SHARED MOBILITY
IMPACTS ON PUBLIC TRANSPORTATION WITH RELEVANCE TO CALTRAIN

ABSTRACT

The past several years have shown a rise in a related set of transportation phenomena that can be collectively described using the label of "shared mobility." Shared mobility refers to various forms of private and public-private modes of travel distinguished by business models that provide vehicles or mobility services on an "as-needed" basis. The purpose of this white paper is to further define the parameters of shared mobility with a specific focus on the relationship of these modes and services to public transit. The paper highlights the potential benefits of shared mobility interaction and partnership with transit agencies (and their customers) as well as discusses potential questions and concerns related to equitable accessibility, system integration, and investment choices. While the paper is written from the perspective of Caltrain, the information provided should lend itself useful to other interested transit agencies and local jurisdictions. As this dynamic sector develops further, it will be important for Caltrain and other public agencies to continuously evaluate the relationship of shared mobility services to their own operations.

INTRODUCTION

For the purpose of this paper, shared mobility is broadly defined as a collection of various forms of private and public-private modes of transport that can be accessed on a short-term or "as-needed" basis. In general, the shared mobility business model involves "renting or borrowing goods and services rather than owning them"[1]. These various forms of mobility services most commonly include bikesharing, carsharing, (private) shuttles, microtransit, ridesourcing, and ridesharing (alongside a slew of various trip planning applications that specifically serve these travel modes in one way or another). Within each of these transport forms are subsets that differentiate between system models and uses. Less common or applicable models will be mentioned briefly in the footnotes.

General Relevance to Transit and Caltrain

Shared mobility services provide a wide variety of new mobility choices to individuals. In doing so, these services have the potential to complement mass transit operators in a number of ways. One of the most important ways that shared mobility services can support regional transit operators, like Caltrain, is by enhancing first- and last-mile connections at stations. Caltrain has 32 stations, all of which are located in different types of urban environments with varying options for first- and last-mile connections. Identifying new ways to address this first- and last-mile challenge can help Caltrain build and sustain ridership and reduce pressure on existing access facilities and programs, such as parking lots, shuttles, and the Bikes-On-Board program (all of which may suffer from capacity constraints or lack of adequate funding). Additionally, shared mobility services may expand the "reach" of transit by providing access to more neighborhoods and districts not previously linked to the Caltrain system, thus "bridging gaps in existing transportation networks"[2] that aid in the provision of first- and last-mile connections.

The implementation of shared mobility programs may also be generally supportive of transit use by enabling low- or no-car lifestyles. Furthermore, shared mobility may be linked to a reduction of greenhouse gas (GHG) emissions, vehicle miles traveled (VMT), and traffic congestion due to less

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1 Shaheen et al., Shared Mobility: Definitions, Industry, [4].
2 Shaheen et al., Shared Mobility: Definitions, Industry, [3].

vehicles on the road. This is evident in studies where "half of all bikesharing members reported reducing their personal automobile use"[3] and more than half increased their cycling. Another study[4] concludes that one carsharing vehicle replaces 9 to 13 vehicles among carsharing members. Additionally, more carshare users increased their overall public transit and non-motorized modal use (including bus, rail, walking, bicycling, and carpooling) than decreased it and were able to save $154-$435 a month after joining carshare[5]. With less people depending on personal vehicles to travel, this opens up the possibility of increased usage and reliance on public transportation for long-distance trips.

MODES OF SHARED MOBILITY
Shared mobility is a blanket term that encompasses many different modes, technologies, and services. The following section provides a framework for defining categories of shared mobility and their respective subsets.

Bikesharing
Bikesharing allows individuals to access bicycles on an "as-needed" basis from a network of stations dispersed throughout an area. These stations are often "publicly owned and contract operated through public-private partnerships"[6]. Number and proximity of stations vary from city to city.

There are three variations of bikesharing: public (requiring payment of a nominal fee to access bicycles), closed-campus (bicycles reserved for specified campus or community use), and peer-to-peer (P2P) (bicycle owners rent their personal bikes to other individuals). Public bikesharing, the most common of the three, consists of either dock-based or dock-less/GPS-based systems. While dock-based systems only allow bicycle pick-up and drop-off at designated stations, GPS-based systems allow bikes to be locked to non-hub bicycle racks during trips in addition to picking them up and dropping them off at designated stations. The latter provides more flexibility in a bicyclist's trip, but there is typically a fee for any bike not returned to a designated hub by the end of a trip.

Bay Area Bike Share (www.bayareabikeshare.com/stations), a dock-based system, presently serves the Bay Area. Basic memberships range by frequency of usage: $9 for 24 hours, $22 for a course of 3-days, and $88 for one year. Membership fees include unlimited trips up to 30 minutes each with overtime fees starting after 30 minutes. Current citywide locations include San Francisco, Redwood City, Palo Alto, Mountain View, and San Jose. Plans for system expansion in San Francisco and San Jose, as well as the East Bay, are underway.

This expansion will provision an additional 4,500 bicycles in San Francisco and 1,000 in San Jose and 1,400 new bicycles throughout Oakland, Berkeley, and Emeryville. Motivate, the bikeshare operator for Bay Area Bike Share, will offer an additional 155 bikes in "Redwood City, Palo Alto, and Mountain View if those cities opt-in to the program by contributing their own funds"[7]. These cities are currently in the process of deciding whether they will opt into the Bay Area Bike Share program, choose a different bikeshare program, or opt-out of supporting a bikeshare program altogether.

