

CalShuttle - The Future of Bay Area Transit

A summary of a 65-page study at www.knowledgewise.com

Shared Autonomous Vehicles (SAVs)



GM Cruise Origin.

(Image Courtesy of Cruise LLC = <https://www.getcruise.com/technology/>)



Amazon-owned Zoox Robotaxi.

(Image courtesy of Zoox = <https://zoox.com/vehicle/>)

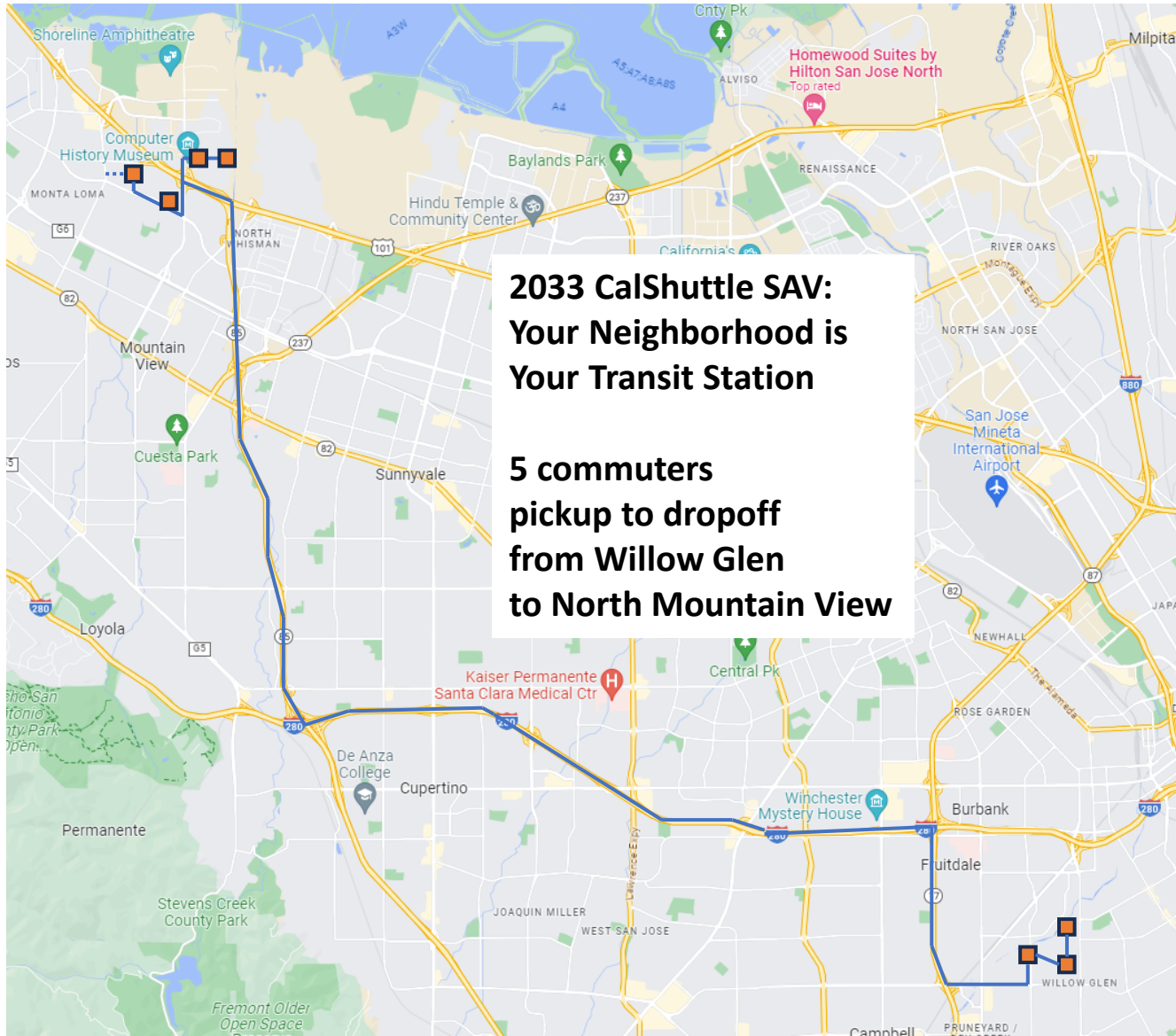


Presto driverless shuttle at Bishop Ranch spring 2023.

(Image courtesy of Contra Costa Transit Authority -

<https://patch.com/california/sanramon/bay-areas-first-autonomous-shuttles-debut-bishop-ranch>)

1. 2033: Your Neighborhood is your Transit Station



[Google Maps]

2. CalShuttle: On-demand, point-to-point, fast, 24-hour shuttle rapid transit

2.1 On-demand

Passengers request travel from one location to another. Algorithms gather riders with similar routes.

