- Building BRT on Madison Street
- Installing 1500 bike parking spaces over three years
- Launching a real-time multimodal travel and wayfinding app

Seattle is also considering once again extending its Third Avenue bus-only lanes to 24/7 operation. Third Avenue had been full-time bus-only lanes during the two years that the nearby Transit Tunnel was under re-construction, but now operates only during peak periods.

## Lessons from Seattle

Seattle's recent decisions and developments are notable for several reasons:

- Transit priority projects are achieved through a comprehensive vision that blends maintenance projects with transportation improvements
- Revenues raised for transportation come from a *property* tax, and not the more common sales tax. In addition to the amounts drawn being relatively stable and predictable (for both taxpayers and the City), the levy encourages greater "buy in" to the city's plans for improvement. (In addition, the "Move Seattle" vision had voter input prior to being put on the ballot.)
- The transit first goal to have 75% of all households within a 10-minute walk of frequent transit service connects service improvements to users, and directs resources in an effective and measurable manner.
- "Move Seattle" was successful at the ballot box with its comprehensive list of relatively small and system-focused projects, even without a major capital "stand out" project to attract voter interest.

# Visions for Places in Urban Regions

## Urban Cores and Centers

In urban environments, transit operates in the context of high population density, limited space, and mixed-use neighborhoods, so agencies provide mobility for a wide range of trips. Urban and compact-community transit can serve a variety of crucial roles, from accommodating population and job growth in urban cores to helping the state meet its greenhouse-gas reduction targets.

Transit works well in these environments for several reasons. First, high population densities mean that demand for shared mobility is aggregated, justifying frequent headways and infrastructure and operational enhancements to support transit priority, and generating a positive ridership feedback loop. Second, the popularity of walking and biking in these neighborhoods means transit riders can make seamless first/last-mile connections without needing a car. Third, parking in urban areas can be relatively expensive (more than $10/day), creating a financial incentive that causes residents to think twice before automatically choosing to drive.

To help urban transit best reach its full potential, this Statewide Transit Strategic Plan recommends a heavy investment in transit priority, which will increase efficiency and speed and improve rider experience. On busy travel corridors, dedicated rights-of-way for buses and trains will enable travelers to avoid congestion. Buses in particular tend to be more expensive to operate in congested areas, so Bus Rapid Transit can both increase bus speed and reduce per-hour operating costs, allowing for increases in vehicle frequency.

## Close-in, Compact and/or Transitional Suburban Communities

These zones have the potential to become vibrant, transit-supportive compact communities, but need strategic interventions to get there. Because they are located in existing metropolitan areas, most of these zones have frequent transit on dedicated rights-of-way, such as commuter rail, light rail, or high-quality Bus Rapid Transit. These high-quality transit options can be used as a pretext for targeted land-use changes that will help these places urbanize and come into their own as complete, livable neighborhoods with a variety of housing and transit amenities.

Officials can encourage a “town center” concept with multiple consumer services, such as grocery markets, cafes, small pharmacies, childcare centers, coffee shops, and restaurants, concentrated around transit stations to make complete neighborhoods. These town centers should serve as transit hubs with rail and BRT services, connecting with Urban and Compact Centers. A variety of public and private shared transportation services will be required to serve

residential neighborhoods and deliver commuters to town center mobility hubs. Building up the ridership for these "feeder" routes will be an essential task.

### Anchored Suburban Communities

Of all the parts of a metropolitan area, post-World War II suburbs have the least compatiblity with frequent, high-quality transit service, but they can be improved with creative thinking. Many California suburbs, especially those that came of age after World War II, were designed to be auto-reliant. Dispersed population patterns and a lack of concentrated job centers mean that frequent, high-capacity transit service has trouble serving these areas. Existing transit services in suburban communities tend to be coverage-based, i.e., they fulfill a mandate to serve the geographic entirety of a jurisdiction or service area.

In these areas, transit will predominantly serve commuters, with express buses, vanpools, and commuter rail connecting suburban dwellers to major job centers. In areas that lack HOV lanes on freeways, Bus On Shoulder service can provide a substitute, and all of these forms of transit should be given prioritized rights-of-way whenever possible.

## Places Outside Major Regions

### Compact Communities

Among all land-use types outside major metropolitan areas, compact communities provide the best opportunities to encourage widespread transit use among a demographically diverse population. These cities tend to have at least one major trip generator — for example, a university — and a large transit-dependent population (e.g., college students who lack the income to own their own cars). Planners' objective should be to increase fixed-route transit ridership in these cities, since they have many of the prerequisites that make transit successful in urban areas (compact neighborhoods, small businesses, a large variety of people traveling to a small handful of locations for work, and so on).

The gold standard for a small, transit-intensive city in California is Davis, and realistically, any small city that is a good fit for transit will also be heavily supportive of pedestrian and bicycle activity. Overall, these cities tend to have a population of between 50,000 and 250,000 residents, and include all California cities meeting the federal small transit intensive city designation[1].

[1] A city with a population of less than 200,000 but that meets or exceeds average levels of service for urbanized areas with populations between 200,000 and 1 million in one or more of six performance categories including trips per capita, vehicle-revenue miles per capita, and person-miles traveled per VRM

## Rural Towns

"Rural Towns" are small, compact settlements well outside of metropolitan regions, with an existing walkable downtown main street area that concentrates retail, government services, and entertainment. In any context, traditional fixed-route transit has a limited role to play, and demand-responsive transit services cannot serve all mobility needs. Bicycle transportation will be a viable on-demand mode in these communities. For-profit shared mobility services have limited utility because of the lack of trip volume and trip-end aggregation, but nonprofit and subsidized mobility services have potential. Transit agencies may operate scheduled, fixed-route, commute-focused services to nearby cities, especially those that have or will have high-speed or regional rail.

## Rural Settlements

Fixed-route transit will not be practical in these contexts, but as planners develop and introduce a variety of demand-responsive and/or automated services, rural areas will start to rely on new mobility modes like nonprofit mobility services and autonomous paratransit to provide social-service mobility. These new modes will provide rural residents with crucial transportation to places like medical appointments, social-service agencies, courts, and grocery stores.

Planners should recognize that in rural areas marked by long distances between people, travel often has a social purpose that cannot easily be understood in strictly economic terms. Continuing to meet the mobility needs of  rural residents who lack the means or ability for personal automobile travel will be a crucial task for planners in such communities.