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3 Shaheen et al., Shared Mobility: Definitions, Industry, [10].
4 Cervero and Tsai, "City CarShare in San Francisco".
5 Shaheen et al., Shared Mobility: Definitions, Industry, [7].
6 Shared-Use Mobility Center, Shared-Use Mobility, [5].
7 Bialick, "Tell Bay Area Bike," Streetblog San Francisco.

Carsharing

Carsharing is marked by short-term automobile use on an hourly or daily rate. As of January 2015, there were 23 carsharing operators in the United States with over 1.1 million members and 16,754 vehicles[8].

Carsharing can expand the use of other transportation modes by connecting passengers to transit and by more generally supporting low- and no-car lifestyles that include regular transit usage. This can be seen with one-way and roundtrip carsharing types. One-way, also known as point-to-point, allows customers to pick-up vehicles at one location and drop-off at another location. Roundtrip, on the other hand, requires that customers borrow and return vehicles at the same location[9]. The flexibility of one-way carsharing makes it more suitable for first- and last-mile connections than roundtrip carsharing, which is still an option but not as viable.

Some examples of roundtrip carsharing are Zipcar and City CarShare. Zipcar is available on a global scale and accommodates a multitude of different membership plans and benefits. The organization engages in community involvement and envisions a future where car-sharing members outnumber car owners in major cities around the globe[10]. Zipcar serves 6 Caltrain Stations (San Francisco, 22nd Street, San Mateo, Redwood, Palo Alto, and Diridon) within a one-block or mile radius.

City CarShare is local to the Bay Area with service primarily in San Francisco and East Bay. The nonprofit organization headlines its mission to improve the environment and quality of life in the communities it serves by promoting innovative mobility options[11]. Although its network may not be as extensive as Zipcar's, it still provides members with local perks, such as discounts from Bay Area-based partners. City CarShare serves only 2 Caltrain Stations within a one-block or mile radius: San Francisco and 22nd Street.

One-way carsharing is not as prevalent in the United States as it is in the rest of the world. Some one-way carsharing organizations are DriveNow and car2go. DriveNow was a service that provided all-electric (BMW i3) and plug-in hybrid (BMW i8) vehicles to Bay Area dwellers. However, it has recently suspended its services as of November 2, 2015 due to issues with parking permit regulations in the San Francisco Bay Area. The organization is expected "to return once the city reforms its parking policies to allow for one-way car sharing" and will work with the city of San Francisco toward achieving that goal[12].

In other parts of the world, car2go is serving point-to-point carsharing in the United States with locations in the following cities: Austin, San Diego, Portland, Minneapolis-Saint Paul, Denver, New York City, and Washington, D.C. This organization also employs electric vehicles for the betterment of the environment and allows members to rent vehicles on a minute, hourly, and daily basis.

Peer-to-peer (P2P) carsharing, such as Getaround, is also a mobile option but lacks the level of demand and network availability that one-way and roundtrip carsharing possess. For these reasons, it is not a viable option for Caltrain to invest infrastructure to accommodate the use of P2P vehicles at its stations. For more information on P2P carsharing, refer to the footnote[13] in this section.

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8 Shaheen et al., Shared Mobility: Definitions, Industry, [6].
9 Shared-Use Mobility Center, Shared-Use Mobility, [Page 5].
10 http://www.zipcar.com/mission
11 "Our Mission," City CarShare.
12 Update, DriveNow.
13 In P2P carsharing, car owners make their vehicles available to individuals interested in driving for temporary use. This renting, or "borrowing", of cars is organized by a third-party application that manages the transaction

While scootersharing, which also includes ebikes, may closely resemble bikesharing with its dock stations and fee rates, it is classified under carsharing due to its motorized features. Scoot is an electric scootersharing service available only in the city of San Francisco. Riders are not required to have motorcycle licenses to operate the electric mopeds and mini cars and can opt for three different membership plans depending on personal extent of usage. The organization has over 75 stations with two types of locations: Garages and Scoot Stops (powered locations where you can charge and on-street parking where you can pick-up or drop off)[14]. There are remotely 3 and 2 Scoot Garages within the vicinity of the San Francisco and 22nd Street Caltrain Stations, respectively.

Shuttles, Buses, and Light Rail
According to *Shared Mobility: Definitions, Industry Developments, and Early Understanding*, shuttles are shared vehicles that connect passengers to public transit stations or employment centers, typically with the focus to alleviate the first- and last-mile problem for commuters. While shuttles may be similar to public transit buses and light rail, a distinction should be made between the two.

Buses[15] and light rail comprise the public transit links to the Caltrain stations. They run on regular schedules and only serve fixed-route stops with predetermined headways. Transit agencies and operators sponsor these with the intention to serve all sectors of the public. County connecting transit routes serve representative Caltrain stations along the line: San Francisco Muni, San Mateo SamTrans, and Santa Clara VTA). Most all connecting transit routes (bus, shuttle, rail routes) are within walking distance of a Caltrain station (if not at the station itself).