2.2 Point-to-point or pickup-to-dropoff locations within 2 blocks of start and destination

First-mile / last-mile is built in.

2.3 Fast

SAVs reduce vehicles on the road and congestion. Connected SAVs minimize acceleration reaction lag.

2.4 24-Hour Availability

Without human drivers, service will be available 24/7.

2.5 Safe travel

SAVs will eliminate human driver fatigue, distraction, or medical incidents.

Algorithms will avoid other vehicles, pedestrians, bicycles, and animals as well as human drivers do.

2.6 Resilient

SAVs will automatically route around accidents or roadways damaged in disasters.

Batteries and fuel-cells will enable operations to continue for a period of time.

2.7 Robustly Redundant

SAVs will automatically select among multiple routes, accounting for traffic conditions.

When a Shuttle breaks down, a replacement Shuttle will quickly pick up the passengers to continue.

2.8 Scalable Down and Up

As demand varies due to weather, disease, holidays, seasons, and other factors, service availability will automatically scale to match the demand.

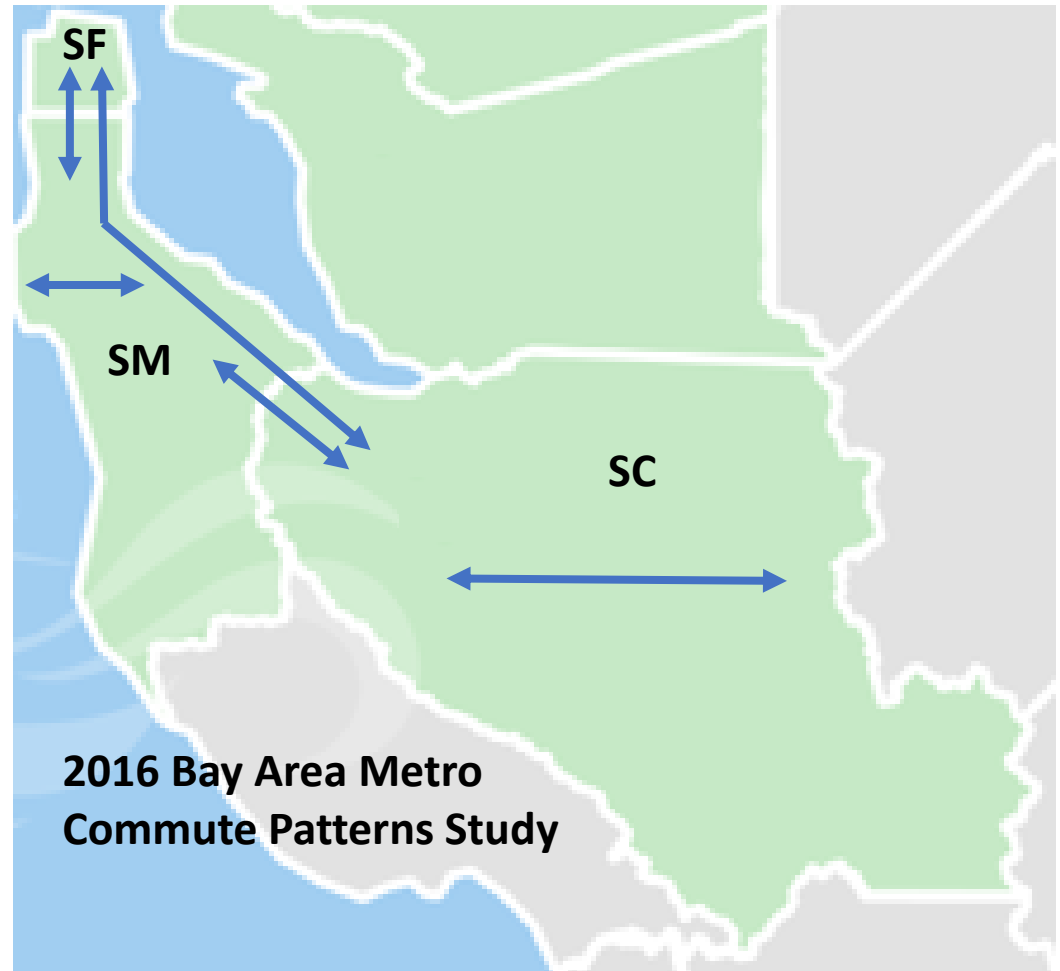
3. CalShuttle Impacts

The travel scope of this analysis includes these Counties:

- San Francisco to and from San Mateo
- San Francisco to and from Santa Clara
- San Mateo to and from Santa Clara
- Within San Mateo
- Within Santa Clara

Travel within densely-populated San Francisco is excluded. The assumption is that travel entirely within San Francisco will continue to be serviced by San Francisco Muni buses and light rail / trolleys, taxis, and other existing means of transportation.