*Refer to **Table A.1** in the Appendix for Caltrain Stations & Connecting Transit Routes | Buses and Light Rail*

Unlike mass transit, shuttles are often sponsored by cities or private companies (i.e. Emery-Go-Round) and typically have service patterns oriented towards specific destinations. They do not always have regular schedules or fixed-routes and may or may not charge a nominal fee for service. Each shuttle has a designated route with specific stops for pick-up and drop-off, but not all Caltrain stations are served by shuttles. The ones that stop at Caltrain stations are typically commute-time (local & regional) shuttles and private-employer shuttles.

Commute-time and private-employer shuttles (public and private shuttles, respectively) serve different riders. Private shuttles are much more restrictive in who they serve and cater to. More often than not, private shuttle ridership consists of specific company employees or commuters that work at corporate parks[16]. According to Caltrain's Final Environmental Impact Report (FEIR), section 3.14: Transportation

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between car owners and interested drivers. P2P availability ranges between cities and neighborhoods with no consistency in number of vehicle availability (i.e. there is no set fleet of vehicles for public use).
14 "Locations," Scoot.
15 Some commercial, long-distance express buses (i.e. Megabus, Greyhound, BoltBus) also serve certain Caltrain stations. These buses are known for their inter-city, "city center-to-city center" travel and charge varying ticket fees depending on time and station location. Express bus stations are predominantly in the San Francisco and San Jose areas. Some express bus arrival/departure stations are located beside the Caltrain station itself while others are within a 15-30 minute walking distance.
*Refer to **Table A.2** in the Appendix for Connecting Transit Routes | Commercial, Long-Distance Express Buses*
16 Corporate parks are commercial complexes that feature a collection of office buildings, parking lots, eateries, and recreational areas, such as parks, plazas, and green roof gardens.

and Traffic, the Palo Alto Station experiences the highest frequency of public and private shuttles with about 75 shuttles each morning, followed by the Milbrae Station (51 shuttles), and the Mountain View Station (37 shuttles). Statistically, private-employer shuttles "draw approximately 20% of their demand from existing public transportation routes and yielded a net reduction of vehicles on Bay Area roads"[17].

Refer to **Table A.3** *for Caltrain Stations & Connecting Transit Routes | Shuttles[18]*

These next three modes of shared mobility are broadly categorized as "On-Demand Ride Services". On-demand ride services refer to mobility modes that focus their business models on providing immediate services at the request of the rider.

Microtransit
Microtransit is one variant of private shuttle services with the key distinction of being technology (IT)-enabled. Unlike private-employer shuttles, microtransit is privately provided but available to the public and provides flexible and on-demand shuttle services.

Flexible shuttles intuitively provide flexible routing, scheduling, or both; they operate on a smaller scale with the capability to serve special populations (i.e. disabled, elder, and low-income) at lower operating costs[19]. On-demand shuttles, on the other hand, operate on fixed, pre-determined routes and fixed schedules. These shuttles are quite similar to vanpools but are in general much larger and employ drivers in a wider range of vehicle types. While these shuttles may appear to be the same as public transit shuttles, their main difference is that on-demand microtransit shuttles serve "crowdsourced" routes. "Crowdsourcing" in this example refers to the solicitation of ideas and input of customers. Passengers/customers can request new routes on-demand through this platform, whereas public transit does not accommodate such requests.

Flexible and on-demand microtransit shuttles must be reserved with mobile applications that offer two types of scheduling. Applications for reservations collect or congregate customers who are all traveling in a similar route or destination in a specified meeting spot, while pick-up applications allow customers going in a similar direction to be picked-up. It should be noted that the pick-up application option is not a door-to-door service, but rather drops people off at intersections along shuttle routes for time efficiency.

Chariot is one example of a microtransit service in the city of San Francisco. Its vehicles operate on an AM (6:30am-9:30am) and PM (5:00pm-8:00pm) schedule on a range of eight active routes. Citizens are encouraged to propose new routes to gain support from other commuters, after which the proposed routes will trend and eventually roll into active routes.

From the eight active routes available, the SOMA Express serves the San Francisco Caltrain Station both in the AM and PM, while the West SOMA Direct only serves at AM. Four other routes serve within two blocks of the San Francisco Station at either AM, PM, or both.

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17 San Francisco County Transportation Authority, The Role of Shuttle.
18 This table specifically lists commute-time shuttles and does not include private-employer shuttles. Private-employer shuttles are employer specific and vary on individual employee travel routes.
19 Shaheen et al., Shared Mobility: Definitions, Industry, [13-14].

Chariot overs a variety of ticket options for rides and monthly passes that range anywhere from $10 for 2 rides to $93 for unlimited rides in a span of 30 consecutive days. Riders reserve their seats ahead of time by using Chariot's mobile application to choose a pickup stop, select the desired Chariot they want to ride, and display the reservation to the driver when boarding[20].

Ridesourcing
The rise of ridesourcing, commonly classified as Transportation Network Companies (TNCs), in the past decade is gaining prominence in the areas that it serves. TNCs rely on online platforms and applications to connect passengers with drivers who tend to use personal, non-commercial vehicles. These drivers are considered to be "for-hire" and connect to passengers by vicinity[21].

TNC's, such as Uber and Lyft, employ drivers who use their personal vehicles to provide transportation to people seeking door-to-door services. All reservations are completed through a mobile application that pairs drivers and riders within the closest vicinity. Trip costs are calculated by a metered fare but are subject to "surge pricing" at any time. The purpose of this price hike is to encourage more drivers to be available in areas that suddenly experience a spike in ride requests. The increase in price is meant to be proportional to demand. These TNCs also provide "ride-splitting" and ridesharing services (UberPOOL and Lyft Line) that allow multiple passengers to split the cost of a single trip. In the case of Uber's "ride-splitting", passengers can split the cost of the fare evenly and pay a small transaction fee[22]. For UberPOOL and Lyft Line, their ridesharing services match and add passengers heading in the same direction. This service is much cheaper than paying regular fares; discount amounts depend on the city, likelihood for getting matched, and current driver supply[23].

Unlike Uber of Lyft, Sidecar offers three TNC services: Sidecar, a ride app that connects riders with everyday drivers in their personal vehicle; Shared Rides, a discounted instant carpooling app; and Sidecar Deliveries, which combines people and packages on the same route for the fastest, most affordable and innovative on-demand delivery solution for retailers[24].

TNC services like Uber and Lyft should not be confused with taxis. Taxis[25] (or taxi-sharing) fall under the category of Dynamic Ride Sharing (DRS), matching riders and drivers with similar spatial and temporal constraints. Rides are provided by licensed taxi drivers or independent contractors[26] and priced by a meter-based fee rate. Contrary to certain TNCs, taxis do not impose "surge pricing".

Flywheel is a mobile platform for the taxi industry that connects passengers with licensed, high quality drivers. The Flywheel mobile application allows passengers to order taxi rides in real-time, track arrival via GPS, and automatically pay their fare via their smartphone device[27]. The service is available in Los Angeles, Portland, Sacramento, San Diego, the San Francisco Bay Area, and Seattle. Taxi drivers can also

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20 "Rides & Monthly Pass," Chariot.
21 Shared-Use Mobility Center, Shared-Use Mobility, [7].
22 "Split Fare," Uber.
23 "Lyft Line Pricing," Lyft.
24 "Our Story," Sidecar.
25 Taxi cab services are on an individual need basis and are usually accessed on street curbs. Some Caltrain stations, such as the San Francisco Caltrain station at 4th and King, have a designated curb spot for taxis to pick-up and drop-off passengers.
26 Mineta Transportation Institute College of Business, San Jose State University, Synergistic Integration of Transportation, [3].
27 "About Us," Flywheel.

opt-in to become Flywheel drivers by signing up online and registering their vehicles to appear in the taxi hailing mobile applications.

Studies on similar services[28] find that passengers take taxis and TNCs to travel to and from transit stations and to access destinations faster than is possible by taking transit[29]. Given this information, taxis and TNCs can be considered as another method of improving first-and last-mile connections.

Ridesharing
Ridesharing essentially involves multiple persons agreeing to ride together on a pre-existing trip. Unlike TNCs (ridesourcing), the drivers of these trips are not necessarily for-hire but rather may be compensated or reimbursed for gas mileage and their time spent driving. There are two available systems within ridesharing modes: acquaintance-based and organization-based trips. Acquaintance-based trips usually involve passengers sharing a ride who are already acquainted, whereas organization-based trips require participants to join the ridesharing service through a membership or website application.

Within these two systems are three available modes: carpooling, vanpooling, and real-time/P2P dynamic ridesharing (DRS). Carpooling usually consists of rides with 7 passengers or less while vanpooling can fit 7-15 passengers. Both of these modes can often be run by public transit systems where commuters share a ride. Real-time or peer-to-peer dynamic ride sharing, on the other hand, matches drivers and passengers based on destinations through a mobile application before the trip starts[30]. Compared to ridesourcing, real-time/dynamic ridesharing is primarily constrained by the driver's own spatial and temporal conditions (i.e. driving boundaries and limited time availability). For this reason, passengers rely on the mobile application to aggregate their trips and pay the relative cost of their trip.

Although real-time/dynamic ridesharing is much more popular in Europe than it is in the United States, the U.S. Department of Transportation's Volpe Center suggests that "ridesharing has the potential to help us reach the tipping point at which the full suite of transportation options—including shared mobility—becomes "reliable, convenient, affordable and otherwise attractive enough to compete with single occupant automobile travel"[31]. It should also be noted that the California Transportation (CTP) 2040 identified ridesharing, specifically carpooling and vanpooling, as key strategies to achieve VMT and GHG reduction goals.

Two examples of ridesharing in the San Francisco Bay Area include Carma and Zimride. Carma memberships are free and fares for each trip are all-inclusive. The organization supports its own fleet of vehicles and allows people to drive them (so long as drivers register and have their licenses pre-approved). Carma maintains a trip history of every carpool trip taken and handles all insurance coverage for the vehicle[32]. Trip and profile searches can be made online as well as on mobile applications.

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28 Rayle et al., App-Based, On-Demand Ride Services.
29 Mineta Transportation Institute College of Business, San Jose State University, Synergistic Integration of Transportation, [4].
30 Shared-Use Mobility Center, Shared-Use Mobility, [9].
31 Shared-Use Mobility Center, Shared-Use Mobility, [10].
32 "FAQ," Carma.