Based on the 2016 Bay Area Metro Study:
Vital Signs: Commute Patterns - Bay Area
<https://data.bayareametro.gov/dataset/Vital-Signs-Commute-Patterns-Bay-Area/c33n-96bi>



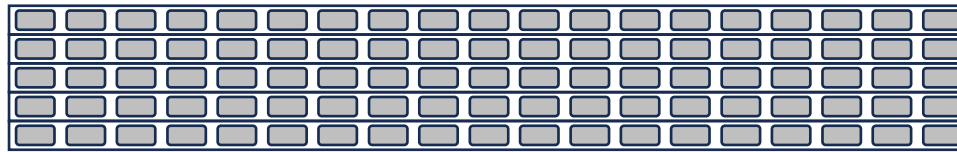
Base Map Courtesy of
San Francisco Bay Area Hispanic Chamber of Commerce
<https://www.sfbayhcc.com/>

3. CalShuttle Impacts

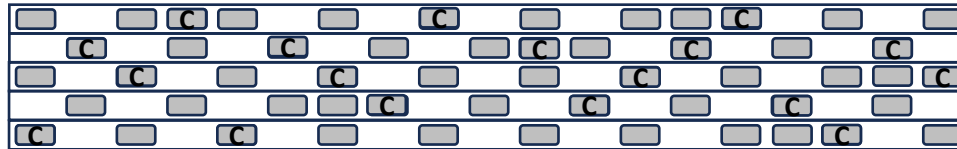
3.1 Reduces vehicle traffic counts, traffic congestion, and energy usage.

31,444 Shuttles will reduce commute periods vehicles on the road by 46% or 498,000 vehicles, thereby reducing traffic congestion.

2016 Rush Period Traffic: 100 commuter vehicles



**2033 Rush Period Traffic: 54 commuter vehicles
Including 18 CalShuttle SAVs**



3.2 Minimizes infrastructure costs through reuse of existing street network.

Our Bay Area streets, expressways, and highways will become our transit network – like subways just not underground, without having to change trains, and departing and arriving close to any destination.

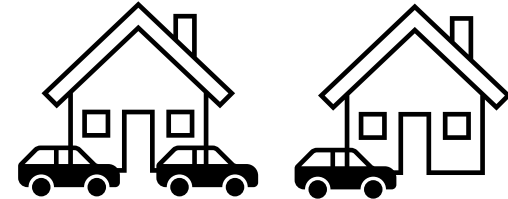
3.3 Eliminates the need for more highway or bridge construction.

For example, a new Southern Crossing bridge from Highways 380 to 238 would not longer be needed.

3. CalShuttle Impacts

3.4 Reduces or eliminates family car ownership cost.
Families' private automobile ownership cost savings:
\$4.75 billion per year

**Many families will downsize to
1 or no cars that they own**



3.5 Reduces passenger and pedestrian injuries and death.
Reduces the 90% of accidents that are caused by human error.

3.6 Improves mobility for our older and disabled residents.
Point-to-point, 24/7, affordable service.

3.7 Enables converting street parking spaces, parking lots and garages to other uses.
Wider sidewalks, bike lanes, housing, and others.



[Google Maps]

3.8 Eliminates the need and cost for corporate shuttle buses.

3.9 Enables productive activities or resting while shuttling.

4. CalShuttle Agency and Private Vendor Shuttles

Private vendors purchase, own, operate, and maintain the SAVs. Likely companies could include:

- On-demand rideshare companies like Uber, Lyft;
- Traditional rental-car companies like Hertz, Avis, National, Alamo, Budget;
- Automobile companies such as Ford, GM, and Tesla.

CalShuttle will be a three-county agency arranging and providing services.

- Akin to an airport like SFO does for airlines but with different and fewer services.
- San Francisco MTA, San Mateo SamTrans, and Santa Clara County VTA will jointly operate this agency.

CalShuttle duties will include:

- Construct and maintain electric and hydrogen charging stations at locations throughout the three counties.
- Manage interoperability among shuttle operation companies [Chan2012a].
- Monitor the shuttle providers to assure that their algorithms achieve the target rush period passenger load.
- Monitor the shuttle fleets to assure sufficient accessible support for disabled passengers.
- Manage fare subsidies for various groups, where applicable: low-income, disabled, seniors, students.