Zimride, supported by Enterprise, focuses specifically on serving college, university, and corporate communities across the nation in 48 states. Each private network connects drivers and passengers heading the same way and ensures online ride payouts are made via PayPal. The organization's legal disclaimer, however, states that Zimride does not verify status of a driver's license or driving/criminal record, in addition to verifying the status or sufficiency of any automobile insurance coverage[33]. To assure safety and trust, Zimride places the power of making informed decisions in the hands of riders through feedback and testimonials.

POTENTIAL PARTNERSHIP AND INTERACTION
Given the potential of shared mobility to change the landscape and development of transportation, it is important to consider how it will impact existing modes of public transportation and infrastructure. As the University of California Transportation Center (UCTC) suggests, shared mobility has the potential to improve "the fidelity of travel demand models in order to assess the broader interaction of policies for fulfilling environmental sustainability targets"[34]. The various potential benefits of shared mobility in relation to transit are discussed in the following section.

First-and Last- Mile Connections and Blending Transit Options
First- and last-mile connections refer to the travel required to and from transit stations and hubs. Shared mobility programs expand multimodal transportation options and can help connect riders to transit in new ways, effectively expanding the boundaries of transit systems and creating access to more neighborhoods and districts. In particular, shared mobility services can expand demand for public transit networks in areas where populations have been stratified (i.e. communities and cities without dense urban cores) by connecting them to transportation hubs and networks[35]. This linkage alludes to "bridging gaps in existing transportation networks"[36] that aid in the resolution of first- and last-mile connections.

The Los Angeles County Metropolitan Transportation Authority and many other agencies have also launched partnerships with carsharing providers, such as Zipcar, to locate vehicles at transit stops to provide better first- and last-mile connectivity[37]. As mentioned previously in the section for modes of shared mobility, carsharing, bikesharing, shuttles, microtransit, ridesourcing, and ridesharing are all viable options to fill the gap of first- and last-mile connections.

Caltrain operates trains that serve different stops and run at different times and frequencies (i.e. not all stations are available on every ride). For example, trains stop at Hayward Park Station once every hour during the morning commute (and these trains usually stop at all stations), lengthening the duration of the commute. Meanwhile, just one station away, trains stop at San Mateo Station two to three times every hour and tend to skip more stations, thus contributing to a shorter commute. This limitation in station service is time constraining or impossible for some riders to make appropriate connects to station stops they really need. Shared mobility programs, like ridesharing or bikesharing, may make it easier for riders to ride express or limited trains, even if those stations are further from their ultimate

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33 "Safety & Trust," Zimride.
34 Circella, McFadden, and Alemi, California Beyond SB 375, [10].
35 Shared-Use Mobility Center, Shared-Use Mobility, [30].
36 Shaheen et al., Shared Mobility: Definitions, Industry, [18].
37 Shared-Use Mobility Center, Shared-Use Mobility, [31].

origin or destination. More options to reach stations mean more riders can opt-in to ride Caltrain at times that work best for them on lines that may not necessarily serve their drop-off stations.

Moreover, there are a disproportionate number of riders per Caltrain station according to Caltrain's 2010/2013 survey access and egress patterns. Shared mobility has the potential to ease traffic congestion at peak commute hours by dispersing Caltrain ridership more evenly throughout its stations. This benefits riders who opt not to use Caltrain due to difficulties in getting to and from stations that are not well connected by transportation hubs. As Caltrain makes modernization efforts towards electrifying the train corridor, it is important to consider if its access and egress modes are in line with its goals of sustainability. Shared mobility is an investment worth considering due to the current transformation of transportation legislation that is pushing to reduce GHG emissions and VMT; which in turn is transforming the fleet of transit vehicles available. With more options to choose from and partner with, it is a step towards embracing the changes taking place and utilizing their potential.

Seamless Integration of Mobile Applications
A distinct attribute of many shared mobility programs and services is their seamless integration with mobile devices, mobile ticketing platforms for transit, and, increasingly, with multi-modal trip planning applications. Mobile applications were primarily used for reserving TNCs, but now serve on-demand transit, taxis, and, more broadly, multi-modal travel routes, costs, traffic, and timetables. Trip planning applications can be classified as either single-mode (focused on only one type of transit) or multi-modal aggregators (single platforms to view multiple different modes of transit). All applications use real-time data and are integral in connecting local, sub-regional, and regional transit systems (i.e. Citymapper, RideScout). The Shared-Use Mobility Center Reference Guide attest that transportation data "generated by shared-use technologies and network aggregators could help public agencies better envision and plan for new mobility patterns", which would be beneficial in long-term planning and operation[38].

Additionally, some applications also provide the means to purchase transit tickets or reservations of the same platform. For example, Dallas Area Rapid Transit (DART) and Uber launched a new partnership featuring linked mobile apps[39]. More locally, San Francisco's Muni just recently employed MuniMobile, allowing riders to purchase their transit ticket on a mobile application. On a similar note, Caltrain is in the midst of exploring a mobile ticketing application and potentially providing a platform for more seamless integration with other modes of transit, including shared mobility services. Additionally, there is a possibility in considering the regional usage of Clipper Card as an applicable means to integrate shared mobility forms of payment to existing or planned platforms and applications.

Flexibility of Accessibility and Back-up Modes of Travel
The flexibility of shared mobility modes allow for increased availability to better serve people outside of peak commute hours, access more remote locations, and serve populations that, traditionally, have not had access to frequent transit service. Not only can shared mobility address weekend and late-night demands, but it can also "lead to transit models that optimize resources and improve performance and efficiency"[40]. In this instance, shared mobility complements existing public transit services and serves as a back-up mode of transit should a rider's primary mode be compromised for some reason (i.e. maintenance, delays, accidents, etc.).

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38 Shared-Use Mobility Center, Shared-Use Mobility, [31].
39 Shared-Use Mobility Center, Shared-Use Mobility, [31].
40 Shared-Use Mobility Center, Shared-Use Mobility, [30].

For instance, the Massachusetts Bay Transportation Authority (MBTA) is in the midst of conducting a pilot program to better serve the disabled community through partnerships with taxis and ride-hail companies, such as Uber and Lyft. This potential partnership would operate in conjunction to existing transit service, The Ride, in order to "increase mobility options across the Commonwealth"[41]. Other examples of partnerships include Boulder Housing Partners (BHP) where carsharing is successfully used to cater to disadvantaged communities. The partnership offers "280 rental households access to multiple shared-use modes" with a core aspect of the program centered around the education and social engagement of these modes[42]. Education and social engagement primarily involve potential and existing renters to carshare and bikeshare opportunities.

Advertising and Income Generation
Another benefit of a Caltrain partnership with shared mobility providers is the opportunity to collect revenue from companies interested in advertising at Caltrain facilities. This can be in the form of website links and pages, posters, and boards at transit stations, offering specific modes of shared mobility fare purchases at existing ticketing booths/stations (i.e. microtransit). At stations that have sufficient space, partnerships can be made to include or install infrastructure for different modes of shared mobility (i.e. bikeshare stations, carshare parking spots, specified curb zones for TNC, microtransit, and rideshare drop-off and pick-up). Charging rental fees in exchange for implementation of infrastructure that that will alter the existing station conditions can become a method to generate revenue. Partnerships paying for these physical implantations (suggesting one-time construction and regular rent) can potentially become a "stable" or "continuous" source of income.

For example, Caltrain's Final Environmental Impact Report (FEIR) establishes that 23% of riders access the Caltrain by car. While not all stations have parking lot capacity, those that do have parking have varying levels of occupancy that range anywhere from 3-100%. Those stations with low occupancy can potentially house one-way carsharing vehicles and, in turn, increase station accessibility as well as profit from renting these parking spaces to shared mobility agencies.

*Refer to **Table A.4** for FEIR 3.14-11. Parking Capacity and Average Weekday Occupancy at Caltrain Station Lots (2012[43])*

QUESTIONS AND POTENTIAL CONCERNS
Despite the potential benefits shared mobility can provide to transit operators, many of these services are still very new. Questions and concerns regarding their business practices and potential relationships to transit remain to be addressed. These issues primarily center on equity and accessibility, sustainability of services, and labor and safety.

Equity and Accessibility
As shared mobility services play an increasingly important role in providing mobility, publicly provided services may retract in response and those resources may otherwise go towards providing services through private shared mobility providers. This raises the concern that equitably provided public services may erode in relation to private forms of shared mobility services that may possibly conduct operations in non-inclusive ways. Non-inclusivity includes but is not limited to inability to the following:

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41 "Split Fare," Uber.
42 Shared-Use Mobility Center, Shared-Use Mobility, [36].
43 Peninsula Corridor Joint Powers Board, 3.14 Transportation and Traffic, [27].

physical disabilities that prevent riders from using shared mobility vehicles (i.e. wheelchair access, etc.); inability to access mobile reservations because riders may not own a smartphone with application capabilities or be able to afford data usage on their mobile phones without WiFi[44]; difficulty in affording the cost of using shared mobility vehicles on a regular basis without a subsidy to aid low-income riders dependent on public transit resources.

This highlights the issue of prioritizing concerns and whether cutting back from one sector to promote another might leave people in critical need hanging in the middle with no services they can afford or depend on. Most importantly, inter-regional blend and geographic limitations of service must be considered if it is a goal to promote a fair distribution of resources and access so that populations are not being singled out due to geographic locations. As it stands, not all modes of shared mobility are available within cities, let alone in consist coverage between counties and regions. Since some drivers of shared mobility modes essentially choose the areas they wish to serve, regulation would need to distribute drivers more evenly to prevent one location from being underserved and prompting "surge fares", making it more unaffordable for these populations.

Sustainability of Services
It is too early to predict the longevity and benefits of some shared mobility business models. The *Shared-Use Mobility Center Reference Guide* points out that "benefits analysis requires controlled experiments that compare transportation behavior with and without shared-use modes…but there have been issues with privacy concerns and companies wanting to protect their competitive advantages"[45]. Transit agencies should exercise caution when entering into partnerships with companies that do not have proven business models or a guarantee of operation in the future. It is crucial to know the sustainability of shared mobility business models so that these potential partners do not suddenly fail, bankrupt, or disappear once they expend their initial investments.