Charging stations will be automated with one or more technologies, so no human will need to be involved:

- A retractable arm connecting to a charging port at a standard location of the side of each Shuttle.
- A retractable post connecting to a charging port at a standard location on the bottom each Shuttle.
- Wireless charging through coils mounted in the ground below the charging lane.

5. Cost-Effective Implementation and Operation

Capital Costs – fully paid for by private shuttle operators

SAV shuttles:	\$2.5B	
Chargers and stations:	<u>\$0.4B</u>	Initially paid for by CalShuttle, but reimbursed over time by operators
Total:	\$2.9B	

Operational Costs and Fares

- Eliminates the driver labor costs that comprise 80% of per-mile cost [Shetty202a].
- Spreads operational costs across multiple passengers and trips.
- As with any EV, Shuttles reduce energy costs. [VanderWerp2021a]

100 per cent fare recover is possible with the following parameters:

- 31,444 CalShuttle-administered, private vendor-operated Shuttles.
- 432.3 million annual passenger trips.
- 143.5 million annual Shuttle trips.
- 20.3 mile average Shuttle trip distance.
- 3.4 average Shuttle passenger load per trip: 4 during commute periods, fewer other times.
- \$2.30 fare per Shuttle passenger, which equals \$0.11 per passenger mile for a 20.3 mile trip.

Vendor-operated Shuttles cover all costs for:

- SAV Shuttle operations.
- CalShuttle charging stations and office operations.
- CalShuttle capital equipment costs, paid back over time.

No ongoing government subsidy is required, except possibly for special classes of passengers such as: low-income; students; seniors; and special assistance shuttles with ramps.

6. CalShuttle - The Future of Bay Area Transit

6.1 Shared Autonomous Vehicles for transit should happen.

- Improved service.
- Financial and other beneficial impacts.
- Reduced government capital and operational costs.

6.2 Shared Autonomous Vehicles for transit will happen.

- On-demand, point-to-point model is already popular.
- Many commuters already "share" transit: carpool, bus, light rail, CalTrain and Altamont.

6.3 The beginnings of a Bay Area-wide network.

- CalShuttle services will grow organically beyond the 3-county confines of this study.
- First expansions would likely be across the San Mateo and Dumbarton bridges.

6.4 Even longer distances.

- CalShuttle would expand to more distant popular destinations: Sacramento, Monterey, Sierras, Bakersfield.
- Businesspeople and families could make effective use of time for such 2-to-4-hour trips.

6.5 Timeframe: Early 2030s.

- Predictions for AV maturity range from now (2023) to many decades hence.
- This study arrived at: 2030 for Level 5 fully autonomous operation plus 3 years for 65 percent acceptance.

6.6 Parallels the automobile revolution in the early 1900s.

7. Changes in Government Approaches: Cost Savings

Cost avoidance savings:

	Potential Cost Avoidance Savings	Taxpayer
		\$Billion
Entity	Item	Savings
Caltrain	Grade Separations	\$10.2B
Caltrain	DTX	\$6.7B
Caltrain	Dumbarton	\$2.4B
VTA	BART Extension	\$12.2B
	Savings	\$31.5B

- **Caltrain grade separations might no longer be necessary ...**
 - If Caltrain Corridor traffic reduces to just CA HSR, event trains, and freight traffic.
- **Caltrain DTX might no longer be necessary ...**
 - If most commuters and travelers use CalShuttle SAVs.
- **Caltrain Dumbarton Extension would no longer be cost-effective ...**
 - When most commuters use CalShuttle SAVs across the Dumbarton Bridge.
- **VTA BART Extension would no longer be cost-effective ...**
 - If most commuters and travelers use CalShuttle SAVs.
- **Operational cost savings ...**
 - On reduced Caltrain, SamTrans, and VTA commuter service.

7. Changes in Government Approaches: Questions

- **Should we suspend planning and arranging funding for ...**
 - **Caltrain grade separations, DTX, and the Dumbarton Corridor projects?**
- **Should we suspend planning and arranging funding for ...**
 - **the BART Santa Clara extension?**
- **Should we refocus city and county government attention on other issues, such**
 - **Housing**
 - **Police and fire department services**
 - **Water and power infrastructure**
 - **Supporting neighborhood retail businesses**

8. The Analysis and Your Questions

- **The Analysis**
 - 19 pages of narrative, summarized in this presentation.
 - 9 pages of arithmetic analysis tables (from the spreadsheet analysis). including the analysis parameters and algorithms.
 - One-half page of terminology and 26 pages of references.
 - 148-row arithmetic spreadsheet analysis.
 - Available for review at <https://www.knowledgewise.com>
- **Your Questions?**