Without voluntary transparency on the side of the shared mobility companies, there is a definite risk of infringing on legal boundaries and procurement regulations. Some shared mobility services may impede on other, existing services. For example, designated taxi and shuttle curb spaces at Caltrain stations may become grounds for competition between TNCs and microtransit vehicles. This can not only increase traffic at already busy intersections but also increase safety concerns for pedestrians and bicyclists trying to share the space with these vehicles.

Labor and Safety
An important aspect of consideration is whether shared mobility organizations conform to fair labor practices and policies. Conducting business with government entities is complicated due to issues of compliance and mainstreaming shared mobility services. Currently, many shared mobility services are not heavily controlled and would require regulation to "[ensure] public safety, adequate insurance, and fair labor practices, depending on the service model"[46]. These tie back to the issue of transparency and maintenance that all workers are provided with proper pay and protection. The questions for Caltrain to consider are whether it would be promoting the labor practices of certain modes of shared mobility and how its partnership will affect its public image and relationship with existing employees.

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44 Caltrain stations and trains currently do not have available WiFi.
45 Shared-Use Mobility Center, Shared-Use Mobility, [15].
46 Shaheen et al., Shared Mobility: Definitions, Industry, [18].

NEXT STEPS

In order to adequately assess if shared mobility is indeed a viable option to complement the goals and efforts of Caltrain, more research must be done to analyze ridership usage, explore variability within subsets of shared mobility modes, and understand the utility of services that Caltrain customers desire and need. This includes refining the means by which Caltrain survey data is collected and distilled, evaluating and comparing individual agencies' membership benefits and offers, and addressing long and short-term infrastructure and operational improvements for customer satisfaction.

CONCLUSION

Shared mobility is a recent advancement in private and public-private modes of transit and has the opportunity to greatly impact transportation development. The benefits of potential partnerships and interaction with these various modes of shared mobility highlight improvements in Caltrain's relationships with first- and last-mile connections and blending transit options, easing peak commute hours and traffic congestion, seamless integration of mobile application, flexibility of accessibility and back-up modes of travel, and advertising and income generation. However, some of the parameters of concern with these potential partnerships correlate to equitable accessibility, system integration, and investment choices. As *Shared Mobility: Definitions, Industry Developments, and Early Understanding* suggests, "it is worth exploring what role shared mobility could play in meeting the targets [of] accessibility and livability score as performance metrics and whether shared mobility could be more directly tied to many of the State's energy and environmental policies"[47]. In the meantime, more research must be done to gather performance data in distinguishing whether shared mobility is indeed a viable option to complement the goals and efforts of Caltrain.

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47 Shaheen et al., Shared Mobility: Definitions, Industry, [4].

APPENDIX

Table A.1
CONNECTING TRANSIT ROUTES | BUSES AND LIGHT RAIL

CALTRAIN STATION	BUSES AND LIGHT RAIL
San Francisco	Muni 10, 30, 45, 47, 80X, 21X, 82X, 83X, N-Judah, T-Third, E-Embarcadero (weekends only)
22nd Street	Muni 22*, 48, T-Third*
Bayshore	Muni 8AX*, *BX*, 8X*, 9*, 9L*, 56*, T-Third*, Sam Trans 292*
South San Francisco	SamTrans 38*, 131*, 133*, 292*, 397*
San Bruno	SamTrans 140, 141, 398
Millbrae Transit Center	SamTrans ECR*, 397, BART
Broadway	SamTrans ECR*, 292, 397*
Burlingame	SamTrans ECR*, 292, 397*
San Mateo	SamTrans 250, 252, 292*, 295
Hayward Park	SamTrans ECR*, 292*, 397*
Hillsdale	SamTrans ECR, KX*, 250*, 251*, 256*, 292*, 294*, 295*, 397*, 398*, AC Transit M*
Belmont	SamTrans ECR, KX, 260, 261, 397, 398
San Carlos	SamTrans ECR, KX, 260, 261, 295, 397, 398, FLX San Carlos
Redwood City	SamTrans ECR, KD, 270, 274, 275, 276, 278, 296, 297, 397, 398
Atherton	SamTrans ECR*
Menlo Park	SamTrans ECR*, 286, 296
Palo Alto	SamTrans ECR, 280, 281, 297, 397, VTA 22, 35, 522, Marguerite Shuttle, Dumbarton Express, AC Transit U
California Avenue	VTA 22*, 89, 522*, Marguerite Shuttle, Dumbarton Express*
San Antonio	VTA 32, 34*, 35, 40*
Mountain View	VTA 34, 35, 51, 52, light rail
Sunnyvale	VTA 32, 53, 54, 55, 304
Lawrence	N/A
Santa Clara	VTA 10, 22, 32, 60, 81, 522
College Park	VTA 22*, 61*, 62*, 522*
San Jose Diridon	VTA 22, 63, 64, 65, 68, 81*, 181, 522, DASH, light rail, SCMTD Highway 17, MST 55
Tamien	VTA 25, 82, light rail
Capitol	VTA 66, 68, 304
Blossom Hill	VTA 42
Morgon Hill	VTA 16*, 68*, 121, 168, MST 55
San Martin	VTA 68, 121, 168
Gilroy	VTA 14, 17, 18, 19, 68, 121, 168, San Benito Transit, MST 55

* Transit stop is within walking distance of station (routes not noted with an * stop at station)
Note: Stanford Station omitted due to availability only during football games

Table A.2
CONNECTING TRANSIT ROUTES | COMMERICAL, LONG-DISTANCE EXPRESS BUSES

STATION	EXPRESS BUSES	ADDRESS/LOCATION
San Francisco	Megabus*	Townsend Street near the intersection of 5th Street (between 5th Street and 4th Street)
	Greyhound**	200 Folsom Street, San Francisco, CA 94105
San Jose Diridon	Megabus*	Crandall Street between Cahill Street and South Montgomery Street across from the train station
	Greyhound**	70 South Alameda Avenue, San Jose, CA 95113
Gilroy	Greyhound	7250 Monterey Street, San Jose, CA 95020

* Megabus arrival/departure stations are located on the Caltrain station premises
** BoltBus shares the same arrival/departure stations as Greyhound

Table A.3
CONNECTING TRANSIT ROUTES | SHUTTLES

CALTRAIN STATION	SHUTTLES
San Francisco	Bayshore/Brisbane Commuter Shuttle Bayshore/Brisbane Senior Shuttle Crocker Park Shuttle*
22nd Street	N/A
Bayshore	N/A
South San Francisco	Oyster Point Shuttle* Oyster Point Ferry Shuttle Utah-Grand Shuttle* Utah-Grand Ferry Shuttle
San Bruno	Bayhill San Bruno Shuttle
Millbrae Transit Center	Broadway-Millbrae Shuttle Burlingame Bayside Area Shuttle North Burlingame North Foster City Shuttle Genentech Shuttle Sierra Point Shuttle
Broadway	Broadway-Millbrae Shuttle
Burlingame	N/A
San Mateo	N/A
Hayward Park	N/A
Hillsdale	Belmont-Hillsdale Shuttle Campus Drive Shuttle Lincoln Centre Shuttle Mariners Island Shuttle Norfolk Shuttle Oracle Shuttle Redwood City Bayshore Technology Park
Belmont	Belmont-Hillsdale Shuttle

San Carlos	Electronic Arts Shuttle Oracle Shuttle Redwood Shores (Clipper) Shuttle Redwood Shores Twin Dolphin Area Shuttle (formerly Bridge Park Area Shuttle)
Redwood City	Pacific Shores Shuttle RWC Midpoint Shuttle Seaport Centre Shuttle
Atherton	N/A
Menlo Park	Marsh Road Shuttle Menlo Park Midday Shuttle Willow Road Shuttle
Palo Alto	East Palo Alto Community Shuttle Embarcadero and Crosstown Shuttles Stanford Marguerite Shuttle
California Avenue	Stanford Marguerite Shuttle
San Antonio	N/A
Mountain View	City of Mountain View Community Shuttle Duane Avenue Shuttle Mary-Moffett Shuttle MVgo Shuttle North Bayshore Shuttle Shoreline Shuttle
Sunnyvale	N/A
Lawrence	Bowers-Walsh Shuttle Duane Avenue Shuttle Mission Shuttle
Santa Clara	N/A
College Park	N/A
San Jose Diridon	Tamien/S.J. Diridon Weekend Shuttle
Tamien	Tamien/S.J. Diridon Weekend Shuttle
Capitol	N/A
Blossom Hill	N/A
Morgon Hill	N/A
San Martin	N/A
Gilroy	N/A

* A valid shuttle pass is required for this route. For more information, call Alliance: 650.588.8170
Note: Stanford Station omitted due to availability only during football games

Table A.4
CALTRAIN FINAL ENVIRONMENTAL IMPACT REPORT (FEIR)
3.14-11. PARKING CAPACITY & AVERAGE WEEKDAY OCCUPANCY AT CALTRAIN STATION LOTS (2012)

Station[a]	Caltrain Parking Lot Available (Yes/No)	Parking Capacity (Number of Parking Spots)	Average Daily Parking Occupancy
4th and King	No	--	--
22nd Street	No	--	--
Bayshore	Yes	38	13%
South San Francisco	Yes	74	51%
San Bruno	Yes	170	22%
Millbrae	Yes	490[b]	80%
Burlingame	Yes	69	30%
San Mateo	Yes	42	20%
Hayward Park	Yes	210	3%
Hillsdale	Yes	513	86%
Belmont	Yes	375	20%
San Carlos	Yes	207	32%
Redwood City	Yes	553	46%
Menlo Park	Yes	155	33%
Palo Alto	Yes	350	87%
California Avenue	Yes	169	31%
San Antonio	Yes	193	33%
Mountain View	Yes	336	97%
Sunnyvale	Yes	391	100%
Lawrence	Yes	122	30%
Santa Clara	Yes	190	62%
College Park[c]	No	--	--
San Jose Diridon	Yes	576	99%
Tamien	Yes	245	98%

Source: Appendix D, *Transportation Analysis*
[a] Stations with Baby Bullet service are displayed in **bold**.
[b] There are approximately 2,980 spaces in shared parking with BART and the lot is 80% utilized, leaving approximately, 640 available spaces. This analysis assumes that 50% of those spaces (320 spaces) are available for Caltrain riders.
[c] There is no Caltrain lot at the College Park station. Parking is on the street. Given limited ridership and no plans to change service levels, parking demand was not evaluated at this location.

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